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TEST REPORT

Project Number 14463

Report Issue Date: 03/06/2015

Applicant:

Aclara RF Systems
30400 Solon Road
Solon, Ohio
44139

Product:

Models – See page 13
Description: Meter Transmitting Unit

FCC ID:LLB2015002
IC ID: 4546A-2015002

Test dates: 02/27/2015 – 03/05/2015 Receive Date: 02/23/2015

For the purpose of demonstrating compliance with
FCC Part 90 & Industry Canada RSS-119 & RSS:GEN

Prepared by: Steven E. Hoke - EMC Site Manager

FCC Registered Test Site Number: 160606
Industry Canada Registered Test Site Number: IC 2087A-1

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Test Procedures

EUT description: "Meter Transmitting Unit" (MTU) designed to provide remote meter reading capability for utility meters that provide a pulsed or encoded output. The transceiver is self-powered and connects to the output of 1 or 2 water meters with an electrical cable. An on-board battery provides power. The transmitter provides a very short, intermittent radio frequency transmission to send a remote reading of the meter. A microprocessor provides timing, control and data processing functions. The built in antenna is inaccessible to the user and no provision is made for an external antenna. The receiver can be used for upgrading firmware, requests for meter reads or other options available in the system. Special test firmware was used for testing in order to provide longer transmission than for normal operation. A prototype unit was used as a test subject for this report. The report presents the data obtained in support of an application for certification under Part 90 of the FCC rules and RSS-119 of Industry Canada.

Direct Power Output: Measurements of the RF power output and spurious emissions were made at the antenna terminal per 2.1046 and 2.1051. The output of the transmitter was connected to the spectrum analyzer through either a 20 dB or 30 dB attenuator and 2 ft. of coaxial cable. When activated, the transmitter was set to transmit continuously. When a reading was obtained, the transmitter was shut off and restarted before the next reading. The fundamental and harmonic emissions were observed and the signal strengths recorded for three test frequencies covering the tuning range of the transmitter.

According to 90.210(d)(3) all emissions greater than 12.5 kHz from the center of the authorized band shall be attenuated below the unmodulated carrier by 50 + 10log(P). The maximum signal level observed was 28.7 dBm. The signal levels of all harmonics greater than the fourth were in the noise of the analyzer and may be less than the reported values.

The determined power outputs, the required harmonic attenuation as well as the attenuation for each harmonic are found in Table 1.

Equivalent power of Spurious Emissions: Using the power measurements of the fundamental described in the previous section as the reference, measurement of the harmonic emissions was made using the substitution method of TIA/EIA 603. These measurements were made with a 50 Ohm dummy load connected to the transmitter output. The EUT operates in the frequency range of (450 - 470) MHz. The first step in the measurement process was to measure the field strength of the fundamental frequency at the lowest, highest and middle operating frequency. These measurements are made in both the vertical and horizontal polarity. The maximum field strength is reported by raising and lowering the measuring antenna height between (1-4) meters and by rotating the EUT (360) degrees. The measurement distance is (3) meters. Measurements made per ANSI/TIA-603-C-2004. The field strength measurements continue as described above for up to the tenth harmonic of each fundamental frequency.

Once the field strength of each signal is recorded, the EUT is replaced with a substitution antenna and signal generator. The substitution antenna is placed at the same height as the EUT had been. The combination of antenna and signal generator is then adjusted to reproduce the recorded field strength at each frequency. The ERP is then calculated by the following:

ERP = PG - CL + ANT

ERP = Effective Radiated Power (dBm)
PG = Signal Generator Output (dBm)
CL = Cable loss (dB)
ANT = antenna gain (dBd)
dBd = (antenna gain dBi) - (2.2 dB)

Occupied Bandwidth: The occupied bandwidth was measured with the EUT set to the middle of the operating frequency range. The emissions mask used was that specified in Part 90.210 (d).

Frequency Stability vs. Supply Voltage: One of the internal batteries was disconnected and replaced with an external variable power supply. The frequency was measured at the normal battery voltage of (7.20) VDC and again with the external power supply adjusted to an (85%) level or (6.12) volts. This was repeated with the external DC voltage adjusted to (8.28) VDC. The maximum allowed deviation is (2.5) ppm or (1,150) Hz at (460) MHz.

