DNB ENGINEERING, INC.
"One World, One EMC Solution"

REPORT OF
ELECTROMAGNETIC IMMUNITY and
ELECTROMAGNETIC INTERFERENCE

Per

EN 61326-1:2013

EN 61000-4-2:2009
EN 61000-4-3:2006+A1: 2006+A2:2010
EN 61000-4-4: 2012
EN 61000-4-5:2014
EC 61000-4-6:2014
EN 61000-4-8:2009
EN 61000-4-11:2010

NVLAP Lab Code 200634-0

EN55011Emissions Class A (2009)A1(2010)
Radiated Emissions
Conducted Emissions
EN 61000-3-2 Harmonics Current Emissions (2014)
EN 61000-3-3 Voltage Fluctuation and Flicker (2013)

EUT:
Quantum NXT DI Water Heater

PREPARED FOR APPLICANT:
Trebor
8100 South 1300 West
West Jordan, UT. 84088

REPORT #
UT76066A-001
Test Completion Date:
14 November 2016

Prepared By:
DNB ENGINEERING, INC.
1100 East Chalk Creek Rd.
Coalville, Utah 84017
Tel: 1(435) 336-4433

EXECUTIVE SUMMARY

The purpose of this series of tests was to demonstrate the Electromagnetic Compatibility (EMC) characteristics of the Quantum NXT DI Water Heater, the tests listed in the table below were used to show compliance to the requirements.

REQUIREMENTS	STATUS	COMPLIANT Yes/No/NA
EN 61326-1:	**Immunity**	**Yes**
EN 61000-4-2 ESD	@ 2,4,8kV Air @ 2,4kV Contact	**Yes**
EN 61000-4-3: Radiated Immunity	@ 10V/m, 80MHz—1000MHz, 3V/m 2.0-2.7 GHz 80% AM modulation	**Yes**
EN 61000-4-4 EFT	@ 2 kV Mains / DC @ 0.5 kV Signal,	**Yes**
EN 61000-4-5 SURGE	@ Mains / DC 1kV-L-L, 2kV L-G @ Signal Ports 0.5kV L-G	**Yes**
EN 61000-4-6 Conducted Immunity	@ 3Vrms, 0.15-80 MHz, 1 kHz 80% AM modulation	**Yes**
EN 61000-4-8 Magnetic Filed Immunity	@ 30A/m 50/60Hz	**Yes**
EN 61000-4-11 Voltage Dips & Variations	Not applicable for device rated over 16A	**N/A**
EN55011	**Emissions**	**Yes**
EN55011 Radiated Emissions	Class A	**Yes**
EN55011 Conducted Emissions	Class A	**Yes**
EN 61000-3-12 Current Harmonic Emissions	Not applicable for devices rated over 75A	**N/A**
EN 61000-3-13 Voltage Fluctuation & Flicker	Not applicable for devices rated over 75A	**N/A**

Signed By:

Clay Allred:
Facility Lab Manager
DNB Engineering Inc.
NVLAP Approved Signatory
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DOCUMENT HISTORY

Revision Letter	Number of Pages	Page No. of Rev.	Description	Date
-001	ALL	ALL	Documentation Release	19 Oct 2016

The latest revisions number noted above replaces all revisions issued prior to the release date indicated.

TABLE OF CONTENTS

CERTIFICATION OF TEST DATA

This report, containing electromagnetic immunity and emissions test data and evaluations, has been prepared by an independent electromagnetic compatibility laboratory, DNB ENGINEERING, Inc, in accordance with the applicable specifications and instructions required per the Introduction.

NVLAP Code: 200634-0

The data evaluation and equipment configuration presented herein are a true and accurate representation of the measurements of the test sample's electromagnetic immunity and emissions characteristics as of the dates and at the times of the test under the conditions herein specified.

Equipment Tested: QUANTUM NXT DI WATER HEATER

Test Completion Date: 14 November 2016

Report Reviewed By:

10/14/14

Clay Allred
Facility Lab Manager

Date

Report Written By:

10/14/14

Jessika Anderson
Report Writer

Date

1. INTRODUCTION

1.1 Administrative Data and Test Description

Applicant:	Trebor 8100 South 1300 West West Jordan, UT. 84088
Contact:	Cory Shorr
Phone:	801-634-9036
Test Completion Date:	14 November 2016
Equipment Under Test (EUT):	QUANTUM NXT DI WATER HEATER

1.2 Test Configuration

Where applicable, cables were routed consistent with the typical application by varying the configuration of the test sample. The effect of varying the position of cables was investigated to find the configuration that produced maximum emissions and susceptibility.

The EUT was evaluated to determine the “worst case” positioning of both cables and axis. Once the “worst case” configuration was determined care was used to maintain this configuration throughout the test.

1.3 Equipment Description

Ultra-pure, deionized water heater. Multiple, three phase voltages (208VAC, 400VAC, & 480VAC) and power combinations (20kW-216kW)

1.4 Mode of Operation

Normal Operation with 3 of the 4 heater branches disengaged and low temperature set point to keep power consumption down; however, 50% duty cycle was target to get maxim noise from SSRs

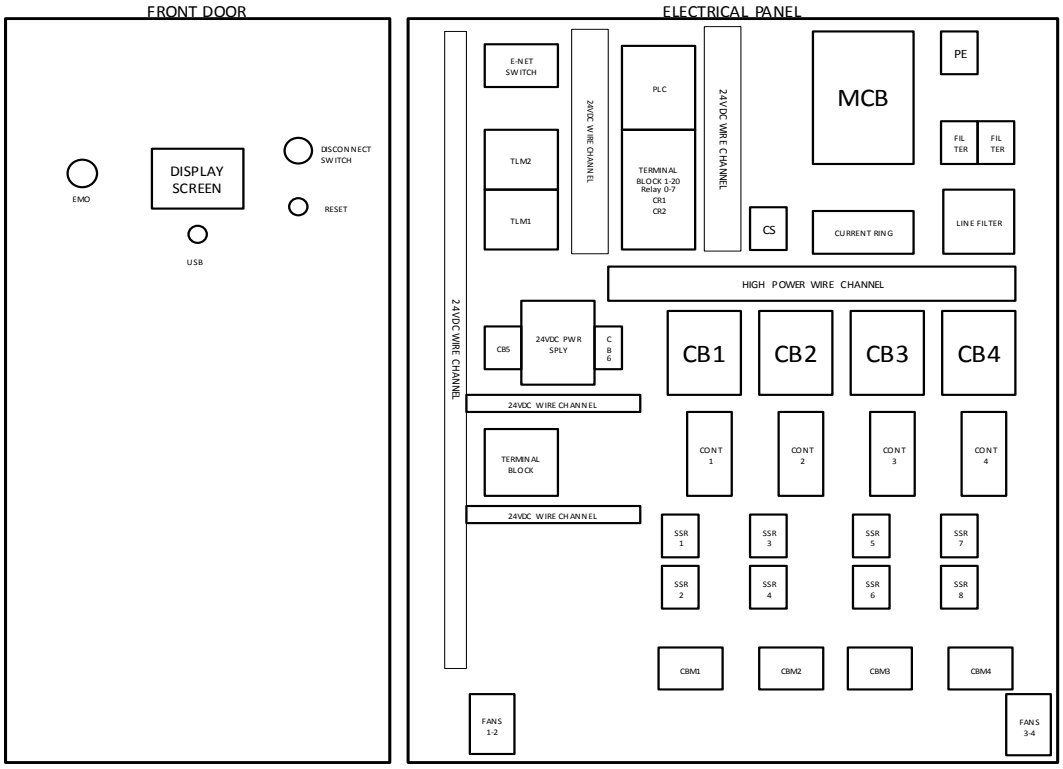
1.5 Test Voltage

480V 3 Phase, 175A

1.6 Immunity Performance Criteria

Perform to EMC standards, continue to operate without heater elements disengaging

1.7 Block Diagram



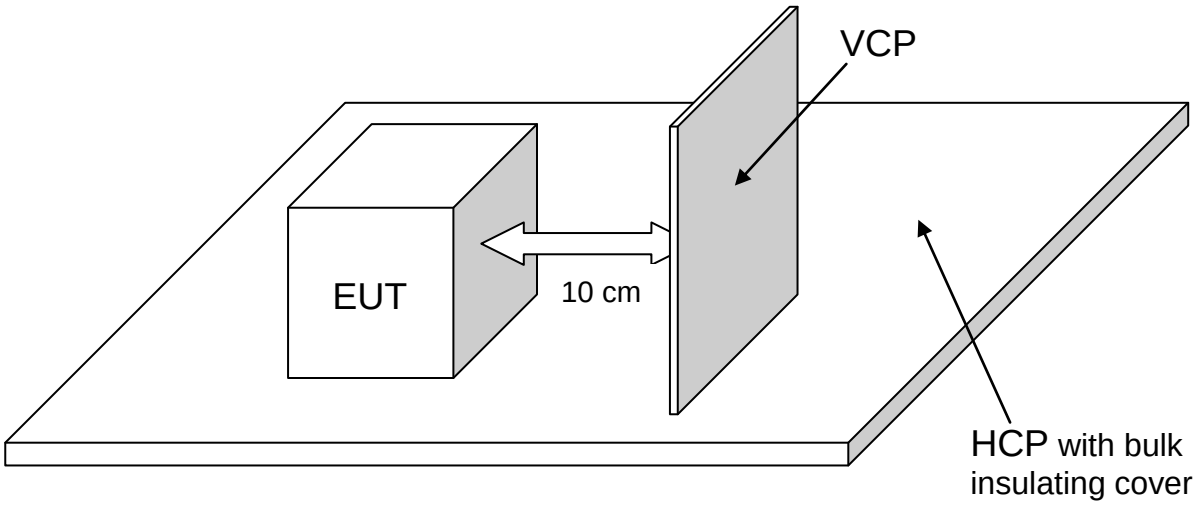
2. ELECTROSTATIC DISCHARGE (ESD) IMMUNITY EN 61000-4-2

2.1 Indirect Discharge Test Setup and Procedure

Indirect discharge is the application of the electrostatic pulse to a coupling plane in the vicinity of the EUT. This method simulates a personnel discharge to objects that are adjacent to the EUT.

The EUT was in the Mode of Operation as stated in Section 1.4 and setup in the testing room as shown below. The ESD pulses were applied to the coupling planes, of 2,4kV Contact for both positive and negative polarities. At least 10 single discharges were applied at each polarity and voltage.

2.1.1 Diagram of Test Setup



2.2 Indirect Discharge Test Results and Data

The EUT was evaluated for immunity to ESD per the performance criteria of Section 1.8. The unit tested did not exhibit any susceptibility to the indirect discharges of up to 2,4kV Contact.

