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FCC Part 15, Subpart C, Section 15.231
Test Report

On

LowPower Oil eSensor Transmitter
FCC ID: X94-0005895

Customer Name:	Senet, Inc.
Customer P.O:	734
Date of Report:	September 1, 2015
Test Report No:	R-5980N-1
Test Start Date:	July 13, 2015
Test Finish Date:	July 14, 2015
Test Technician:	M. Seamans
Approved By:	S. Wentworth
Report Prepared By:	J. Ramsey

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Technical Information

Report Number:	R-5980N-1
Customer:	Senet, Inc.
Address:	46 River Road
	Hudson, NH 03051
Manufacturer:	Senet, Inc.
Manufacturer Address:	46 River Road
	Hudson, NH 03051
Test Sample:	LowPower Oil eSensor Transmitter
Part Number:	3870
Serial Number:	0003872-00007F51
FCC ID:	X94-0005895
Antenna Type:	Non-removable Omni Directional - No Antenna Connector
Power Requirements:	3.6VDC internal battery
Frequency of Operation:	433 MHz
Equipment Use:	Measures Oil Tank Level and Sends Data

Test Specification:
FCC Rules and Regulations Part 15, Subpart C, Section 15.231

Test Procedure:
ANSI C63.4:2009

Test Facility:
Retlif Testing Laboratories
101 New Boston Road
Goffstown, NH 03045

FCC Registered Test Site Number: 90899

Tests Performed

The test methods performed on the Oil Transmitter are shown below:

FCC Part 15, Subpart C	Test Method
15.231(e)	Field Strength of Emissions – Fundamental
15.231	Duty Cycle Determination
15.231(e)	Field Strength of Spurious Emissions
15.231(c)	Bandwidth of Emission

General Test Requirements

1. The measurement procedures of ANSI C63.4:2009 were utilized as specified in FCC Part 15, Subpart C, Section 15.31(a)(3) and the ANSI C63.4 transition period allowed by the FCC.
2. All radiated emissions measurements were performed on an Open Area Test Site (OATS), listed with the FCC.
3. All testing was performed with a new battery installed in the EUT.
4. All measurements were performed at the specified 3 meter test distance as required by FCC Section 15.31 (f).
5. The EUT was rotated throughout 360 degrees for all radiated emissions measurements.
6. All readily accessible EUT controls were adjusted in such a manner as to maximize the level of emissions.
7. Appropriate accessories were attached to all EUT ports during the performance of radiated emissions measurements.
8. The EUT was battery powered and AC line conducted emissions were not required.
9. The EUT operated at a single frequency of 433 MHz.
10. The frequency spectrum was investigated from the lowest frequency generated in the device up to the 10th harmonic of the highest fundamental frequency.
11. All measurements were taken with a peak detector function as specified in FCC Section 15.35(a). The duty cycle, calculated in accordance with FCC Section 15.35(c) was applied to the peak readings in order to obtain the average value of emissions. The peak value of emissions was verified to meet the 20 dB requirement of FCC Section 15.35(b).
12. The EUT transmits for a maximum of 1 second once every hour which meets the requirement of 15.231 (e).

Certification and Signatures

We certify that this report is a true representation of the results obtained from the tests of the equipment stated. We further certify that the measurements shown in this report were made in accordance with the procedures indicated and vouch for the qualifications of all Retlif Testing Laboratories personnel taking them.

Scott Wentworth
Branch Manager
NVLAP Approved Signatory

Todd Hannemann
Laboratory Supervisor
iNARTE Certified Technician ATL-0255-T

Non-Warranty Provision
The testing services have been performed, findings obtained and reports prepared in accordance with generally accepted laboratory principles and practices. This warranty is in lieu of all others, either expressed or implied.

