# Class 2 Permissive Change Test Report

**For**

**Neptune Technology Group Inc.**

**Model: L900**

**FCC ID: P2SL900M2**
**IC: 4171B-L900M2**

**UST Project No.: 18-0105**

**Issue Date: July 2, 2018**

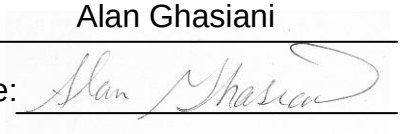
Total Pages in This Report: 16

**3505 Francis Circle Alpharetta, GA 30004**
**PH: 770-740-0717 Fax: 770-740-1508**
**www.ustech-lab.com**

I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date July 2, 2018

TESTING
NVLAP LAB CODE 200162-0



**3505 Francis Circle Alpharetta, GA 30004**
**PH: 770-740-0717 Fax: 770-740-1508**
**www.ustech-lab.com**

# MEASUREMENT TECHNICAL REPORT

**COMPANY NAME:** Neptune Technology Group Inc.

**MODEL:** L900

**FCC ID:** P2SL900M2

**IC:** 4171B-L900M2

**DATE:** July 2, 2018

This report concerns (check one): Original grant
Class 2 change [X]

Equipment type: 902-928 MHz ISM Radio

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: _____N/A_____
date
agrees to notify the Commission by N/A
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004

Phone Number: (770) 740-0717
Fax Number: (770) 740-1508

# Table of Contents

## List of Tables

**Table** **Title** **Page**



## List of Figures

**Figures** **Title** **Page**

# 1 General Information

## 1.1 Purpose of this Report

This report is prepared to show that the modifications made to the EUT do not impact the performance of the EUT in such as way that it would warrant full retesting and submittal of new test data.

The modification consists of the following:

> An additional antenna is being added to the list of approved antennas. All previously approved antennas are considered “external” to the module and are connected to the module using a 75 ohm F connector. The new antenna is “internal” to the module and attaches directly to the module using a separate switchable port.

Based on this addition, a comparative evaluation of the previous approved antennas versus the new antenna was performed. The focus was on intentional radiated emissions. Since the intentional emissions test results show that there are no significant changes between the existing antennas and the new antenna, no additional testing was performed. The test data is presented in this test report.

## 1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on June 11, 2018 in good operating condition.

## 1.3 Product Description

The Equipment Under Test (EUT) is the Neptune Technology Group Inc. Model L900. The EUT is a transceiver designed to wirelessly provide RF telemetry readings for a water meter. It operates within the 902-928 MHz ISM band. The EUT is battery powered (3.6Vdc) and spends the majority of its time in a low power consumption mode (asleep). The on board microprocessor utilizes an internal clock to briefly "wake up" the EUT for periodic wireless communication of telemetry information from the water meter.

The EUT provides for several communication modes to accommodate different installation site requirements. Available communication modes are as follows:

- Neptune Proprietary Standard
  - Mode 1- SURF (OOK modulation)
  - Mode 2- Enhanced fixed network
  - Mode 3- Enhanced mobile network uplink/downlink (GFSK, Data log Retrieval)
- LoRaWAN, open protocol based on proprietary modulation scheme from Semtech

This test report documents the compliance of the Neptune Proprietary Standard Mode 1.

Antenna: Multiple antennas – see Paragraph 2.6
Modulation: OOK (911.0815 - 919.0769 MHz)
Maximum Output Power: 20 dBm (Rated)

The equipment is designed to be installed with a water meter and is available only to qualifying utilities (not for sale to the consumer market). The unit was tested with the internal wire antenna and must be professionally installed only by trained utility installers. Also, the equipment is capable of several transmit modes of operation (hybrid). For this report only the OOK (FHSS) mode was used.

## 1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices*.

A list of EUT and Peripherals is found in Table 1 following. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

## 1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is US5301. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

## 1.6 Related Submittals

The EUT is currently approved as an Intentional transmitting device under FCC ID: PS2L900M2 and IC: 4171B-L900M2.

No other related submittals apply.

## Table 1. EUT and Peripherals

| PERIPHERAL MANUFACTURER | MODEL NUMBER | SERIAL NUMBER | FCC/IC ID | CABLES P/D |
|---|---|---|---|---|
| Neptune Technology Group Inc. | L900 | Engineering Sample | P2SL900M2<br>4171B-L900M2 | None |
| Internal Antenna | R900 Wire Antenna | Engineering Sample | -- | None |