VOLTAGE	PROBE LOCATION	TEST RESULTS
2,4kV Contact	Discharge to HCP (bottom side of EUT)	PASS
2,4kV Contact	Discharge to VCP (front side of EUT)	PASS
2,4kV Contact	Discharge to VCP (back side of EUT)	PASS
2,4kV Contact	Discharge to VCP (right side of EUT)	PASS
2,4kV Contact	Discharge to VCP (left side of EUT)	PASS

NOTES: 1. Positive and Negative polarity, indirect contact discharge.
2. VCP = Vertical Coupling Plane.
3. HCP = Horizontal Coupling Plane.
4. At least 10 discharges to each location.

2.3 DIRECT DISCHARGE METHOD

Test Setup and Procedure

Direct discharge is the application of the electrostatic pulse directly to points on the EUT. This method simulates a personnel discharge directly to the EUT. The EUT was subjected to the following electrostatic discharge (ESD) pulses:

Level and Type of Discharge	Discharge Polarity
2,4kV Contact	Positive/Negative
2,4,8kV Air	Positive/Negative

The ESD voltages were injected in the following two ways:

- **Direct Contact Discharge**

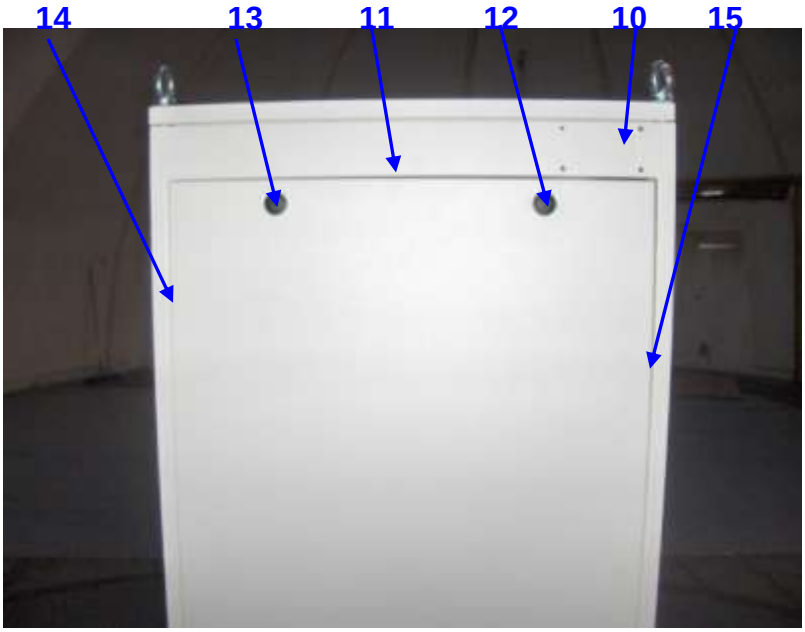
Direct contact discharge is a method of testing in which the electrode of the test generator is held in contact with the EUT and the discharge is actuated by the discharge switch in the generator.

- **Direct Air Discharge**

Direct air discharge is a method of testing in which the charged electrode of the test generator is brought close to the EUT and the discharge is actuated by a spark to the EUT.

The equipment was in the Mode of Operation as stated in Section 1.4 and set up as shown in Section 2.9 The ESD voltages were applied with positive and negative discharge polarity by discharges of 2,4kV Contact and 2,4,8kV Air. A minimum of 10 discharges was applied at each location as recorded in the data records.

2.4 Photograph of Test Points



2.5 Direct Discharge Test Results and Data

The unit tested operated within the stated performance criteria of Section 1.8, from discharges of up to 4kV Contact and discharges up to 8kV Air.

Ambient Temp	**21° C**	**Relative Humidity**	**32%**	**Atmospheric Pressure**	**102.6kPa**

X or A Normal Performance within specification limits.
B Temporary degradation or loss of function or performance, which is self –recoverable.
C Temporary degradation or loss of function or performance, which requires operator intervention or system reset.
D Degradation or loss of function, which is not recoverable due to damage of the equipment (components) or software, or loss of data.

# ↓	Injected Level																			
	Level 1				Level 2				Level 3				Level 4				Special			
	2KV Contact		2KV Air		4KV Contact		4KV Air		6KV Contact		8KV Air		8KV Contact		15KVAir					
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
1	X	X			X	X														
2			X	X			X	X			X	X								
3	X	X			X	X														
4	X	X			X	X														
5	X	X			X	X														
6	X	X			X	X														
7	X	X			X	X														
8	X	X			X	X														
9	X	X			X	X														
10	X	X			X	X														
11	X	X			X	X														
12	X	X			X	X														
13	X	X			X	X														
14	X	X			X	X														
15	X	X			X	X														
16			X	X			X	X			X	X								

Notes: 1. Positive and negative polarity, direct air discharge. 2. At least 10 discharges at each location.

EUT performed within the requirements of the applicable Standard(s) YES ☒ NO ☐ SIGNED Yancey Staples

2.6 Test Point Locations

1	Latch	2	ON/OFF Switch	3	Lifting Eye
4	Seam	5	Latch	6	Seam
7	Hinge	8	Seam	9	Seam
10	Screw Back of Unit	11	Seam Back of Unit	12	Latch Back of Unit
13	Latch Back of Unit	14	Seam Back of Unit	15	Seam Back of Unit
16	Display				

2.7 Measurement Uncertainty

Contributor	Distribution	Value	Comments
Expanded uncertainty U on rise time	Norma: k=2	65ps	As indicated on ESD simulator calibration certificate
Expanded uncertainty U on Peak Current	k=2	5.0%	As indicated on ESD simulator calibration certificate
Expanded uncertainty U on I30	Norma: k=2	5.6%	As indicated on ESD simulator calibration certificate
Expanded uncertainty U on I60	Norma: k=2	6.1%	As indicated on ESD simulator calibration certificate

2.8 Photographs of Test Setup EN 61000-4-2 ESD Immunity

EUT: Quantum NXT DI Water Heater
View: Test Setup

3. RADIATED RF IMMUNITY EN 61000-4-3

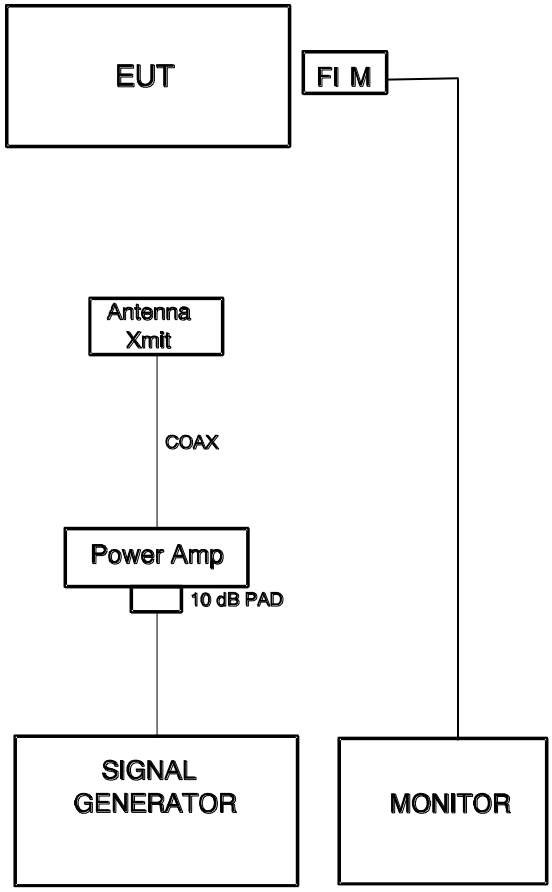
3.1 Test Setup and Procedure

The EUT was subjected to a modulated (Amplitude Modulation 1 kHz sine, 80%) RF Electric -Field over the frequency range of 80MHz-2700MHz at an E-field of 10V/m minimum

Using data taken from the most recent uniform Field calibration per EN 61000-4-3, An E-Field level of 10V/m was established with the EUT in the field. An E-Field sensor is used to confirm field presence. The E-Field was directed toward each side of the EUT. The frequency of the signal generator was discretely stepped over the range of 80MHz-2.7 GHz at an E-field of 10V/m minimum, with each step being 1% of previous frequency, while maintaining the E-field at & 3V/m

The EUT was in the Mode of Operation as stated in Section 1.4 and set up in the room along with the transmitting antenna as shown below. The isotropic E-field sensor, which measures the field strength, was set up level with the vertical radiated surface of the EUT. During application of the E-field, the EUT was operating and monitored for any performance degradation per Section 1.8.

3.1.1 Diagram of Test Setup



FIM - Field Intensity Monitor
1% steps for 2 seconds

3.2 Radiated RF Immunity Test Results and Data

The EUT operated within the stated performance criteria A of Section 1.8, when subjected to the E-field of 10V/m from 80-2700 MHz, Amplitude Modulation 1 kHz sine, 80%.

Ambient Temp: 19C	**Relative Humidity: 32%**	**Atmospheric Pressure 101.2kPa**	☐ **TEM Cell** ☒ **Antennas**

X or A Normal Performance within specification limits.
B Temporary degradation or loss of function or performance, which is self –recoverable.
C Temporary degradation or loss of function or performance, which requires operator intervention or system reset.
D Degradation or loss of function, which is not recoverable due to damage of the equipment (components) or software, or loss of data.

Antenna Faces ↓	EN 61000-4-3 and EN 61326								Notes:
	Level 1		Level 2		Level 3		Special		**480Vac 3Phase**
	1V/M		3V/M		10V/M				
	H	V	H	V	H	V	H	V	
Front			X	X					
Right			X	X					
Rear			X	X					
Left			X	X					
Top (1)									
Bottom (1)									

EUT performed within the requirements of the applicable Standard(s) YES ☒ NO ☐ SIGNED Yancey Staples

3.3 Measurement uncertainty

Contributor	Distribution	Value	Comments
Expanded uncertainty U (y) cal for Calibration Process.	Norma: k=2	0.97	Per EN 61000-4-3 annex J
Expanded uncertainty U (y) for level setting.	Norma: k=2	1.20	Per EN 61000-4-3 annex J

3.4 Photographs of Test Setup EN 61000-4-3 Radiated Immunity

EUT: Quantum NXT DI Water Heater
View: Test Setup

4. ELECTRICAL FAST TRANSIENT IMMUNITY EN 61000-4-4

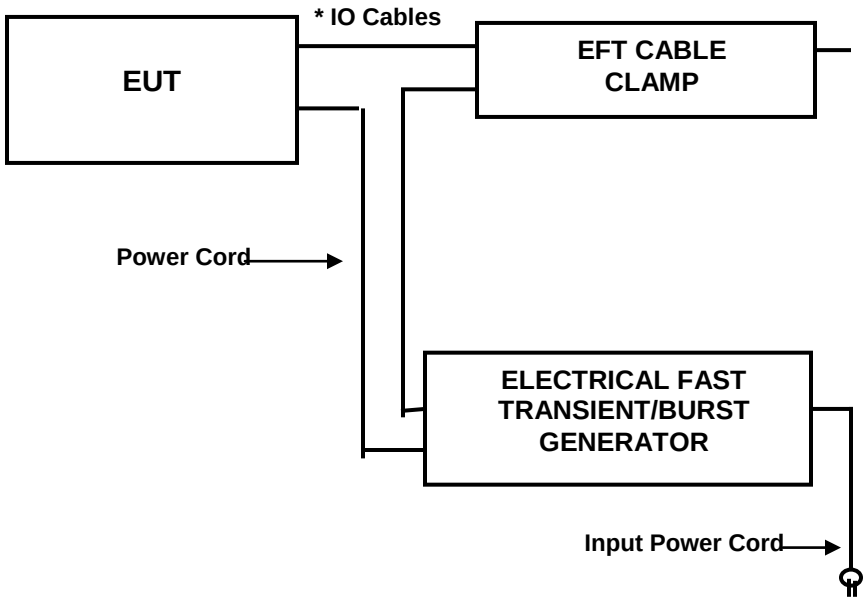
4.1 Test Setup and Procedure

This test is intended to demonstrate the immunity of the EUT to the types of transient interference, such as that originating from switching transients (interruption of inductive loads, relay contact bounce, etc.), that are coupled into the power supply or I/O cables from the power lines.