Non-Endorsement
This test report contains only findings and results arrived at after employing the specific test procedures and standards listed herein. It is not intended to constitute a recommendation, endorsement or certification of the product or material tested. This test report must not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

Requirements and Test Results

Requirement:
FCC Section 15.231(a) - Periodic operation in the band 40.66 - 40.7 MHz and above 70 MHz
The provisions of this Section are restricted to periodic operation within the band 40.66-40.7 MHz and above 70 MHz. Except as shown in Paragraph (e) of this Section, the intentional radiator is restricted to the transmissions of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal.

- Results:
  The device operates at a frequency of 433 MHz and is used for the transmission of oil tank level data.

Requirement:
FCC Sections 15.231(a)(1)-(5)
Periodic operation in the band 40.66 - 40.7 MHz and above 70 MHz
The following conditions were met in order to comply with the provisions for momentary operation:

FCC 15.231(a)(1): A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

- Results:
  The device is not manually operated.

FCC 15.231(a)(2): A transmitter activated automatically shall cease transmission within 5 seconds after activation.

- Results:
  The device will transmit for 24.85 msec after activation and cease transmission.

Requirements and Test Results (con't)

FCC 15.231(a)(3): Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

- Results:
  The device will transmit for a duration of 24.85 msec. The device will transmit 1 time per hour. The device operates in accordance with 15.231 (e).

FCC 15.231(a)(4): Intentional radiators which are employed for radio control purposes during emergencies involving fire, security and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

- Results:
  This device is not employed for radio control purposes during emergencies involving fire, security and safety for life.

FCC 15.231(a)(5): Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmission are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

- Results:
  The device is not employed for security systems.

Requirements and Test Results (con't)

Requirement:
FCC Section 15.231(e) - Field Strength of Emissions
In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the limits specified in Table 1.

Table 1 - Test Limits, Field Strength of Emissions

Fundamental Frequency (MHz)	Field Strength of Fundamental microvolts/meter @3 meters (watts, e.i.r.p.) Quasi Peak or Average	Field Strength of Spurious Emissions microvolts/meter @3 meters Quasi Peak or Average
40.66 – 40.70	1,000	100
70 -- 130	500	50
130 – 174	500 – 1,500**	50 to 150**
174 – 260	1,500	150
260 – 470	1,500 to 5,000**	150 – 500**
Above 470	5,000	500

**Linear Interpolations
For 130-174 MHz: FS (microvolts/m) = (22.73 x F) - 2,454.55
For 260-470 MHz: FS (microvolts/m) = (16.67 x F) - 2,833.33
The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.

The Fundamental and Spurious Emissions limits for a device operating at 433 MHz are listed in Table 2.

Table 2 - Fundamental and Harmonic Limits

Frequency of Operation MHz	Fundamental µV/m	Harmonics µV/m
433.0	4384.78	438.4

- Results:
  The Fundamental and Harmonics field strengths did not exceed the limits specified in Table 2 at a test distance of 3 meters. See test data for the Fundamental and Harmonic emissions test results.

Requirements and Test Results (con't)

Requirement:
FCC Section 15.231(b)(2) - Duty Cycle Determination-Pulsed Operation

Intentional radiators operating under the provisions of the Section shall demonstrate compliance with the limits on the field strength emissions, as shown in Table 1, based on the average value of the measured emissions. As an alternative, compliance with the limits in the Table 1 may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in Section 15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of Section 15.205 shall be demonstrated using the measurement instrumentation specified in that Section.

When the field strength (or envelope power) is not constant or when it is in pulses, and an average detector is specified to be used, the value of field strength or power shall be determined by averaging over one complete pulse train, including blanking intervals within the pulse train, as long as the pulse train does not exceed 0.1 seconds. In cases where the pulse train exceeds 0.1 seconds, the average value (of field strength or output power) shall be determined during a 0.1 second interval during which the field strength or power is at its maximum value.