Frequency Stability vs. Temperature: The fundamental frequency was measured at an ambient temperature of (20) degrees C and recorded. The transmitter was then placed in an environmental chamber that was adjusted until a low temperature of (-30) degrees C was achieved. The transmitter was allowed to stabilize for (20) minutes at this temperature and then the frequency was again measured with a spectrum analyzer. The chamber was allowed to warm to (-20) degrees C and the measurement process was repeated. The environment was moved to a maximum temperature of (+70) degrees C in (10) degree increments, allowed to stabilize for (10) minutes and the frequency was re-measured.

Transient Frequency Behavior: Connect the output of the transmitter under test (EUT) to an attenuator, and this to a directional coupler. Connect an RF Modulation analyzer to the coupled output of the directional coupler, and connect the output of the modulation analyzer to the input on a storage oscilloscope. The output of the directional coupler is mixed, via an RF combining network, with the output of a signal generator. Verify that the EUT signal level present at the combining network output is approximately 40 dB below the maximum input level of the modulation analyzer. Set the signal generator at the same frequency as the EUT, modulated with a 1 kHz tone, with an FM deviation equal to the assigned channel spacing (+12.5 kHz). Adjust the signal generator to provide 20 dB less power at the combiner. . Connect the output of the RF combiner to the modulation analyzer, and the modulation analyzer modulation output port to a vertical input channel of the storage scope. Adjust the horizontal sweep rate on the oscilloscope to 10 msec/div, and the vertical amplitude to display the 1 kHz tone over +/- 4 divisions centered on the display. Reduce the transmit attenuation by 30 dB so that the difference in the power between the reference signal and the EUT signal at the combiner is 50 dB when the EUT is turned on. Switch on the EUT and record the display (for RF Output Power ON). Switch off the transmitter and record the display (for RF Output Power OFF).

Low Frequency Emissions: Low frequency emissions were examined from 30 kHz to 1,000 MHz using a passive loop antenna, biconical antenna and log periodic antenna. All emissions observed between 30 kHz and 1 GHz, other than the harmonics of the transmitter were determined to be more than 20 dB below the limit levels for spurious emissions of Part 90.210 and RSS-119.

Testing Summary

Test	Pass / Fail
Power Output and Spurious Emissions	PASS
Occupied Bandwidth	PASS
Frequency Stability vs. Temperature	PASS
Frequency Stability vs. Supply Voltage	PASS
Transient Stability	PASS

TEST EQUIPMENT CALIBRATION INFORMATION

Manufacturer	Model	Description	Serial Number	Cal Due Date
Hewlett Packard	8566B	Spectrum Analyzer	2532A02418	11/05/15
Hewlett Packard	85662A	Display	2403A07352	11/05/15
Hewlett Packard	85650A	Quasi-Peak Adapter	2043A00358	11/05/15
Hewlett Packard	8447D	Preamp	2944A06832	03/08/15
Hewlett Packard	8449B	Preamp	3008A00320	06/06/15
Hewlett Packard	8648B	Signal Generator	3443U00312	05/12/15
Hewlett Packard	8672A	Signal Generator	2211A02426	03/26/15
Electro-Metrics	BIA-30	Biconical Antenna	3852	06/17/16
EMCO	3148	Log Periodic Antenna	00075741	02/07/16
Electro-metrics	LPA-30	Log Periodic Antenna	2280	07/18/15
Electro-metrics	ALR-25	Loop Antenna	722	09/19/15
Tektronix	TDS-680B	Oscilloscope	B010311	03/12/15
Electro-Metrics	3115	Double Ridge Guide Antenna	3810	07/16/15
ETS Lindgren	3117	Double Ridge Guide Antenna	00109296	02/11/16
Agilent	7402A	Spectrum Analyzer	US39150137	02/04/16
Fluke	52	Digital Thermometer	447533	01/10/16
Hewlett Packard		DC Power Supply	None	N/A
Fluke	87V	DVM	95570315	01/05/16
Sun Systems	EC127	Environmental Chamber	EC0154	N/A
Hewlett Packard	8901B	Modulation Analyzer	3226A	12/31/15