The EUT was subjected to transients injected in 15 ms bursts with repetition rates of 5 kHz onto the power lines.

The EUT was in the Mode of Operation as stated in Section 1.4 and set up and connected to the test equipment as shown below. The KeyTek EMC Pro Surge Generator was to provide positive or negative pulses with a rise-time of 5 ns and pulse width of 50 ns. The generator was triggered to produce a 15 ms burst of pulses at a 5 kHz repetition rate. The transients were injected for 1 minute onto the phase line (line 1), neutral line (line 2) and ground line with reference to protective earth ground. The EUT was monitored for malfunctions and equipment errors.

4.1.1 Diagram of Test Setup



*** Disregard EFT Cable Clamp if no IO cables were tested.**

4.2 EFT Immunity Test Results and Data

The EUT operated within the stated performance criteria of Section 1.8.

Ambient Temp	21° C	Relative Humidity	51%	Atmospheric Pressure	101.3kPa

X or A Normal Performance within specification limits.
B Temporary degradation or loss of function or performance, which is self –recoverable.
C Temporary degradation or loss of function or performance, which requires operator intervention or system reset. Degradation or loss of function, which is not recoverable due to damage of the equipment (components) or software, or loss of data.

	Input and Output AC Power Ports											Input and Output DC Power Ports									
	Level1		Level 2		Level 3		Level 4		Special			Level 1		Level 2		Level 3		Level 4		Special	
Cable	.5KV		1KV		2KV		4KV				Cable	0.25KV		0.5KV		1KV		2KV			
Description	+	-	+	-	+	-	+	-	+	-	Description	+	-	+	-	+	-	+	-	+	-
L					X	X															
N					X	X															
PE					X	X															
L-N					X	X															
L-PE					X	X															
N-PE					X	X															
L-N-PE					X	X															

	Process, measurement & control											I/O, signal, & data bus									
	Level1		Level 2		Level 3		Level 4		Special			Level1		Level 2		Level 3		Level 4		Special	
Cable	0.25KV		0.5KV		1KV		2KV				Cable	0.25KV		0.5KV		1KV		2KV			
Description	+	-	+	-	+	-	+	-	+	-	Description	+	-	+	-	+	-	+	-	+	-

Notes

EUT performed within the requirements of the applicable Standard(s) YES ☒ NO ☐ ***SIGNED Yancey Staples***

4.3 Measurement uncertainty

Contributor	Coverage Factor	Confidence (%)	Comments
Measurement Uncertainty	K-2	95%	As noted in the EFT simulator calibration certificate.

4.4 Photographs of Test Setup EN 61000-4-4 EFT Immunity

EUT: Quantum NXT DI Water Heater
View: Test Setup

5. SURGE IMMUNITY EN 61000-4-5

5.1 Test Setup and Procedure

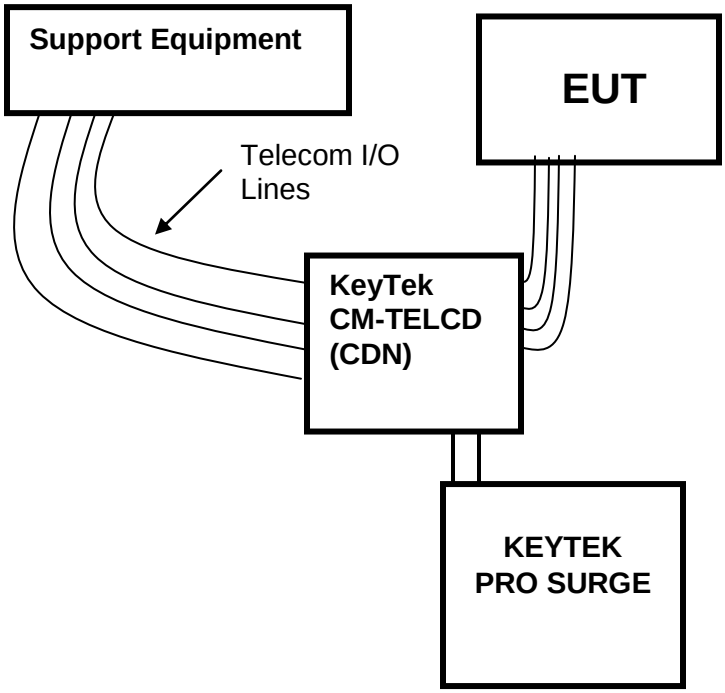
The EUT was in the Mode of Operation as stated in Section 1.4. It was subjected to surges applied line to line and line to earth. This method simulates unidirectional surges caused by over-voltages from switching and lightning transients.

5.1.1 Telecom / I/O Lines

Telecom and I/O lines are connected to the Coupling/Decoupling Network as shown below, with up to 4 lines (2 pair) connected at one time. The Coupling/Decoupling Network
Is then connected to the surge output of the KeyTek EMC Pro Surge Generator for the applicable waveform, (10/700µs or 1.2/50µs) and the applicable surge levels are then applied to the Lines under test. Either a Line-Line or Line-Ground Configuration is selected by adjusting the jumpers on the Coupling/Decoupling Network. Ten surges are applied, 5 positive and 5 negative with an interval between surges of one minute

5.1.2 Diagram of Test Setup

Surge Immunity Test



5.2 Surge Immunity Test Results and Data

The EUT operated within the stated performance in Section 1.6 to the surges at Mains 0.5 kV LL, 1 kV LG (line to line) or (line to earth).

Ambient Temp	26°C	Relative Humidity	37%	Atmospheric Pressure	102.2kPa

X or A Normal Performance within specification limits.
B Temporary degradation or loss of function or performance, which is self –recoverable.
C Temporary degradation or loss of function or performance, which requires operator intervention or system reset.
D Degradation or loss of function, which is not recoverable due to damage of the equipment (components) or software, or loss of data.

Cable Description	Common Mode (1.2/50, 8/20 Combination Wave 12Ohm)																											
	Level 1						Level 2						Level 3						Level 4						Special			
	0.5 KV						1.0 KV						2.0KV						4.0KV									
	L1-PE		L2-PE		L1-L2		L1-PE		L2-PE-		L1-L2		L1-PE		L2-PE		L1-L2		L1-PE		L2-PE		L1-L2		L1-PE		L2-PE		L1-L2	
	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-		-
AC Mains Phase 0°	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
AC Mains Phase 90°	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
AC Mains Phase270°	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												

Cable Description	Differential Mode (1.2/50, 8/20 Combination Wave 2 Ohm)									
	Level 1		Level 2		Level 3		Level 4		Special	
	0.5 KV		1.0 KV		2.0KV		4.0KV			
	L1+L2- [PE]		L1+L2- [PE]		L1+L2- [PE]		L1+L2- [PE]		L1+L2- [PE]	
	+	-	+	-	+	-	+	-	+	-

Notes: 1. One pulse per minute. 2. Five pulses each polarity. 3.LL refers to 'Line to Line, LG refers to 'Line to Ground'.

EUT performed within the requirements of the applicable Standard(s) YES ☒ NO ☐ ***SIGNED Jonathon Payne / Yancey Staples***

5.3 Measurement uncertainty

Contributor	Coverage Factor	Confidence (%)	Comments
Measurement Uncertainty	K-2	95%	As noted in the Surge simulator calibration certificate.

5.4 Photographs of Test Setup EN 61000-4-5 Surge Immunity

EUT: Quantum NXT DI Water Heater
View: Test Setup

6. RF CONDUCTED IMMUNITY EN 61000-4-6

6.1 Test Setup and Procedure

The EUT was subjected to RF electric fields over the frequency range of 0.15-80 MHz at an E-field of 3 Vrms. minimum.

RF energy from 0.15-80 MHz is injected onto the cables entering and leaving the EUT. All cables longer than 3 m shall be tested as well as the input power to the system, cable lengths normally shorter than 1m shall not need to be tested.

Systems comprised of two or more enclosures will be tested as if there are auxiliary and EUT enclosures until all enclosures are tested as the EUT, unless interconnecting cables are shorter than 1 m, in this case the system can be considered one unit.

The injection is accomplished in two modes;

1. Direct injection via a Coupling De-coupling Network (CDN).
2. Clamp injection via a current clamp.

6.1.1 Direct Injection

To set the test levels the CDN is placed in a test fixture that simulates the typical impedance of a power line as specified in EN 61000-4-6. A CW signal is generated in a RF synthesizer, passed through an amplifier into the CDN, and injected into the test fixture. The CDN output is then put into a spectrum analyzer to measure the V rms. on the output of the CDN and check for harmonic content.

A calibration level for the synthesizer output CW signal is recorded in 10% steps from 0.15-80 MHz. The calibration level is then used in conjunction with a computer to provide the proper injection voltage, frequency step, and time delay required for each test.

The EUT must be raised off the reference ground plane by 0.1 m, all cables must be raised by 3 cm to 5 cm. The test is setup with the CDN 0.1 m to 0.3 m from the projected geometry of the EUT and in line with power source. The AE port is positioned toward the mains supply, the EUT port is toward the EUT, and the input port is the RF input for the CDN. The CDN must be grounded to the reference ground plane.

Once the system is setup, with de-coupling networks on all the cables leading away from the system and cable sections before de-coupling networks and all interconnecting cables are raised off the ground plane, the test will proceed.