The duty cycle of the EUT was evaluated in all operating modes to determine the worst case duty cycle. The sweep time was then adjusted in order to display one full pulse train. The transmitter on time was then summed and compared to the time for one full cycle in order to obtain the duty cycle. As the transmitter cycle time exceeded 100msec, 100msec was used as the cycle time for the duty cycle calculation and the maximum on time within any 100msec period was recorded as the on time (See plots for additional information).

- Results:
  The emissions did not exceed the limits specified in Table 1. See below for the exact method of calculating the average field strength.

Transmitter On Time = 100 milliseconds (maximum per cycle)

Transmitter Cycle Time = 24.85 milliseconds (100 ms maximum)

Transmitter Duty Cycle = 24.85 %

CALCULATION

Duty Cycle (24.85/100) = 24.85 %

Correction Factor =20 log (0.2485 = 12.1 dB

Requirements and Test Results (con't)

Field Strength Calculation:

The final average field strength of the emission was calculated by subtracting the duty cycle factor in dB from the maximized corrected peak reading in dBuV/m.

The maximized peak field strength of the emission was obtained as follows:

$P_C = M_R + C_F$

Where:
P_C = Corrected Peak Reading in dBµV/m
M_R = Uncorrected Meter Reading in dBµV
C_F = Correction Factor in dB (Antenna Factor, Pre-amp + Cable Loss)

The final average field strength of the emission was obtained as follows:

$A_F = P_C - D_F$

Where:

A_F = Average Field Strength in dBµV/m
P_C= Corrected Peak Reading in dBµV/m
D_F = Duty Cycle Factor in dB

Example: For the Oil eSensor at a frequency of 433 MHz:

M_R = 60.09 dBµV
C_F = 23.77 dB
P_C = 60.09 dBuV + 23.77 = 83.86 dBµV/m
D_F = 12.1 dB

A_F = 83.86 dBuV/m – 12.1 dB = 71.76 dBuV/m

71.76 dBuV/m = 3872.58 uV/m

Requirements and Test Results (con't)

Requirement:
FCC Section 15.231(e) - Field Strength of Spurious Emissions
The limits on the field strength of the spurious emissions specified in Table 1 are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in Table 1 or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

- Results:
  No spurious emissions were observed within 10 dB of the specified limit.

Requirement:
FCC Section 15.231(c) - Bandwidth of Emissions
The bandwidth of the emissions shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier. For a frequency of 433 MHz the limit is 1.08 MHz.

- Results:
  The bandwidth was measured and found to be less than 0.25% of the center frequency.

Equipment Lists

Field Strength of Emissions – Fundamental

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
4029	RETLIF	OPEN AREA TEST SITE, FILING	3 / 10 Meters	RNH	5/15/2013	5/31/2016
5053	ETS / EMCO	ANTENNA, BICONILOG	26 MHz - 3 GHz	3142C	2/24/2015	8/31/2016
5070	ROHDE & SCHWARZ	RECEIVER, EMI	20 Hz - 40 GHz	ESIB40	10/29/2014	10/31/2016

Duty Cycle Determination - Pulsed Operation

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
5070	ROHDE & SCHWARZ	RECEIVER, EMI	20 Hz - 40 GHz	ESIB40	10/29/2014	10/31/2016
5135	NARDA MICROWAVE	ATTENUATOR, COAXIAL	10 dB, DC - 12.4 GHz	757C-10	10/28/2014	10/31/2015

Field Strength of Spurious Emissions

EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
1232	AGILENT / HP	PRE-AMPLIFIER	1 - 26.5 GHz	8449B	6/17/2015	6/30/2016
3258	ETS / EMCO	ANTENNA, DOUBLE RIDGED GUIDE	1 - 18 GHz	3115	3/24/2015	9/30/2016
4029	RETLIF	OPEN AREA TEST SITE, FILING	3 / 10 Meters	RNH	5/15/2013	5/31/2016
5053	ETS / EMCO	ANTENNA, BICONILOG	26 MHz - 3 GHz	3142C	2/24/2015	8/31/2016
5070	ROHDE & SCHWARZ	RECEIVER, EMI	20 Hz - 40 GHz	ESIB40	10/29/2014	10/31/2016
R462	AGILENT / HP	ANALYZER, SPECTRUM	9 kHz - 26.5 GHz	E7405A	1/8/2015	1/31/2016