Direct Power Output and Spurious Emissions

02/27/2015 – 03/05/2015

TABLE 1

Frequency		Direct	Attenuator	Cable loss	Adj. Level	Limit	Margin
MHz		dBm	dB	dB	dBm	dBm	dB
450		-2.3	30	1	28.7	na	na
900		-66.6	30	1.2	-35.4	-20	15.4
1350		-63	30	1.2	-31.8	-20	11.8
1800		-68.5	30	1.3	-37.2	-20	17.2
2250		-61.5	30	1.5	-30	-20	10
2700		-63	30	1.9	-31.1	-20	11.1
3150		-63.8	30	2.1	-31.7	-20	11.7
3600		-69.2	30	2.1	-37.1	-20	17.1
4050		-79	20	2.2	-56.8	-20	36.8
4500		-77	20	2.3	-54.7	-20	34.7
460		-2.3	30	1	28.7	na	na
920		-66.7	30	1.2	-35.5	-20	15.5
1380		-58.3	30	1.2	-27.1	-20	7.1
1840		-63.5	30	1.3	-32.2	-20	12.2
2300		-66.6	30	1.5	-35.1	-20	15.1
2760		-62.2	30	1.9	-30.3	-20	10.3
3220		-62.8	30	2.1	-30.7	-20	10.7
3680		-69.5	30	2.2	-37.3	-20	17.3
4140		-76.4	20	2.3	-54.1	-20	34.1
4600		-78.5	20	2.4	-56.1	-20	36.1
470		-2.9	30	1	28.1	na	na
940		-60	30	1.2	-28.8	-20	8.8
1410		-54.9	30	1.3	-23.6	-20	3.6
1880		-66.5	30	1.3	-35.2	-20	15.2
2350		-64.9	30	1.5	-33.4	-20	13.4
2820		-66	30	1.9	-34.1	-20	14.1
3290		-63.6	30	2.1	-31.5	-20	11.5
3760		-70.2	30	2.2	-38	-20	18
4230		-74	20	2.3	-51.7	-20	31.7
4700		-82	20	2.5	-59.5	-20	39.5

The spurious emissions shown above meet the requirements of Part 90.120 (d) (3) defined as: On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