U= Unshielded S= Shielded
P= Power D= Data

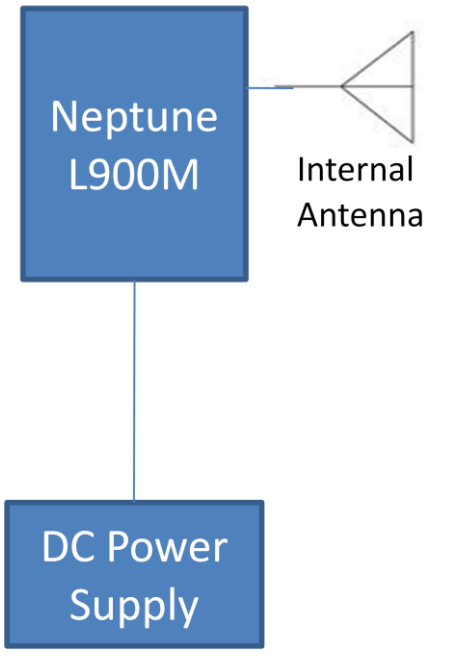



**Figure 1. Block Diagram of Test Configuration**

# 2 Tests and Measurements

## 2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers, and calibration status are indicated.

**Table 2. Test Instruments**

| TEST INSTRUMENT | MODEL NUMBER | MANUFACTURER | SERIAL NUMBER | Calibration Due Date |
|---|---|---|---|---|
| SPECTRUM ANALYZER | E4407B | AGILENT | US41442935 | 6/22/2018 |
| LOG PERIODIC ANTENNA | 3146 | EMCO | 9305-3600 | 5/01/2019 2 yr. |
| HORN ANTENNA | 3115 | EMCO | 9107-3723 | 9/22/2018 2 yr |
| PREAMP | 8449B | HEWLETT-PACKARD | 3008A00480 | 12/01/2018 |
| DC Power Supply | 6236B | HEWLETT-PACKARD | 2438A17539 | 08/23/19 2 yr |

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

## 2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT

## 2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

**Table 3. Number of Test Frequencies for Intentional Radiators**

| Frequency Range over which the device operates | Number of Frequencies | Location in the Range of operation |
|---|---|---|
| 1 MHz or less | 1 | Middle |
| 1 to 10 MHz | 2 | 1 near the top<br>1 near the bottom |
| Greater than 10 MHz | 3 | 1 near top<br>1 near middle<br>1 near bottom |

Because the EUT operates over a range of 8 MHz, 2 test frequencies were used: 911.08 and 919.08 MHz.

## 2.4 Frequency Range of Radiated Measurements (Part 15.33)

### 2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the $10^{th}$ harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

## 2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

### Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

### Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

### Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may be expressed logarithmically in dB.

The duty cycle correction factor was determined to be -20 dB for this radio as recorded in the previous submittal under UST Test report 17-0481 dated January 9, 2018.

During testing the radio was programmed to transmit at > 98% therefore the duty cycle correction factor was used to correct Peak measurements to AVG measurements.

## 2.6 EUT Antenna Requirements (CFR 15.203)

This equipment is not available to the general public and will only be installed by a professional installer working for an approved utility. The equipment therefore meets the intent of the above requirement. Only the antenna listed in Table 4 was used for this test report. For information about the other antennas used with this equipment please see the original certification report.

**Table 4. Allowed Antenna(s)**

| MANUFACTURER | TYPE OF ANTENNA | MODEL | GAIN $dB_i$ | TYPE OF CONNECTOR |
|---|---|---|---|---|
| Neptune | Monopole | R900 Wire Antenna | 2.15 | Soldered |

## 2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement. See paragraph 2.8 of the test report.

## 2.8 Intentional Radiator Radiated Emissions (CFR 15.209, 15.247(d))

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98% or max level possible duty cycle) and tested per ANSI C63.10:2013. The EUT was tested in the orientation of normal operation because the device is designed to operate in a fixed position.

Radiated measurements were conducted between the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (not greater than 40 GHz). In the band below 125 kHz, a resolution bandwidth (RBW) of 200 Hz was used. In the band from 125 kHz to 30 MHz, a RBW of 9 kHz was used; emissions below 1 GHz were tested with a RBW of 100/120 kHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