Bandwidth of Emission

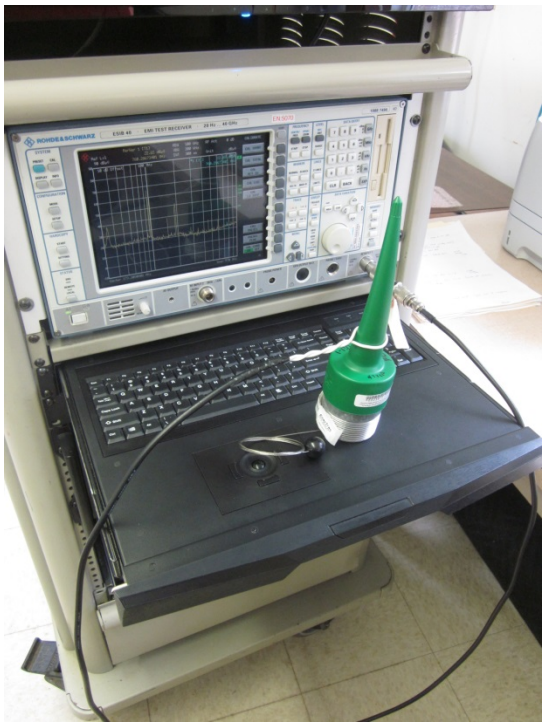
EN	Manufacturer	Description	Range	Model No.	Cal Date	Due Date
5070	ROHDE & SCHWARZ	RECEIVER, EMI	20 Hz - 40 GHz	ESIB40	10/29/2014	10/31/2016
5135	NARDA MICROWAVE	ATTENUATOR, COAXIAL	10 dB, DC - 12.4 GHz	757C-10	10/28/2014	10/31/2015