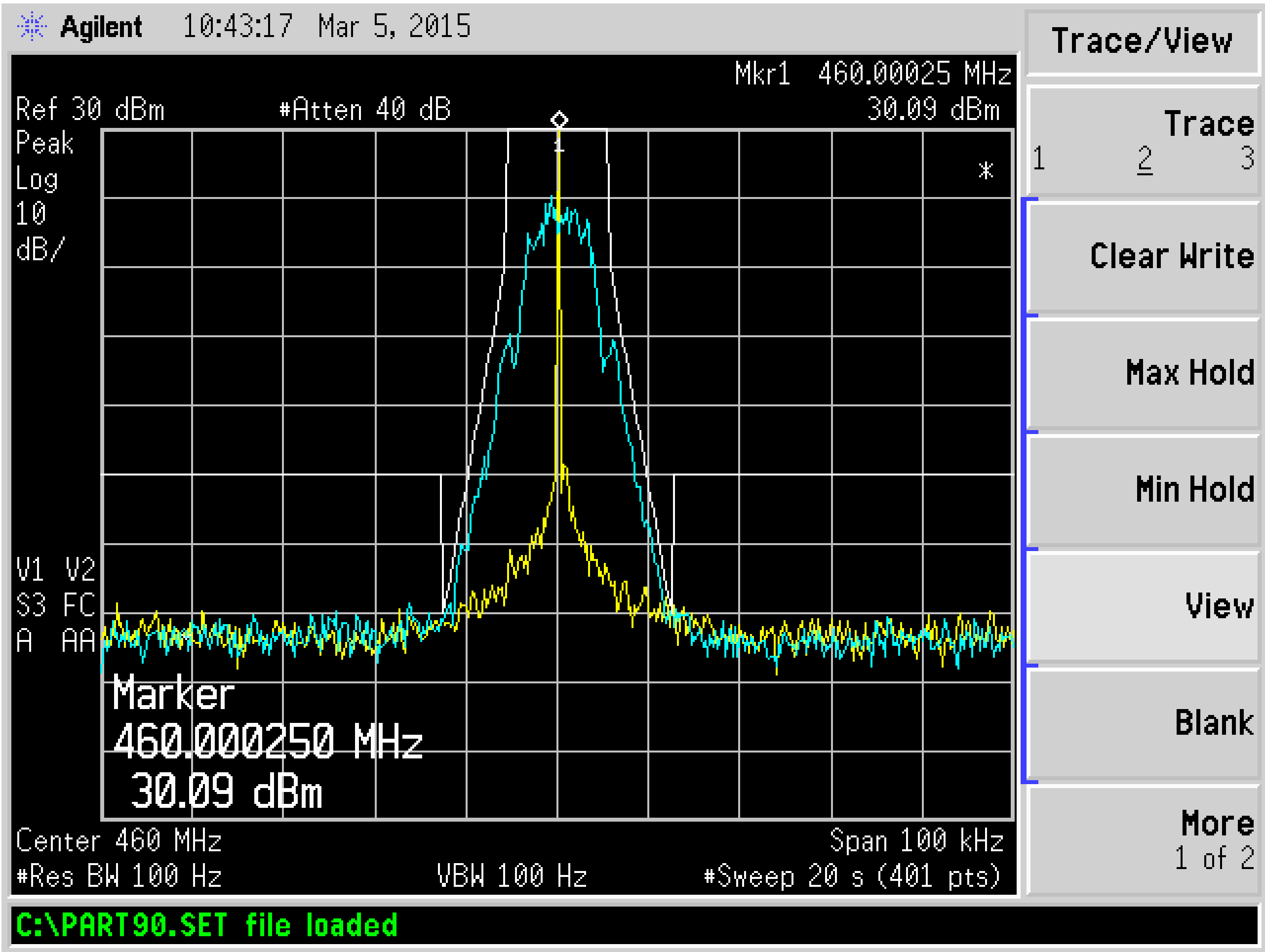
Spurious Emissions

Substitution Method

02/27/2015 – 03/05/2015

Frequency		Equivalent	Antenna	Limit	Margin
		Power	Polarity		
MHz		dBm	V/H	dBm	dB
450					
900		-39.2	H	-20	19.2
1350		-25.4	V	-20	5.4
1800		-27.3	V	-20	7.3
2250		-26.0	V	-20	6.0
2700		-26.5	H	-20	6.5
3150		-31.8	V	-20	11.8
3600		-26.4	H	-20	6.4
4050		-24.5	V	-20	4.5
4500		-32.5	V	-20	12.5
460					
920		-45.4	H	-20	25.4
1380		-27.2	V	-20	7.2
1840		-22.5	V	-20	2.5
2300		-26.6	V	-20	6.6
2760		-36.3	H	-20	16.3
3220		-32.2	V	-20	12.2
3680		-23.4	V	-20	3.4
4140		-31.4	V	-20	11.4
4600		-30.5	V	-20	10.5
470					
940		-42.4	H	-20	22.4
1410		-30.9	V	-20	10.9
1880		-26.3	V	-20	6.3
2350		-24.8	V	-20	4.8
2820		-24.1	V	-20	4.1
3290		-28.0	V	-20	8.0
3760		-23.4	H	-20	3.4
4230		-34.3	V	-20	14.3
4700		-31.1	V	-20	11.1

OCCUPIED BANDWIDTH



The above plot demonstrates that the EUT meets the 90.210 Emission Mask D requirements:

(d) Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd-2.88 kHz) dB.

FREQUENCY STABILITY VS TEMPERATURE

			3/3/2015
Temperature	Measured Freq	Deviation	Deviation
Degrees C	Hz	Hz	PPM
-30	460,000,130	130	0.28
-20	460,000,122	122	0.27
-10	460,000,116	116	0.25
0	460,000,100	100	0.22
10	460,000,086	86	0.19
20	460,000,068	68	0.15
30	459,999,050	50	0.11
40	459,999,040	40	0.9
50	459,999,050	50	0.11
60	459,999,060	60	0.13
70	459,999,030	30	0.07
	Limit = 2.5 ppm		