6.1.2 Clamp Injection

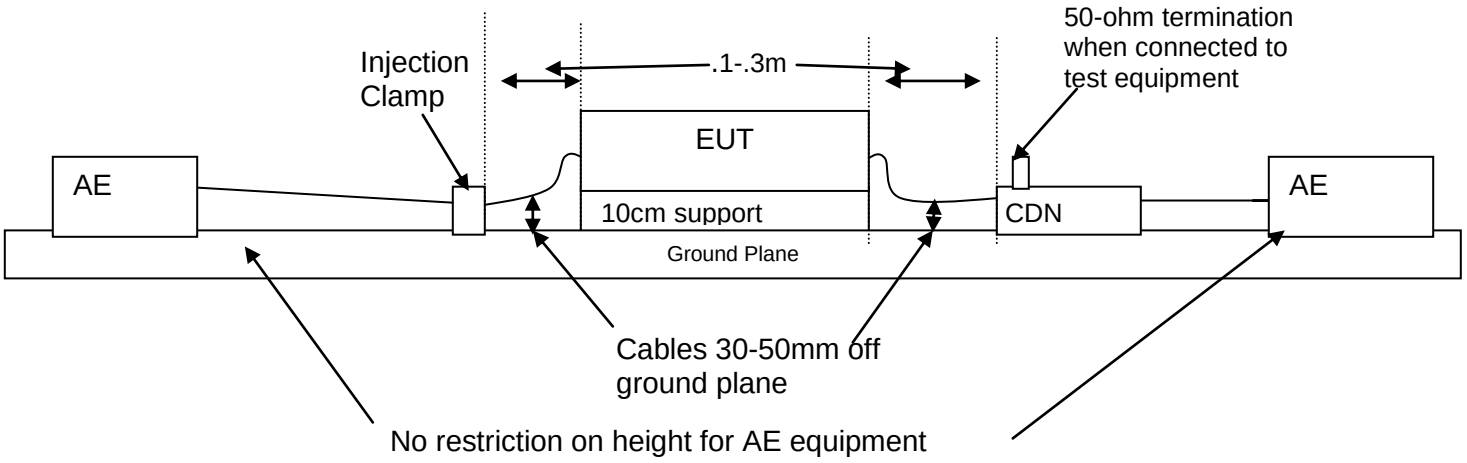
To set the test levels the Current Clamp is placed in a test fixture to simulate a cable passing through its center. A CW signal is generated in an RF synthesizer, then passed through an amplifier into the Clamp, and injected into the test fixture. The test fixture output is then put into a spectrum analyzer to measure the Vrms, on the test fixture and check for harmonic content. The end of the test fixture without the spectrum analyzer is terminated with the same impedance as the test fixture (50 ohms).

A calibration level for the synthesizer output CW signal is recorded in 10% steps from 0.150 to 80 MHz. The calibration level is then used in conjunction with a computer to provide the proper injection voltage, frequency step, and time delay required for each test.

The EUT must be raised off the reference ground plane by 0.1 m. All interconnecting cables must be raised by 3 cm to 5 cm. All cable sections before the de-coupling networks must also be raised 3 cm to 5 cm. The test is setup with the Current Clamp 0.1 m to 0.3 m from the EUT. The AE port (de-coupling network) is positioned toward the Current Clamp. The outside of the Current Clamp must be grounded to the reference ground plane. Cables that follow the same routing may be tested simultaneously. Cables that are routed via separate paths must be separated and tested individually.

Once the system is setup, with de-coupling networks on all the cables leading away from the system and cable sections before de-coupling networks and all interconnecting cables are raised off the ground plane, the test will proceed
The E-field will be coupled into each cable of the EUT. The cables of the EUT will be placed in the coupling device. The frequency of the signal generator will be discretely stepped over the range of 0.15-80 MHz, with each step being 1% of previous frequency, while maintaining the E-field at 3 Vrms. Each step will be delayed sufficient time to perform each function of the test routine.

6.1.3 Setup Diagram



6.2 RF Conducted Immunity Test Results and Data

The EUT was in the mode of operation as stated in Section 1.4 and operated within the stated performance criteria of Section 1.8, when subjected to the field of 3 Vrms. from 0.15-80 MHz.

Ambient Temp	**18° C**	**Relative Humidity**	**32%**	**Atmospheric Pressure**	**102.7kPa**

X or A Normal Performance within specification limits.
B Temporary degradation or loss of function or performance, which is self –recoverable.
C Temporary degradation or loss of function or performance, which requires operator intervention or system reset.
D Degradation or loss of function, which is not recoverable due to damage of the equipment (components) or software, or loss of data.

Cable Description	Input and Output AC Power Ports				Cable Description	Input and Output DC Power Ports			
	Level 1	Level 2	Level 3	Special		Level 1	Level 2	Level 3	Special
	1V	3V	10V			1V	3V	10V	
AC Mains		X							
Cable Description	Process, measurement & control				Cable Description	I/O, signal, & data buss			
	Level 1	Level 2	Level 3	Special		Level 1	Level 2	Level 3	Special
	1V	3V	10V			1V	3V	10V	

Notes:**480Vac 3Phase**

EUT performed within the requirements of the applicable Standard(s) YES ☒ NO ☐ ***SIGNED Yancey Staples***

6.3 Measurement uncertainty

Contributor	Distribution	Value	Comments
Expanded uncertainty U on CDN Level Setting Process (CAL)	Norma: k=2	1.67	Per EN 61000-4-6 Table G1
Expanded uncertainty U on CDN test process	k=2	1.947	Per EN 61000- 4-6 Table G2
Expanded uncertainty U on Current Clamp Level Setting Process (CAL)	Norma: k=2	0.86	Per EN 61000-4-6 Table G5
Expanded uncertainty U on Current Clamp test process	Norma: k=2	0.976	Per EN 61000-4-6 Table G6

6.4 Photographs of Test Setup EN 61000-4-6 RF Conducted Immunity

EUT: Quantum NXT DI Water Heater
View: Test Setup

7. POWER FREQUENCY MAGNETIC FIELD EN 61000-4-8

7.1 General Test Procedure

The following tests are intended to demonstrate the immunity of equipment when subjected to power frequency magnetic fields related to the specific location and installation condition of the equipment (e.g. proximity of equipment to the disturbance source). The power frequency magnetic field is generated by power frequency current in conductors or, more seldom, from other devices (e.g. leakage of transformers) in the proximity of equipment.

7.2 Test Set-Up and Procedure

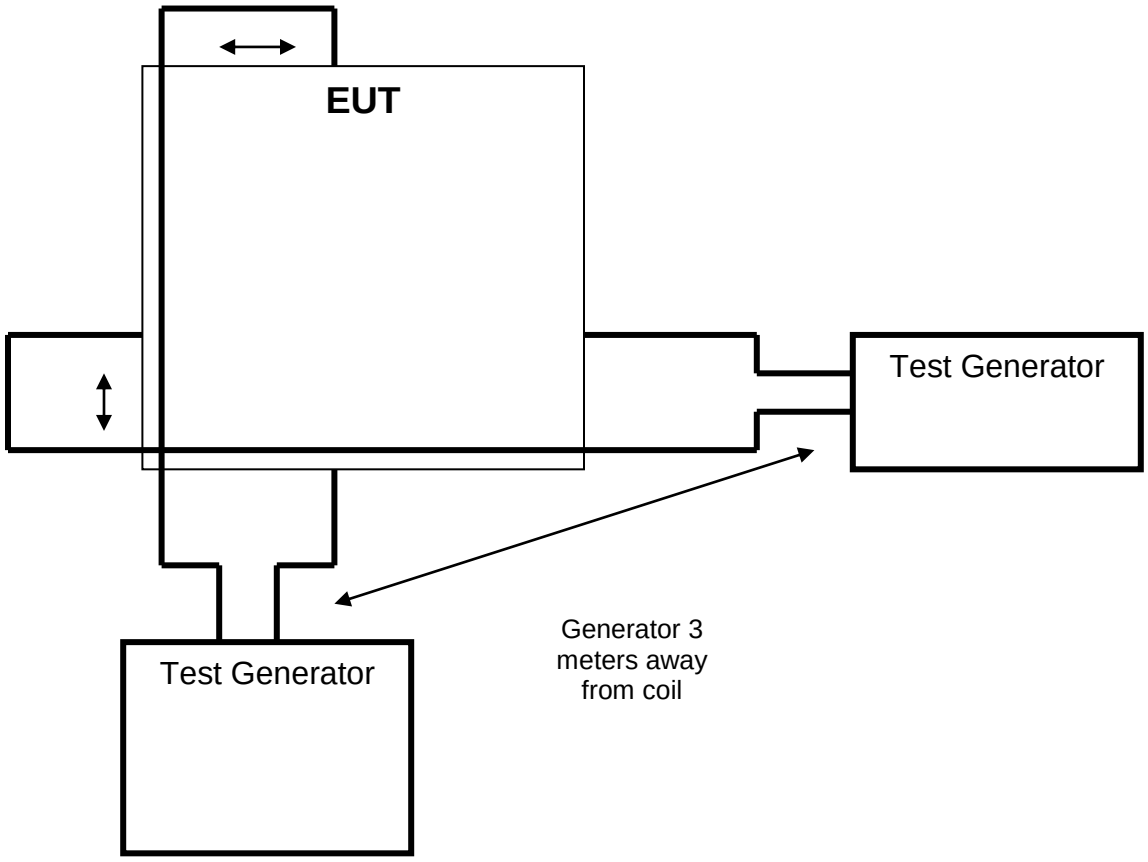
Preliminary verification of equipment performances shall be carried out prior to applying the test magnetic field.

The test magnetic field shall be applied by the immersion method to the EUT.

In order to make it possible to compare the test results from different test equipment, the induction shall be calibrated in their operating condition, before conducting the test (without the EUT, in free space condition) An induction coil of the correct dimensions for the EUT dimensions, shall be positioned at 1 m minimum distance from the wall of the laboratory and any magnetic material, by using insulating supports, and shall be connected to the test generator. Appropriate magnetic field sensors shall be used to verify the magnetic field strength generated by the induction coil. The field sensor shall be positioned at the center of the induction coil (without the EUT) and with suitable orientation to detect the maximum value of the field. The current in the induction coil shall be adjusted to obtain the field strength specified by the test level. The calibration shall be carried out at power frequency. The calibration procedure shall be carried out with the test generator and induction coil.

The equipment under test shall be configured and connected to satisfy its functional requirements. It shall be placed on the ground plane with interposition of a .1m thickness insulating support. The induction coil then shall be rotated 90° in order to expose the EUT to the test field with different orientations.