Test Photograph(s)
Field Strength of Emissions – Fundamental

Horizontal Antenna Polarization

Vertical Antenna Polarization

Test Photograph(s)
Duty Cycle Determination



Test Setup

Test Photograph(s)
Field Strength of Spurious Emissions

Horizontal Polarization, 30 MHz to 1 GHz

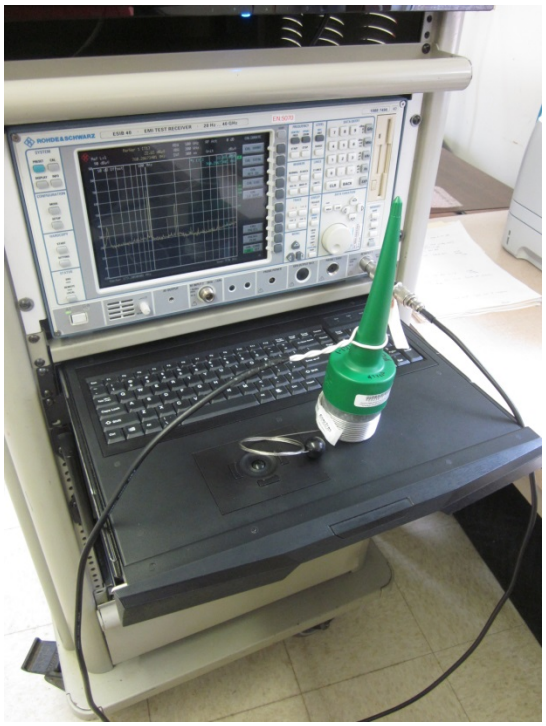
Vertical Polarization, 30 MHz to 1 GHz

Test Photograph(s)
Field Strength of Spurious Emissions

Horizontal Polarization, 1 GHz to 4.4 GHz

Vertical Polarization, 1 GHz to 4.4 GHz

Test Photograph(s)
Bandwidth of Emission



Test Setup

FCC Section 15.231(e) - Field Strength of Emissions – Fundamental Test Data

RETLIF TESTING LABORATORIES

EMISSIONS TEST DATA SHEET		
Test Method	**Field Strength of Emissions - Fundamental Field Strength**	
Customer	Senet, Inc.	
Job Number	R-5980N-1	
Test Sample	Oil Transmitter	
Part Number	3870	
Serial Number	0003872-00007F51	
Test Specification	FCC Part 15, Subpart C	Paragraph: 15.231(e)
Operating Mode	Transmitting modulated signal at 433 MHz	
Technician	M. Seamans	
Date	July 13th, 2015	

Notes: Test Distance: 3 meters Detector: Peak Resolution BW: 100 kHz

TEST PARAMETERS

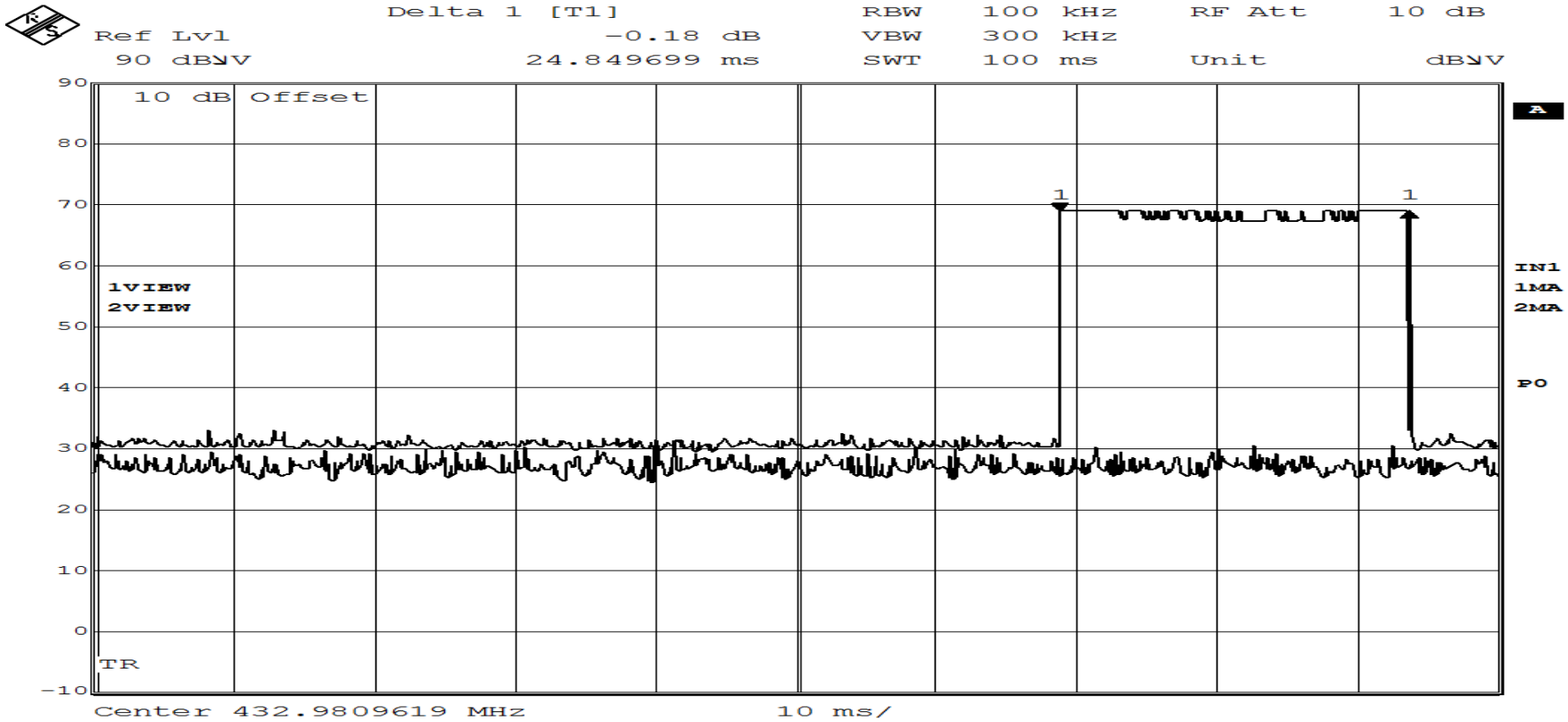
Frequency	Antenna Position	Measured level	Correction Factor	Corrected Peak Reading	Duty Cycle Factor	Corrected Average Reading	Converted Average Reading	Average Limit at 3m
MHz	**(H/V)**	**dBuV**	**dB**	**dBuV/m**	**dB**	**dBuV/m**	**uV/m**	**uV/m**
432.95	V	60.09	23.77	83.86	-12.1	71.76	3872.58	4384.78