## Table 5. Average Radiated Fundamental & Harmonic Emissions

| **Test:** FCC Part 15, Para 15.209, 15.247(d), RSS-247 | | | | | **Client:** Neptune Technology Group Inc. | | | |
|---|---|---|---|---|---|---|---|---|
| **Project:** 18-0105 | | | | | **Model:** L900 | | | |
| **Frequency (MHz)** | **Test Data (dBuv)** | **Extra Factor** | **AF+CA-AMP (dB/m)** | **Results (dBuV/m)** | **Limits (dBuV/m)** | **Antenna Distance/ Polarization** | **Margin (dB)** | **Detector Mode** |
| **Low Channel – AVERAGE** | | | | | | | | |
| 911.07 | 90.99 | -20.00 | 26.39 | 97.38 | -- | 3m./VERT | -- | **AVG** |
| 1822.10 | 63.94 | -20.00 | -3.07 | 40.87 | 77.9 | 3.0m./VERT | 37.0 | **AVG** |
| 2733.28 | 54.13 | -20.00 | 0.71 | 34.84 | 54.0 | 3.0m./HORZ | 19.2 | **AVG** |
| 9110.90 | 46.07 | -29.50~ | 20.62 | 37.19 | 54.0 | 1.0m./VERT | 16.8 | **AVG** |
| **High Channel – AVERAGE** | | | | | | | | |
| 919.07 | 91.12 | -20.00 | 26.19 | 97.31 | -- | 3m./VERT | -- | **AVG** |
| 1838.18 | 61.94 | -20.00 | -3.07 | 38.87 | 77.3 | 3.0m./VERT | 38.4 | **AVG** |
| 2757.20 | 50.90 | -20.00 | 0.83 | 31.73 | 54.0 | 3.0m./HORZ | 22.3 | **AVG** |
| 7352.60 | 46.93 | -29.50~ | 19.30 | 36.73 | 54.0 | 1.0m./VERT | 17.3 | **AVG** |
| 9190.80 | 46.67 | -29.50~ | 20.51 | 37.68 | 54.0 | 1.0m./VERT | 16.3 | **AVG** |

-

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in constant broadcast mode, with a duty cycle greater than its normal operating duty cycle (>98%) therefore a correction factor of -20 dB was used in the extra factor column. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 911.07 MHz:

| | | |
|---|---|---|
| Magnitude of Measured Frequency | 90.99 | dBuV |
| +Peak to Average Factor | -20.00 | dB |
| +Antenna Factor + Cable Loss+ Amplifier Gain | 26.39 | dB/m |
| Corrected Result | 97.38 | dBuV/m |

Test Date: June 13, 2018
Tested By
Signature: _____ Name: Bruce Arnold

## Table 6. Peak Radiated Fundamental & Harmonic Emissions

| **Test:** FCC Part 15, Para 15.209, 15.247(d), RSS-247 | | | | **Client:** Neptune Technology Group Inc. | | | |
|---|---|---|---|---|---|---|---|
| **Project:** 18-0105 | | | | **Model:** L900 | | | |
| **Frequency (MHz)** | **Test Data (dBuv)** | **AF+CA-AMP (dB/m)** | **Results (dBuV/m)** | **Limits (dBuV/m)** | **Antenna Distance/ Polarization** | **Margin (dB)** | **Detector Mode** |
| **Low Channel – PK** | | | | | | | |
| 911.07 | 90.99 | 26.39 | 117.38 | | 3m./VERT | | **PK** |
| 1822.10 | 63.94 | -3.07 | 60.87 | 97.4 | 3.0m./VERT | 36.5 | **PK** |
| 2733.28 | 54.13 | 0.71 | 54.84 | 74.0 | 3.0m./HORZ | 19.2 | **PK** |
| 9110.90 | 46.07 | 11.12~ | 57.19 | 74.0 | 1.0m./VERT | 16.8 | **PK** |
| **No harmonics greater than the levels seen at the high channel.** | | | | | | | |
| **High Channel – PK** | | | | | | | |
| 919.07 | 91.12 | 26.19 | 117.31 | | 3m./VERT | | **PK** |
| 1838.18 | 61.94 | -3.07 | 58.87 | 97.3 | 3.0m./VERT | 38.4 | **PK** |
| 2757.20 | 50.90 | 0.83 | 51.73 | 74.0 | 3.0m./HORZ | 22.3 | **PK** |
| 7352.60 | 46.93 | 9.80~ | 56.73 | 74.0 | 1.0m./VERT | 17.3 | **PK** |
| 9190.80 | 46.67 | 11.01~ | 57.68 | 74.0 | 1.0m./VERT | 16.3 | **PK** |

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for **peak** measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB).
4. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than its normal operating duty cycle. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 911.07 MHz:

| | | |
|---|---|---|
| Magnitude of Measured Frequency | 90.99 | dBuV |
| +Antenna Factor + Cable Loss+ Amplifier Gain | 26.39 | dB/m |
| Corrected Result | 117.38 | dBuV/m |

Test Date: June 13, 2018
Tested By
Signature: Bruce Arnold Name: Bruce Arnold

## 2.9 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

### Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.

## 3 Conclusions

Based on the evaluation above it can be determined that the changes made to the module will not have any significant impact on the test data that has already been provide to applicable agencies (FCC and Innovation, Science and Economic Development Canada). This modification meets the requirements of a Class 2 Permissive Change as documented herein.

Please keep a copy of this report along with the permissive change letter in your records as proof that the product has been evaluated.