Assigned Frequency = 460.000000 MHz

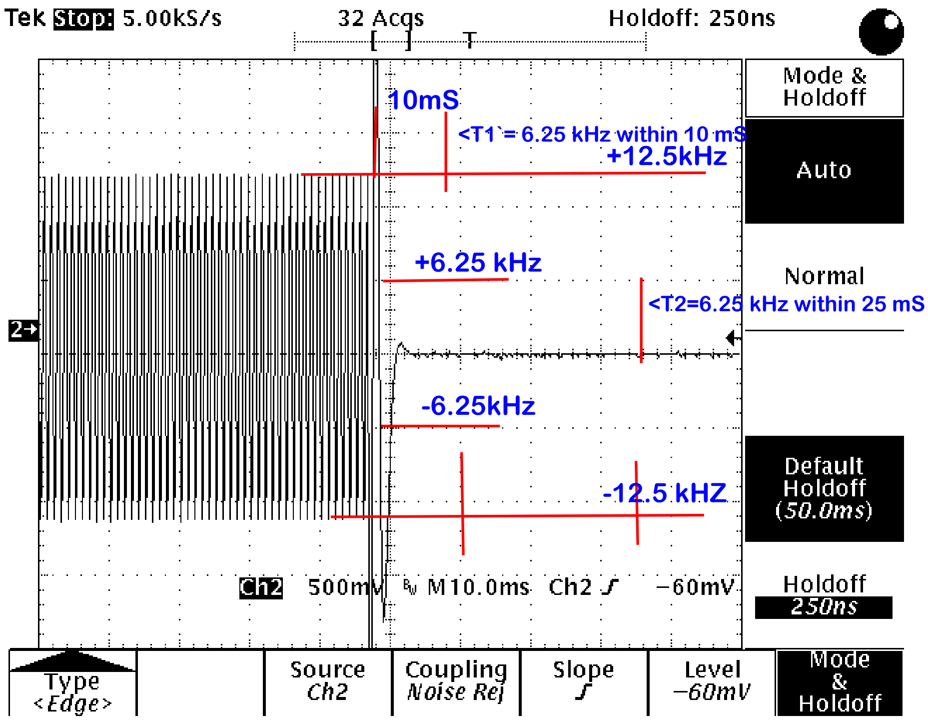
FREQUENCY STABILITY VS VOLTAGE

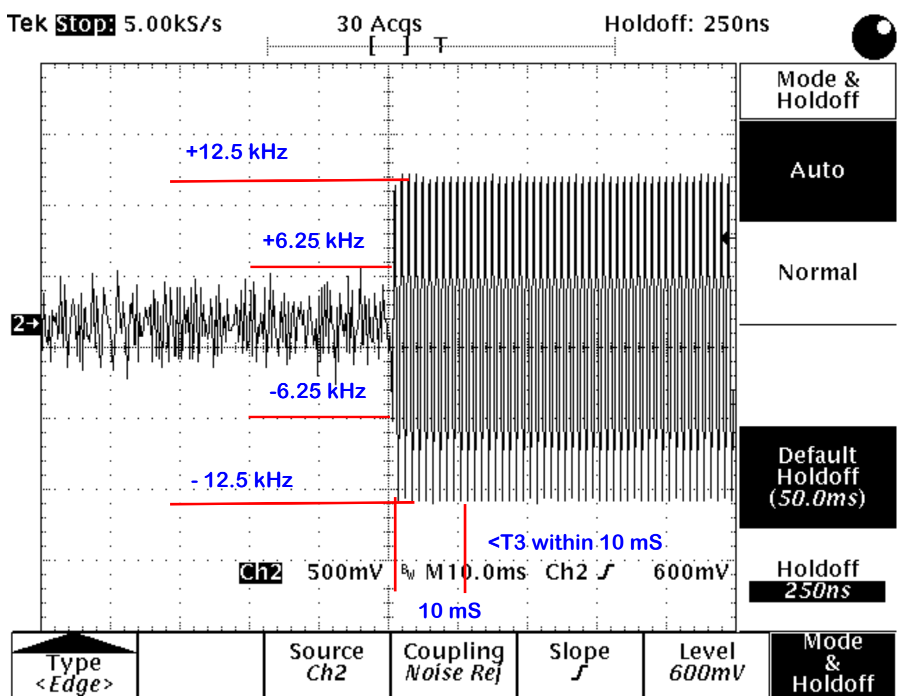
Voltage Input	Output Frequency (Hz)	Deviation (Hz)	Deviation (ppm)
6.12 VDC	459999987	13	0.028
7.20 VDC	459999971	29	0.063
8.28 VDC	459999981	19	0.041
	Assigned Frequency = 460,000,000 Hz		

The maximum allowed deviation is (2.5) ppm or (1,150) Hz at (460) MHz.

The receiver/digital device portion of the transmitter was also examined for radiated emissions per Part 15, and has been verified to comply with the appropriate sections of that part. The data used for verification of the receiver/digital device portion is presented in a separate report.