Data Sheet 1 of 1

FCC Section 15.231 - Duty Cycle Determination - Pulsed Operation
Test Data

RETLIF TESTING LABORATORIES

Test Method:	Duty Cycle Determination		
Customer	Senet, Inc.	**Job No.**	R-5980N-1
Test Sample	Oil Transmitter		
Part Number	3870	**Serial No.**	0003872-00007F51
Operating Mode	Transmitting modulated signal at 433 MHz		
Test Specification	FCC part 15.35		
Technician	M. Seamans	**Date**	July 13th, 2015
Climatic Conditions	Temp: 22.0 °C Relative Humidity: 40.0 %		
Notes	Measured maximum transmit time: 24.849ms		



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RETLIF TESTING LABORATORIES

EMISSIONS TEST DATA SHEET	
Test Method	**Duty Cycle Determination**
Customer	Senet, Inc.
Job Number	R-5980N-1
Test Sample	Oil Transmitter
Part Number	3870
Serial Number	003872-00007F51
Test Specification	FCC part 15.35
Operating Mode	Transmitting modulated signal at 433 MHz
Technician	M. Seamans
Date	July 13th, 2015
Notes: Measured maximum transmit time: 24.849ms	

TEST PARAMETERS

Measured on time	Measured time interval	Duty Cycle Factor Calculation	Result	Duty Cycle Factor Allowed
msec	**msec**		**dB**	**dB**
24.849	100	= 20*Log_{10}(24.849 ms/ 100 ms)	-12.093	-12.1

Data Sheet 2 of 2

FCC Section 15.231(e) - Field Strength of Spurious Emissions Test Data

RETLIF TESTING LABORATORIES

EMISSIONS TEST DATA SHEET		
Test Method	**Field Strength of Spurious Emissions 30 MHz to 1 GHz**	
Customer	Senet, Inc.	
Job Number	R-5980N-1	
Test Sample	Oil Transmitter	
Part Number	3870	
Serial Number	0003872-00007F51	
Test Specification	FCC Part 15, Subpart C	Paragraph: 15.231(e), 15.205, 15.209
Operating Mode	Transmitting modulated signal at 433 MHz	
Technician	M. Seamans	
Date	July 14th, 2015	
Notes: Test Distance: 3 meters Detector: Quasi-Peak		