7.2.1 Diagram of Test Setup



7.3 Magnetic Field Immunity Datasheet EN 61000-4-8

PERFORMANCE CRITERA: (A) The apparatus shall continue to operate as intended. No degradation of performance or loss of function is allowed below a level specified by the manufacturer, when the apparatus is used as intended. In some cases the performance level may be replaced by a permissible loss of performance. If the minimum loss is not specified by the manufacturer then either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.	X or 0	Normal performance within specification limits.	Environmental Conditions	
	1	Temporary degradation or loss of function or performance which is self-recoverable.	**Temp C**	**15 - 35** **22**
	2	Temporary degradation or loss of function or performance which requires operator intervention or system reset.	**rH %**	**15 to 60** **32**
	3	Degradation or loss of function which is not recoverable due to damage of the equipment (components) or software, or loss of data.	**kPa**	**86 to 106** **101.7**

AC Power Frequency Magnetic Field

	Verification		Level 1		Level 2		Level 3		Level 4		Special		
	-20dB of 1A/m		1 A/m		3 A/m		30 A/m		100 A/m				
Freq In Hz --->	1.256637mG		12.56673mG		37.699112mG		376.991118mG		1.256637061G				EUT side
	50	60	50	60	50	60	50	60	50	60			
X-Axis	X	X	X	X	X	X	X	X					Front
Y-Axis	X	X	X	X	X	X	X	X					Left
Z-Axis	X	X	X	X	X	X	X	X					Rear
^ Loop Axis													Right
													Top
													Bottom

VERIFICATION CHECK

Place ELF meter in the center of the loop and verify that the level is 1.256637mG or lower. Check the appropriate box.

Notes:

EUT performed within the requirements of the applicable Standard(s) YES ☒ NO ☐ ***SIGNED Yancey Staples***

7.4 Measurement uncertainty

	Distribution	**Value**	**Comments**
Expanded uncertainty U on 30A/m (worse case)	k=2	0.175	Calculated per EN 61000-4-8

7.5 Photographs of Test Setup EN 61000-4-8

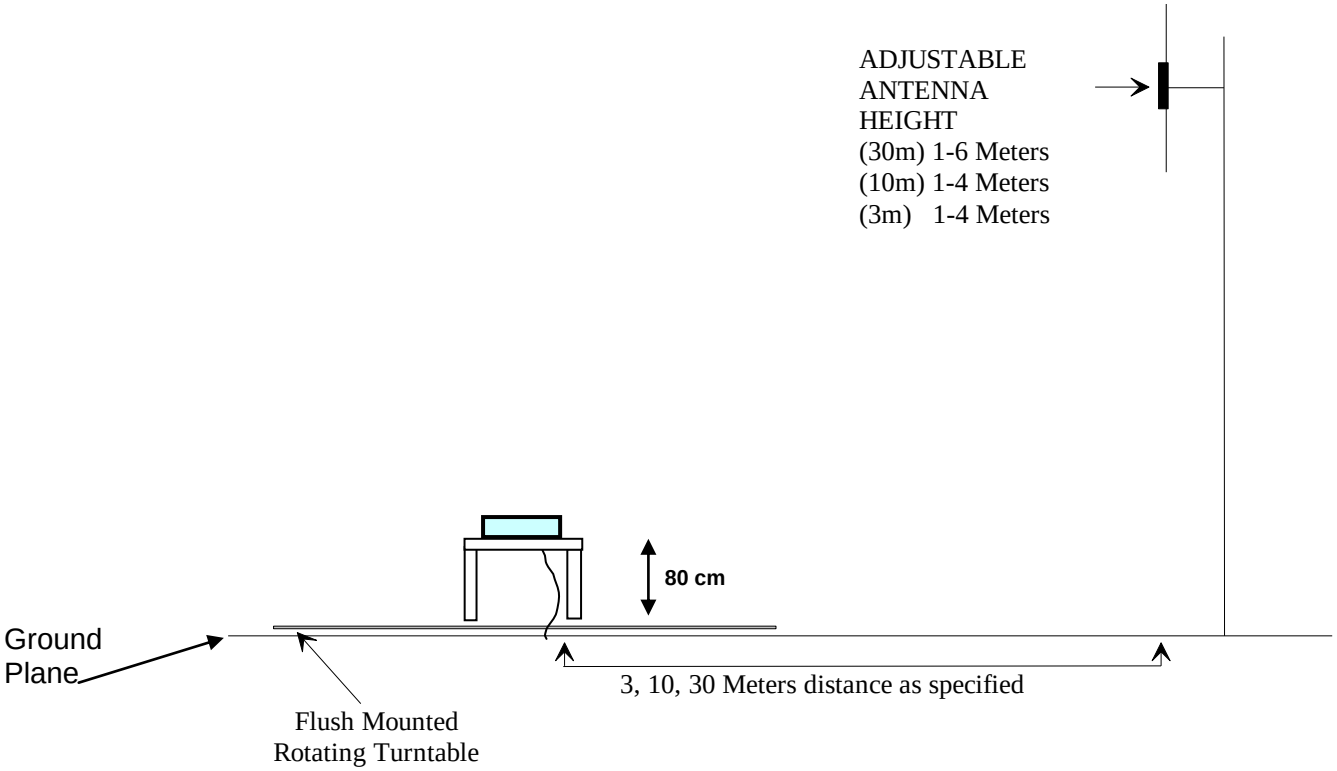
EUT: Quantum NXT DI Water Heater
View: Test Setup

8. RADIATED EMISSIONS EN55011 CLASS A

8.1 Test Setup and Procedure

The EUT was placed on a wooden table 80 cm above the flush mounted, steel-top turntable on the open area test site as shown below. The turntable can be rotated 360 degrees. Measuring antenna is set at the prescribed distance. Measurements are made with broadband antennas that have been correlated with tuned dipole antennas. The mast is 4.5 meters high and is self-supporting. The height of the antenna can be varied from 1 to 4 meters. Positioning of the antenna is controlled remotely.

Open Area Test Site



Radiated Test Setup and Procedure

The EUT is put into the operational test mode as stated in Section 1.4 it is then started.

The spectrum analyzer is setup to store the peak emission over the band of the antenna. Peak EUT and ambient emissions are stored while the turntable is rotated 360^0. The Peak spectrum analyzer trace is then plotted with the addition of antenna and cable correction factors. The limit is plotted on the same graph. A receiver with CISPR Quasi Peak capabilities is then used on the frequencies identified as the highest with respect to the plotted limit. Ambients are noted on the graph along with EUT emissions. The highest EUT frequencies, with respect to the limit, are maximized.

To maximize emissions levels, the turntable is rotated and the antenna is raised and lowered to determine the point of maximum emanations. The cables are then manipulated at that point to maximize emissions. Measurements are made with the antennas in each horizontal and vertical polarization separately. The data obtained from these tests is corrected with the proper cable, preamplifier and antenna factors. The results are then transcribed onto tables that show the maximum emission levels. The highest emissions are listed in a Radiated Emissions Summary table.

If no emissions can be found, the lowest Harmonics Emissions of the EUT clocks within the bands of the standard are tuned into with the receiver. If no emissions are found, the noise floor will be entered into the table and noted. Summary results will reflect only actual emissions from the EUT.

The field intensity measurements are made using standard techniques with a spectrum analyzer or EMI receiver as the calibrated Field Intensity Meter (FIM). Preamplifiers and filters are used when required.

When using the Hewlett Packard Model 8568B Spectrum Analyzer as the FIM, the Analyzer is calibrated to read signal level in dBm. Where:

0 dBm (50 ohms) = 107 dBµV (50 ohms)

The signal level (dBµV) = indicated signal level (dBm) + 107 dB. To obtain the signal level in dBµV/m it is necessary to add the antenna factor in dB.

Example of Typical Calculation

Measurement Distance = 10 Meter

Rohde and Schwarz reading @ 60 MHz	49.0	dBµV
Antenna Factor	+7.5	dB/m
Cable Loss	+2.0	dB
Preamplifier	-25.5	dB
Total Factors	-16.0	dB/m
Field Strength dBµV/m at 10 Meter =	33.0	dBµV/m

8.2 Radiated Emissions Compliance Data

Per EN55011 Class A, at 10 meters

480Vac 3 Phase SP 35							EUT: QUANTUM NXT DI WATER HEATER					
Freq. (MHz)	Meas'd (dBuV)	Amp Factors (dB)	Cable Factors (dB)	Antenna Factors (dB)	Total Factors (dBuV/m)	Total (dBuV/m)	Limit (dBuV/m)	Delta (dB)	Azimuth (degree)	Height (m)	Hor/ Vert	Meas. Type QP,AVE,PK
373.351	46.1	26.4	4.2	16.3	-5.9	40.22	47.0	-6.78	50	2.11	Vert	QP
426.684	44.1	26.8	4.5	17.8	-4.5	39.59	47.0	-7.41	25	2.06	Vert	QP
453.350	43.5	26.9	4.8	18.2	-3.9	39.56	47.0	-7.44	0	1.74	Vert	QP
400.019	40.5	26.6	4.3	17.5	-4.8	35.68	47.0	-11.32	54	1.83	Vert	QP
400.019	40.2	26.6	4.3	17.5	-4.8	35.39	47.0	-11.61	7	1.17	Hor/	QP
373.351	40.4	26.4	4.2	16.3	-5.9	34.53	47.0	-12.47	0	1.86	Hor/	QP

6 Highest frequencies relative to the Limit

8.3 Climatic Conditions

The climatic conditions during the Radiated Emissions tests were recorded as follows:

	Measured Value
Ambient Temperature	12° C
Relative Humidity	27%

8.4 Compliant Statement

The EUT was compliant with EN55011

YES	NO
YS	

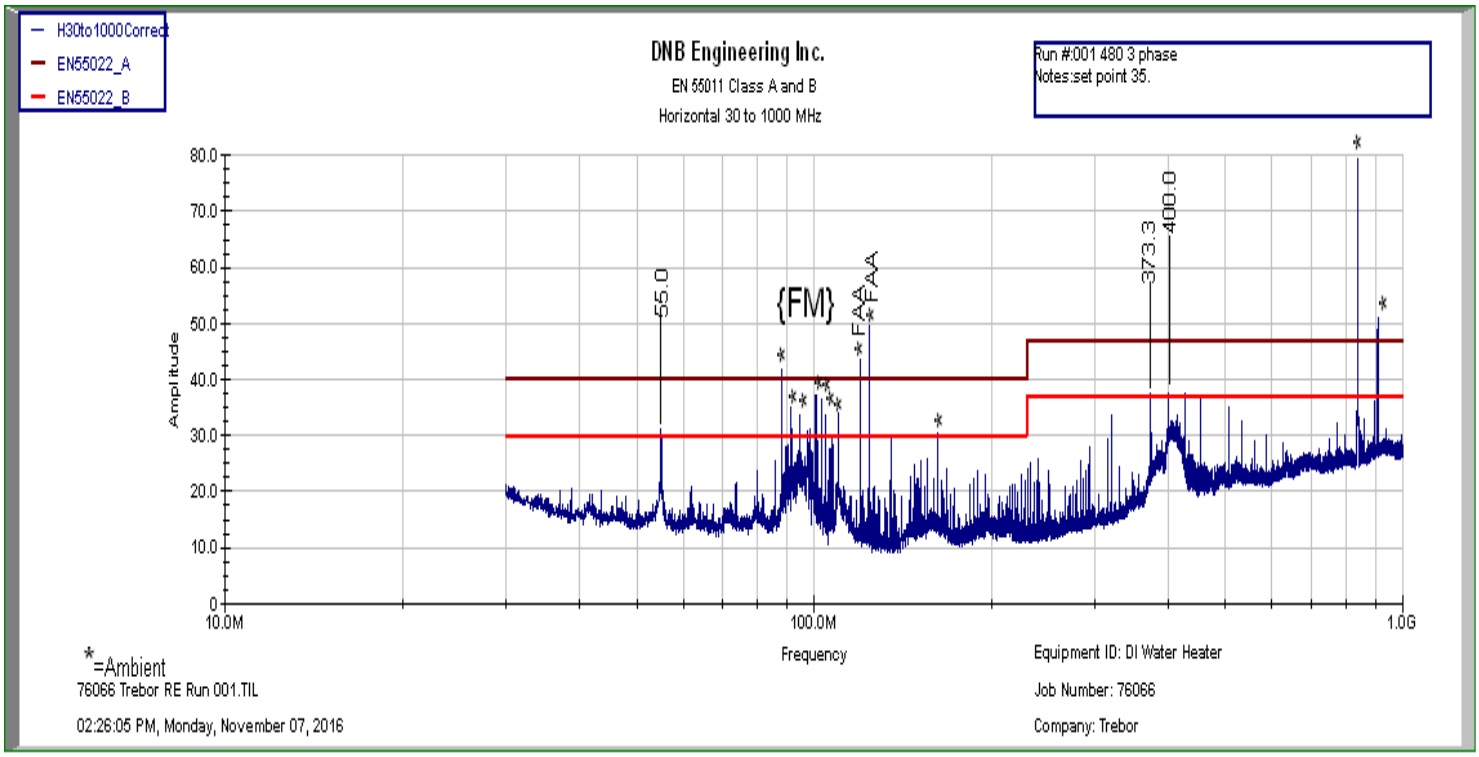
YS Test Engineer's Initials

8.1 Measurement uncertainty

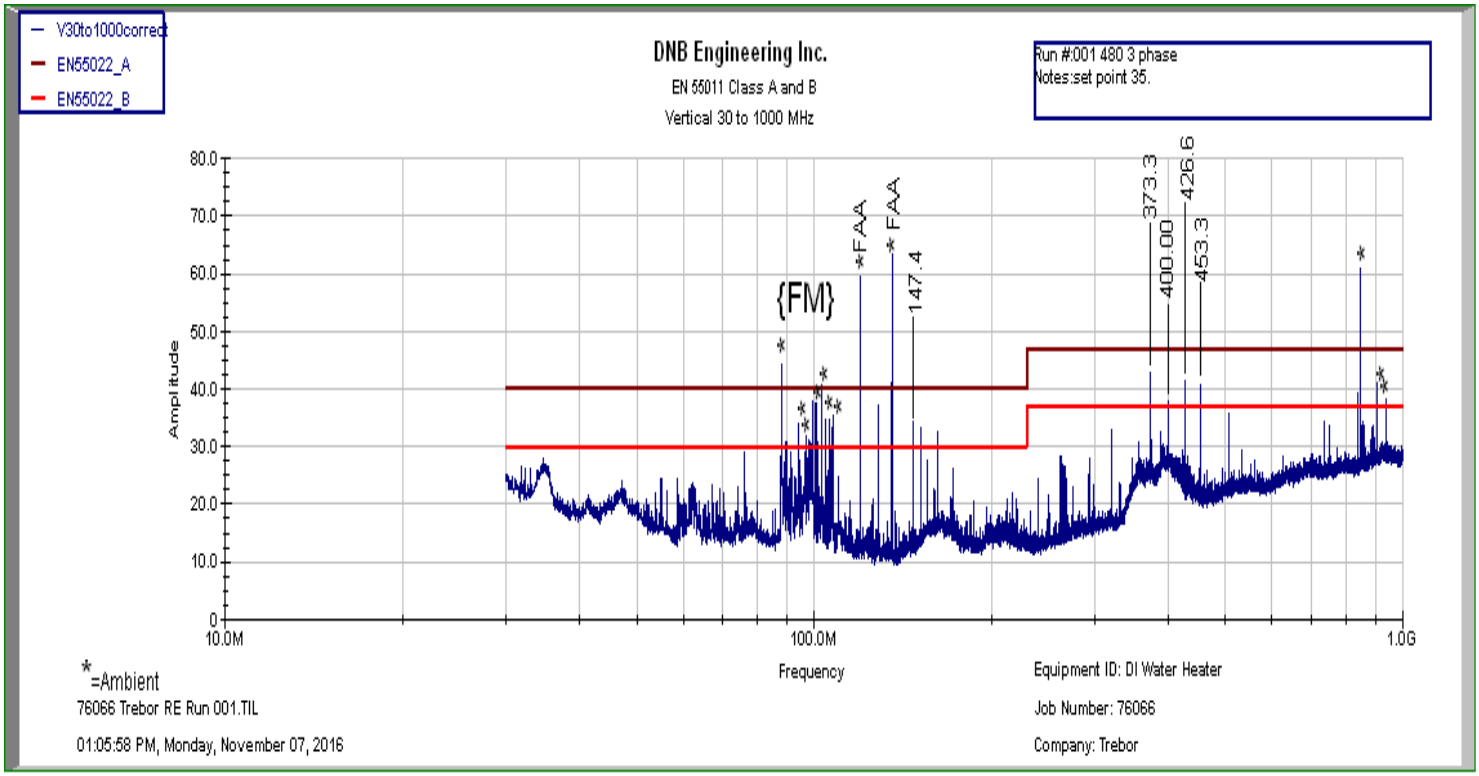
Contributor	Distribution	Value	Comments
Expanded uncertainty U(E) for Horizontally polarized radiated disturbances from 30 MHz to 200 MHz using a biconical antenna at a distance of 10 m	k=2	4.22	Calculated per CISPR 16-4-2
Expanded uncertainty U(E) for Vertically polarized radiated disturbances from 30 MHz to 200 MHz using a biconical antenna at a distance of 10 m	k=2	4.17	Calculated per CISPR 16-4-2
Expanded uncertainty U(E) for Horizontally polarized radiated disturbances from 200 MHz to 1 GHz using an LPDA antenna at a distance of 10 m	k=2	4.79	Calculated per CISPR 16-4-2
Expanded uncertainty U(E) for Vertically polarized radiated disturbances from 200 MHz to 1 GHz using an LPDA antenna at a distance of 10 m	k=2	4.92	Calculated per CISPR 16-4-2
Expanded uncertainty U(E) for Radiated disturbance measurements from 1 GHz to 6 GHz in a FAR (FSOATS) at a distance of 3 m	k=2	N/A	Calculated per CISPR 16-4-2
Expanded uncertainty U(E) for Radiated disturbance measurements from 6 GHz to 18 GHz in a FAR (FSOATS) at a distance of 3 m	k=2	N/A	Calculated per CISPR 16-4-2

8.2 Radiated Emissions Compliance Test Data

30-1000 MHz Horizontal



30-1000 MHz Vertical



8.3 Photographs of Test Setup EN55011 Radiated Emissions

EUT: Quantum NXT DI Water Heater
View: Test Setup

9. CONDUCTED EMISSIONS PER EN55011 CLASS A

9.1 Test Setup and Procedure

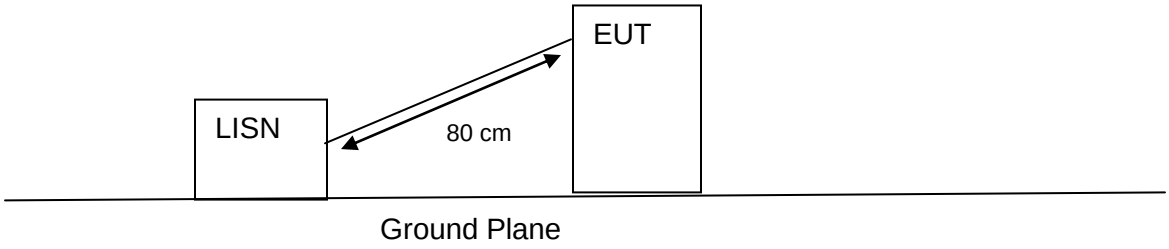
The EUT was in the Mode of Operation as stated in Section 1.4 and set up in the open area test site as shown test setup 8.4, with the EUT being placed on a 40cm table. The conducted tests are performed by inserting a 50-ohm, 50 uH LISN in series with the power line of the EUT. The tests are either performed on each unit individually or on several units at a time for each test configuration.

The spectrum analyzer is setup to store the peak emissions over the range stated in the applicable standard. Cables are then adjusted to maximize emissions. The peak spectrum analyzer trace and limits are plotted onto graph paper. A receiver (with CISPR quasi peak and average capability) is used to identify the highest frequencies with respect to the limit. Ambient signals are noted on the graph along with emissions from the EUT. EUT emissions with more than 10 dB margin may only have peak spectrum analyzer measurements taken. The highest levels are listed in the Conducted Emissions Summary Test Data.