TEST PARAMETERS

Frequency	Antenna Position	EUT Orientation	Meter Reading	Correction Factor	Corrected Reading			Limit at 3M
MHz	**(H/V) / Height**	**Degrees**	**dBuV**	**dB**	**dBuV/m**			**dBuV/m**
30.00	-	-	-	-	-			40.0
|	-	-	-	-	-			|
35.00*	V-1m	0.0	7.48	15.72	23.20	*		|
|	-	-	-	-	-			|
88.00	-	-	-	-	-			40.0
88.00	-	-	-	-	-			43.5
|	-	-	-	-	-			|
105.00*	V-1m	0.0	11.29	10.31	21.60	*		|
110.00*	V-1m	0.0	8.08	10.12	18.20	*		|
205.00*	V-1m	0.0	0.56	13.64	14.20	*		|
|	-	-	-	-	-			|
216.00	-	-	-	-	-			43.5
216.00	-	-	-	-	-			46.0
|	-	-	-	-	-			|
600.00*	V-1m	0.0	-0.79	27.29	26.50	*		|
|	-	-	-	-	-			|
960.00	-	-	-	-	-			46.0
960.00	-	-	-	-	-			54.0
|	-	-	-	-	-			|
995.00*	V-1m	0.0	1.71	32.59	34.30	*		|
|	-	-	-	-	-			|
1000.00	-	-	-	-	-			54.0

EUT emissions within 10 dB of the specified test limit were observed at the specified test distance throughout the given frequency spectrum. * This emission is not from the EUT. It is a measurement of minimum measurement system sensitivity (Noise Floor).

Data Sheet 1 of 2

RETLIF TESTING LABORATORIES

EMISSIONS TEST DATA SHEET		
Test Method	**Field Strength of Spurious Emissions 1 GHz to 4.4 GHz**	
Customer	Senet, Inc.	
Job Number	R-5980N-1	
Test Sample	Oil Transmitter	
Part Number	3870	
Serial Number	0003872-00007F51	
Test Specification	FCC Part 15, Subpart C	Paragraph: 15.231(e), 15.205, 15.209
Operating Mode	Transmitting modulated signal at 433 MHz	
Technician	M. Seamans	
Date	July 14th, 2015	
Notes: Test Distance: 3 meters Detector: Peak		

TEST PARAMETERS

Frequency	Antenna Position	EUT Orientation	Meter Reading	Correction Factor	Corrected Reading	Duty Cycle Factor	Corrected Average Reading	Average Limit at 3M
MHz	(H/V) / Height	Degrees	dBuV	dB	dBuV/m	dB	dBuV/m	dBuV/m
1000.00	-	-	-	-	-	-	-	54.0
|	-	-	-	-	-	-	-	|
|	-	-	-	-	-	-	-	|
1299.00*	V	0.0	42.52	-10.04	32.48	-12.1	20.38	|
1732.00*	V	0.0	44.67	-8.85	35.82	-12.1	23.72	|
2165.00*	V	0.0	43.30	-6.76	36.54	-12.1	24.44	|
2598.00*	V	0.0	43.40	-5.55	37.85	-12.1	25.75	|
3031.00*	V	0.0	41.92	-4.22	37.70	-12.1	25.60	|
3464.00*	V	0.0	42.03	-2.98	39.05	-12.1	26.95	|
3897.00*	V	0.0	42.31	-0.37	41.94	-12.1	29.84	|
4330.00*	V	0.0	42.17	-1.75	40.42	-12.1	28.32	|
|	-	-	-	-	-	-	-	|
4400.00								54.0