Example of Typical Calculation

Rohde and Schwarz reading @ 10 MHz	49.0	dBµV
LISN Factor	+7.5	dB
Cable Loss	+2.0	dB
Total Factors	9.5	dB
Voltage dBµV at LISN =	58.5	dBµv

9.1.1 Setup Diagram



9.2 Conducted Compliance Data

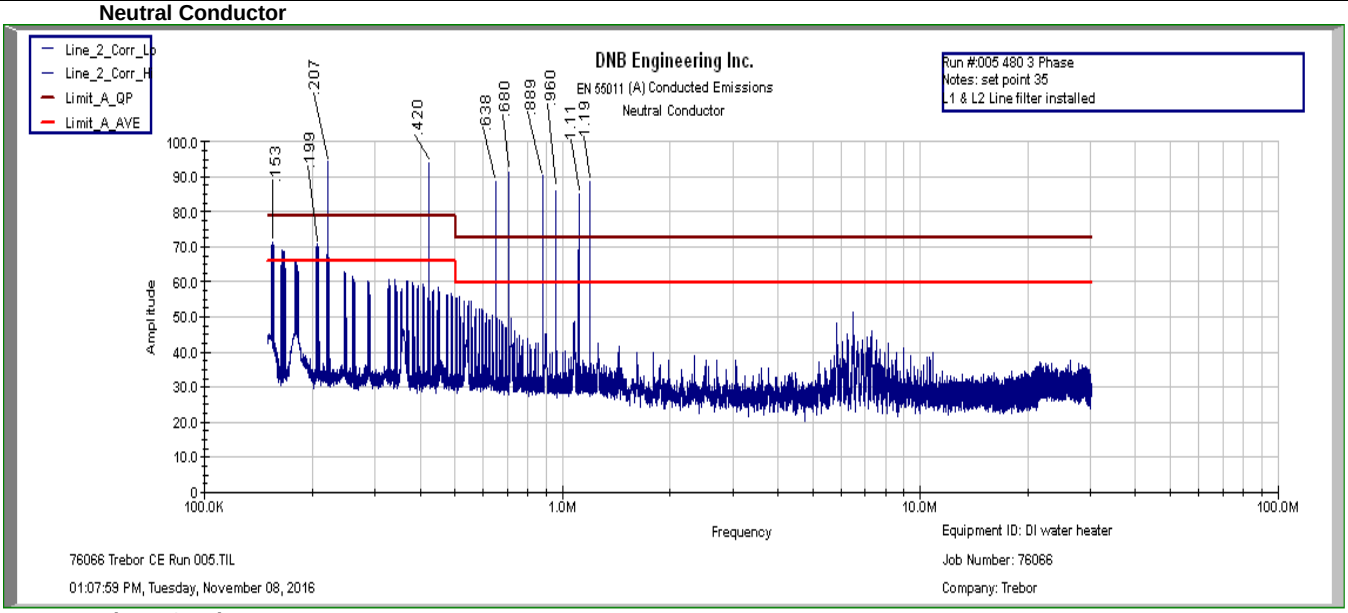
Per EN55011 Class A

Run 005 480V 3 Phase line filter installed	EUT:Quantum NXT DI Water Heater

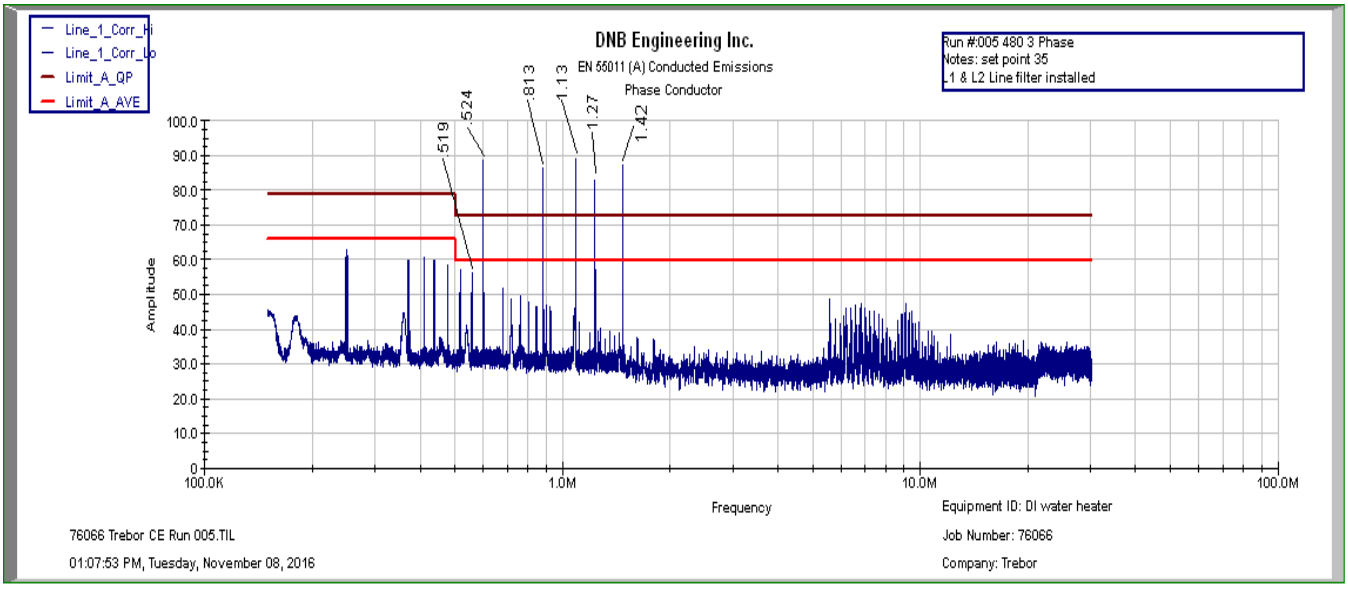
Freq. (MHz)	Meas'd (dBuV)	Filter Factors (dB)	Amp Factors (dB)	LISN Factors (dB)	Cable Factors (dB)	Total Factors (dB)	Total (dBuV)	Limit (dBuV)	Delta (dB)	Limit Type AVE,QP	Line L1 L2 L3 L4	Meas. Type AVE, QP, Peak
1.271	56.44	0.00	0.00	0.0	0.1	0.1	56.54	73.0	-16.46	QP	L1	QP
1.113	41.72	0.00	0.00	0.0	0.1	0.1	41.82	60.0	-18.18	AVE	L1	AVE
0.680	40.76	0.00	0.00	0.0	0.0	0.0	40.76	60.0	-19.24	AVE	L2	AVE
0.720	40.14	0.00	0.00	0.0	0.0	0.0	40.14	60.0	-19.86	AVE	L2	AVE
0.519	39.34	0.00	0.00	0.0	0.0	0.0	39.34	60.0	-20.66	AVE	L1	AVE
0.524	38.86	0.00	0.00	0.0	0.0	0.0	38.86	60.0	-21.14	AVE	L1	AVE

Highest Measurements

Neutral Conductor



Phase Conductor



9.3 Conducted Compliance Data

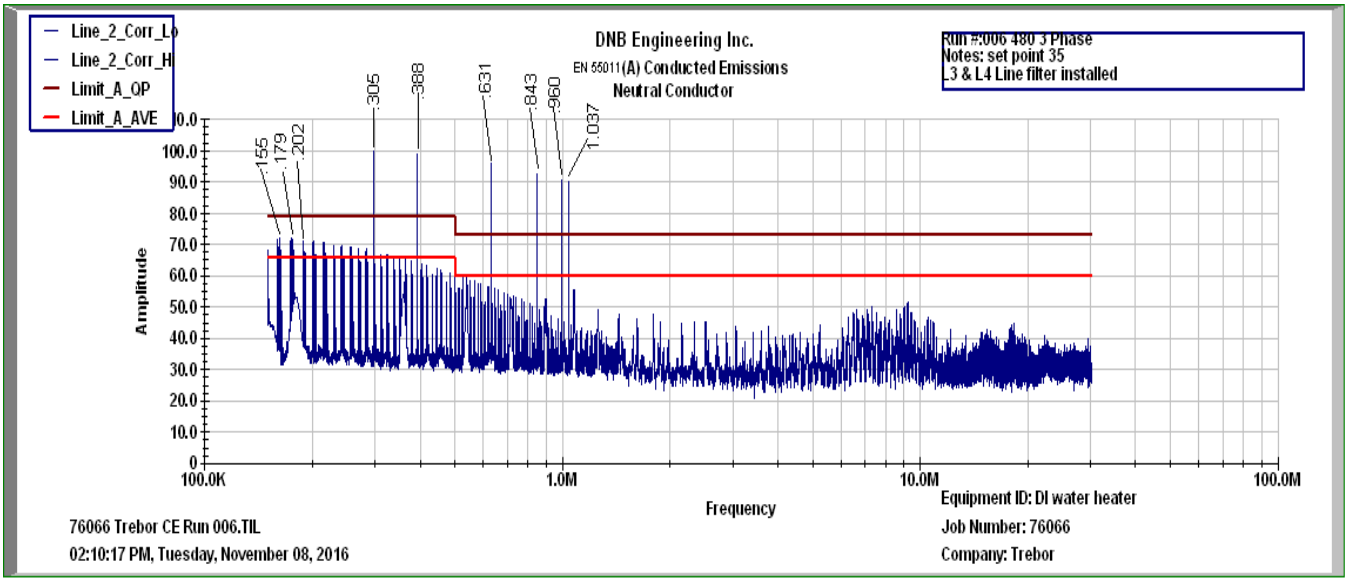
Per EN55011 Class A

Run006 480V 3 Phase line filter installed	EUT:Quantum NXT DI Water Heater

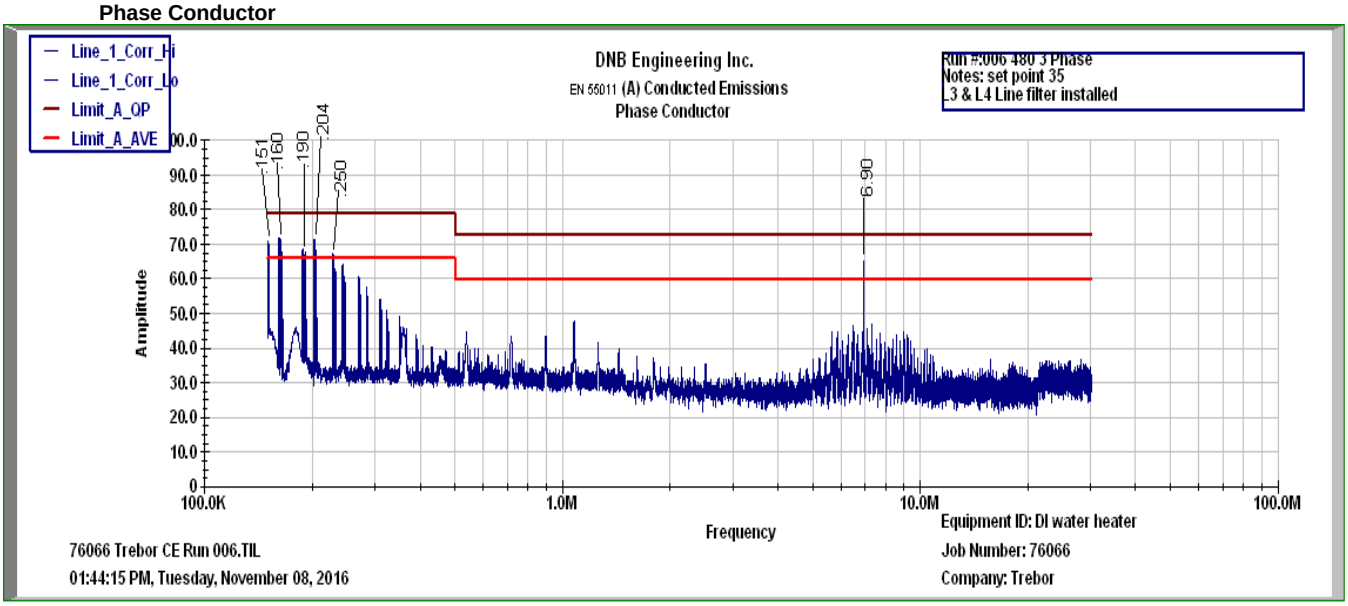
Freq. (MHz)	Meas'd (dBuV)	Filter Factors (dB)	Amp Factors (dB)	LISN Factors (dB)	Cable Factors (dB)	Total Factors (dB)	Total (dBuV)	Limit (dBuV)	Delta (dB)	Limit Type AVE,QP	Line L1 L2 L3 L4	Meas. Type AVE, QP, Peak
0.202	71.66	0.00	0.00	0.1	0.0	0.1	71.76	79.0	-7.24	QP	L4	QP
0.608	65.30	0.00	0.00	0.0	0.0	0.0	65.30	73.0	-7.70	QP	L4	QP
0.179	70.99	0.00	0.00	0.2	0.0	0.2	71.19	79.0	-7.81	QP	L4	QP
0.155	70.81	0.00	0.00	0.2	0.0	0.2	71.01	79.0	-7.99	QP	L4	QP
0.305	69.40	0.00	0.00	0.1	0.0	0.1	69.50	79.0	-9.50	QP	L4	QP
0.388	69.02	0.00	0.00	0.1	0.0	0.1	69.12	79.0	-9.88	QP	L4	QP

Highest Measurements

Neutral Conductor



Phase Conductor



9.4 Climatic Conditions

The climatic conditions during the Conducted Emissions tests were recorded as follows:

	Measured Value
Ambient Temperature	22° C
Relative Humidity	18%

9.5 Compliant Statement

The EUT was compliant with EN55011

YES	NO
YS	

YS Test Engineer's Initials

9.6 Measurement uncertainty

Contributor	Distribution	Value	Comments
Expanded uncertainty U(V) for Conducted disturbance measurements from 150 kHz to 30 MHz using a 50 Ω/50 µH AMN	k=2	3.48	Calculated per CISPR 16-4-2
Expanded uncertainty U(V) for Uncertainty budget for conducted disturbance measurements at a telecommunication port using an asymmetrical artificial network (AAN)	k=2	N/A	Calculated per CISPR 16-4-2
Expanded uncertainty U(I) for Conducted disturbance measurements from 9 kHz to 30 MHz using a CP	k=2	N/A	Calculated per CISPR 16-4-2

9.7 Photographs of Test Setup EN55011 Conducted Emissions

EUT: Quantum NXT DI Water Heater
View: Test Setup

10. LABELING REQUIREMENTS

To indicate compliance with European Union requirements, this device shall bear the CE mark. The CE mark shall be affixed to the unit in a conspicuous position. The CE mark shall additionally be affixed to the owner's Manual and the shipping carton.

A copy of the "Declaration of Conformity" shall accompany import papers into the European community. A copy of the Declaration must be supplied with each product.

The supporting test records must be kept on file for ten years after the end of production, and must be kept at the disposal of the appropriate European agent.

Quantum NXT DI Water Heater appropriate directive and standards for your product.

Declaration of Conformity

Application of council Directive 2014/30/EU
Standard(s) to which conformity is declared. .EN61326-1:2013
EN55011Emissions
Manufacturer's Name . . . . . .
Manufacturer's Address . . . . . .
Importer's Name . . . . . .
Importers Address . . . . . .
Type of Equipment . . . . . .
Model Number . . . . . .
Serial Number . . . . . .
Year of Manufacture . . . . . .

I, The undersigned hereby declare that the equipment specified above conforms to the above Directive(s) and Standards.

Place _____ Signature _____

Date _____ Full Name _____

Position _____

11. EC DECLARATION OF CONFORMITY

The EC declaration of conformity must contain the following:

- Description of the apparatus to which it refers,
- Reference to the specifications under which conformity is declared, and, where appropriate, to the national measures implemented to ensure the conformity of the apparatus with the provisions of the Directive.
- Identification of the signatory empowered to bind the manufacturer or his authorized representative.
- Where appropriate, reference to the EC type-examination certificate issued by a notified body.

EC Conformity Mark

- The EC Conformity Mark shall consist of the letters CE as set out and the figures of the year in which the mark was affixed.

12. EQUIPMENT MANUFACTURED AFTER COMPLIANCE TESTING

It is prudent that manufacturers have an established Quality Assurance program to spot-check their products on a periodic basis, either based upon time or quantities produced. Obviously, a change in the engineering design should be sufficient justification for a re-test.

The Quality Assurance test need not be formal such as required during the initial production of the product. However, it should be sufficient in scope to assure that the EMI characteristics of the product have not changed to the degree that the product exceeds the specified limits. If a new model of a product is produced, it must undergo full testing.

13. MANUAL

Per CFR 47 2.1075(a)(2)(xi)

Refer to Exhibit D

Per Section 2.1077 Compliance information.

(a) If a product must be tested and authorized under a Declaration of Conformity, a compliance information statement shall be supplied with the product at the time of marketing or importation, containing the following information:

(1) Identification of the product, e.g., name and model number.

(2) A statement, similar to that contained in Section 15.19(a)(3) of this chapter, that the product complies with Part 15 of the regulations.

"NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help."

(3) The identification, by name, address State and telephone number, of the responsible party, as defined in Section 2.909 of this chapter. The responsible party for a Declaration of Conformity must be located within the United States.

14. APPENDIX SECTION

14.1 APPENDIX A: UNCERTAINTY TOLERANCE

DNB Engineering's Utah Facility is within acceptable uncertainty tolerances per ANSI C63.4 sections 5.4.6.1 and 5.4.6.2 as well as CISPR 16-1 Annex M, section M.2.

ANSI C63.4

5.4.6.1 Site Attenuation. A measurement site shall be considered acceptable for radiated electromagnetic field measurements if the horizontal and vertical NSA derived from measurements, i.e., the "measured NSA," are within ± 4 dB of the theoretical NSA (5.4.6.3) for an ideal site.

5.4.6.1 NSA Tolerance. The ± 4-dB tolerance in 5.4.6.1 includes instrumentation calibration errors, measurement technique errors, and errors due to site anomalies. These errors are analyzed in ANSI C63.6, wherein it is shown that the performance of a well-built site contributes only 1 dB of the total allowable tolerance.

CISPR 16-1

M.2 Error analysis

The total estimated errors are the basis for the ± 4-dB site acceptability criterion consisting of approximately 3-dB measurement uncertainty and an additional allowable 1 dB for site imperfections.

14.2 APPENDIX B: SITE CHARACTERISTICS CHALK CREEK EMI TEST SITE

The DNB Engineering test facility is located in Chalk Creek Canyon near Coalville, Utah. Site characteristics were measured according to the procedures outlined in ANSI C63.4 "Characteristics of Open Field Test Site". The results of these characterizations indicate that the Chalk Creek site is an outstanding facility to perform accurate and repeatable EMI tests.

14.3 Ambient Emissions

Ambient Emission measurements were made to determine the level of the ambient emanations at the DNB test facility. The results indicate that all ambient signals are below the FCC Radiated Emission limits or that each can easily be identified as an ambient signal.

15. NVLAP ACCREDITATION

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200634-0

DNB Engineering, Inc.
Coalville, UT

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Electromagnetic Compatibility & Telecommunications

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2016-08-29 through 2017-06-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program

16. APPENDIX C: EMC INSTRUMENTATION AND MEASUREMENT EQUIPMENT

Calibration of test and measurement equipment is performed by an approved commercial facility, whose standards are traceable to the National Institute of Standards and Technology.

Radiated Emissions Equipment

Description	Manufacturer/MN	Asset #	Serial #	Cal Due
Amplifier	HP/8447D	U-065	2727A06180	05JAN17
Amplifier	HP/8447D	U-067	2727A06182	05JAN17
Bicon Antenna	SCH/BBA9106	U-186	7	18MAY17
Log P Antenna	SCH/UHAL09107	U-010	10	21DEC16
Horn Antenna, Double Rdg GD	AH Systems/SAS-200/571	U-156	222	23APR17
Spectrum Analyzer	Agilent/E7401A	U-257	MY42000103	29DEC16
TILE Software	ETS- Lindgern/ 3.4.11.13	U-317	8112006	01DEC16

Conducted Emissions Equipment

Description	Manufacturer/MN	Asset #	Serial #	Cal Due
LISN	Fisher LISN-50/32-4-01	U-286	02020	17DEC17
LISN	FisherFCCLISN-50/250/25/8	U-062	05003	16NOV17
Spectrum Analyzer	Agilent/E7401A	U-257	MY42000103	29DEC16
CDN 16 amp	Fischer/FCC801M316A	U-169	64	09JUL17
TILE Software	ETS Lindgren/ 3.4.11.13	U-317	8112006	01DEC16
Current Probe	Solar/ 6741-1	U-267	966727	17DEC17

Radiated Immunity Equipment

Description	Manufacturer/MN	Asset#	Serial #	Cal Due
Signal Generator	Marconi/2024	U-266	112235/080	07AUG17
Field Monitor	AR/FP2000	U-115	14426	21DEC17
E-Field Meter	AR/FM2000	U-116	14551	Reference
Directional Coupler	AR/DC6080	U-308	302553	04DEC16
Power Meter	Boonton/4231A	U-054	146502	23OCT16

Conducted Immunity Equipment

Description	Manufacturer/MN	Asset #	Serial #	Cal Due
AM/FM Signal Generator	MARCONI/2024	U-266	112235080	7AUG17
RF Current Probe	SOLAR/6741-1	U-267	966727	17DEC17
Directional Coupler	AR/DC2600	U-307	302980	04DEC16
CDN 16 Amp	Fischer/FCC801M316A	U-169	64	09JUL17
Power Meter	Boonton/4231A	U-054	146502	23OCT16

EFT

Description	Manufacturer/MN	Asset #	Serial #	Cal Due
EFT Generator	Keytek/0104401	U-227	0105262	30MAR18
Capacitive Coupling Clamp	Haefley/CC-300-5003	U-105	082390-09	13OCT16
CE Ware32 software	KeyTek/MA-95-050-005-00	U-227	Version 4.00	30MAR18
EMC Pro Plus	Thermo Scientific\Pro Base	0410188		16DEC16

SURGE

Description	Manufacturer/MN	Asset #	Serial #	Cal Due
CE Ware32 software	KeyTek/MA-95-050-005-00	U-227	Version 4.00	30MAR18
EMC Pro Plus	Thermo Scientific\Pro Base	0410188		16DEC16

Voltage Dips and Variations

Description	Manufacturer/MN	Asset #	Serial #	Cal Due
AC Power Supply	Ametek/SW5250A	U-265	512	04NOV16
EMC Pro Plus	Thermo Scientific/Pro Base	0410188		16DEC16
CE Ware32	KeyTek/MA-95-050-005-00	U-227	Version 4.00	30MAR18

ESD

Description	Manufacturer/MN	Asset #	Serial #	Cal Due
ESD Simulator	Haefely/PESD 3000	U-265	H110072	21DEC17

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