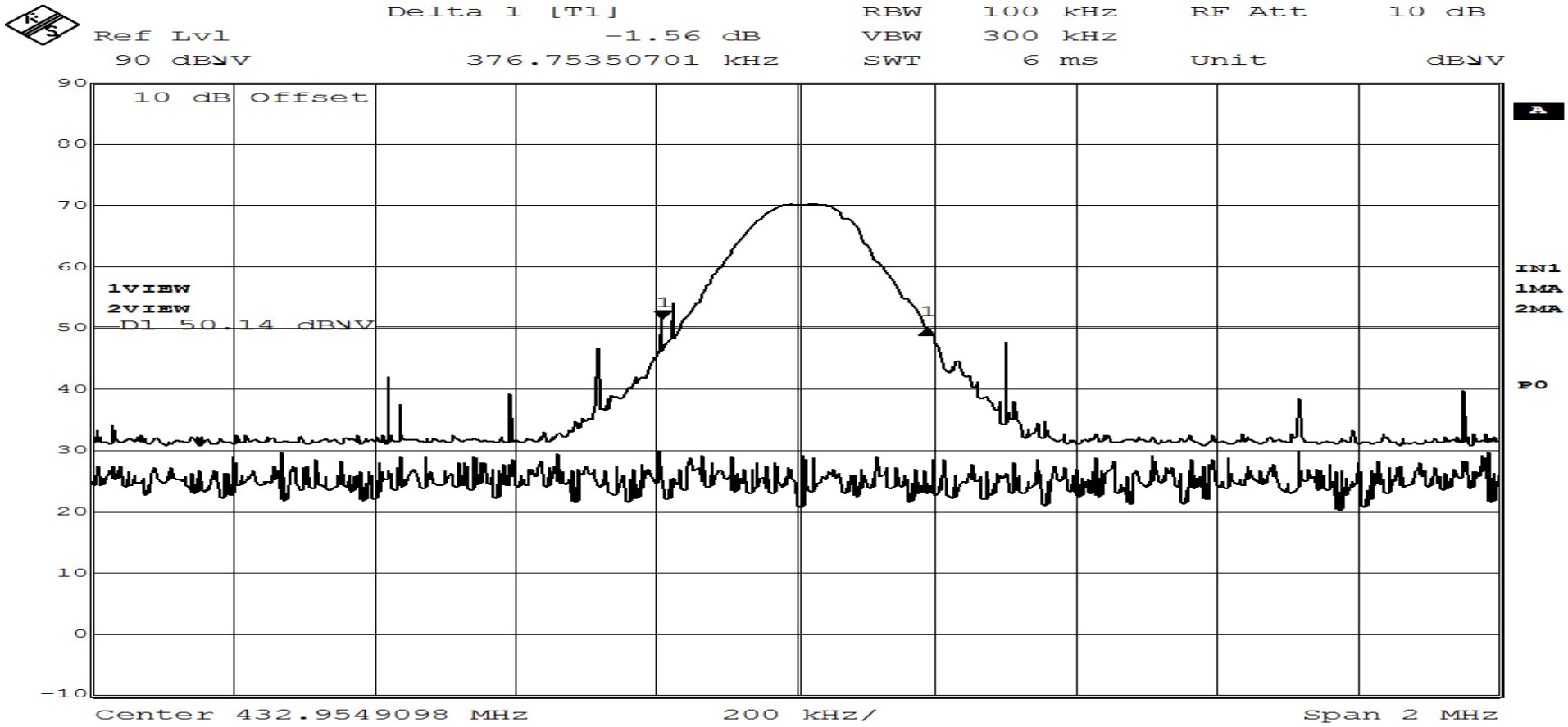
EUT emissions within 10 dB of the specified test limit were observed at the specified test distance throughout the given frequency spectrum. * This emission is not from the EUT. It is a measurement of minimum measurement system sensitivity (Noise Floor).

Data Sheet 2 of 2

FCC Section 15.231(c) - Bandwidth of Emission
Test Data

RETLIF TESTING LABORATORIES

Test Method:	Bandwidth of Emission – 20dB Bandwidth		
Customer	Senet, Inc.	**Job No.**	R-5980N-1
Test Sample	Oil Transmitter		
Part Number	3870	**Serial No.**	0003872-00007F51
Operating Mode	Transmitting modulated signal at 433 MHz		
Test Specification	FCC Part 15, Subpart C Paragraph: 15.231 (c)		
Technician	M. Seamans	**Date**	July 13th, 2015
Climatic Conditions	Temp: 22.0 °C Relative Humidity: 40.0 %		
Notes	20dB Bandwidth: 376.75 kHz		



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