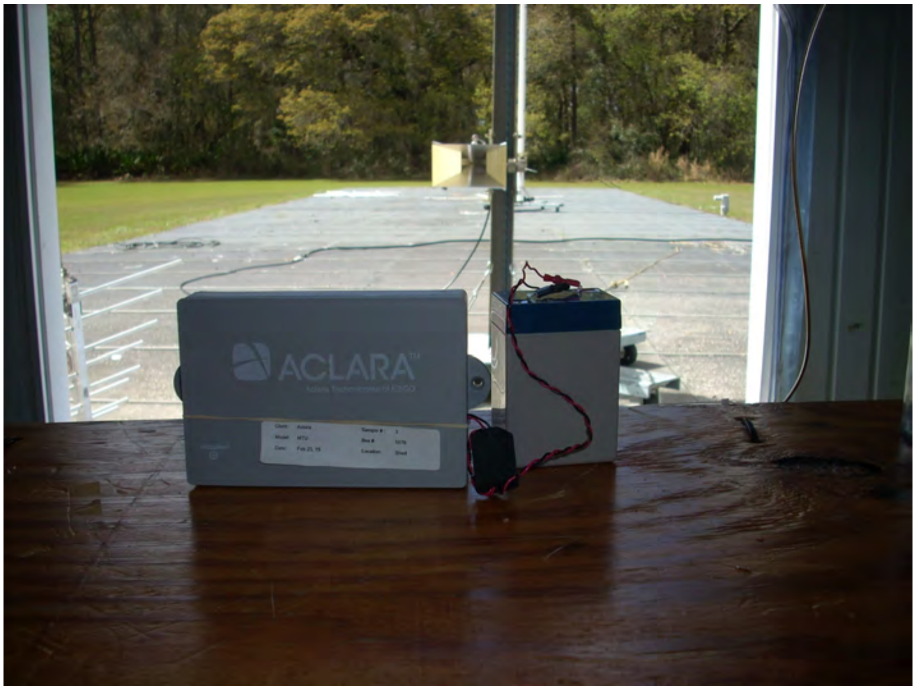
TRANSIENT FREQUENCY BEHAVIOR





Test Requirements: Frequency deviation during t_1 (10 ms duration after t_{on}) may be greater than ±12.5 kHz because the output power is less than 6 Watts. Frequency deviation during t_2 (25 ms duration after t_1) must be less than ±6.25 kHz. 3. Frequency deviation after t_2 must be less than ±2.5 ppm, or ±1150 Hz at 460 MHz. Frequency deviation during t_3 (10 ms duration after transmitter is turned off) may exceed ±12.5 kHz because output power is less than 6 Watts.

OUTPUT POWER AND SPURIOUS EMISSIONS
SETUP PHOTOGRAPHS



POSSIBLE ANTENNA MODEL NUMBERS (some of these are not currently being built)

3/3/2015 DSR

		No Connector	No Connector	Nicor	Badger	Neptune 6'
Single Port	STD range	3321-012-DB-A	3321-025-DB-A	3321-103-DB-A	3321-206-DB-A	3321-306-DB-A
		3321-012-RB-A	3321-025-RB-A	3321-103-RB-A	3321-206-RB-A	3321-306-RB-A
		3321-012-XB-A	3321-025-XB-A	3321-103-XB-A	3321-206-XB-A	3321-306-XB-A
	Ext range	3321-012-DBW-A	3321-025-DBW-A	3321-103-DBW-A	3321-206-DBW-A	3321-306-DBW-A
		3321-012-RBW-A	3321-025-RBW-A	3321-103-RBW-A	3321-206-RBW-A	3321-306-RBW-A
		3321-012-XBW-A	3321-025-XBW-A	3321-103-XBW-A	3321-206-XBW-A	3321-306-XBW-A
Dual Port	STD range	3322-012-DB-A	3322-025-DB-A	3322-103-DB-A	3322-206-DB-A	3322-306-DB-A
		3322-012-RB-A	3322-025-RB-A	3322-103-RB-A	3322-206-RB-A	3322-306-RB-A
		3322-012-XB-A	3322-025-XB-A	3322-103-XB-A	3322-206-XB-A	3322-306-XB-A
	Ext range	3322-012-DBW-A	3322-025-DBW-A	3322-103-DBW-A	3322-206-DBW-A	3322-306-DBW-A
		3322-012-RBW-A	3322-025-RBW-A	3322-103-RBW-A	3322-206-RBW-A	3322-306-RBW-A
		3322-012-XBW-A	3322-025-XBW-A	3322-103-XBW-A	3322-206-XBW-A	3322-306-XBW-A

		Neptune 25'	Sensus (iPERL) 6'	Sensus (iPERL) 12'	Hydroconn 3'	Hydroconn 12'
Single Port	STD range	3321-325-DB-A	3321-606-DB-A	3321-612-DB-A	3321-703-DB-A	3321-712-DB-A
		3321-325-RB-A	3321-606-RB-A	3321-612-RB-A	3321-703-RB-A	3321-712-RB-A
		3321-325-XB-A	3321-606-XB-A	3321-612-XB-A	3321-703-XB-A	3321-712-XB-A
	Ext range	3321-325-DBW-A	3321-606-DBW-A	3321-612-DBW-A	3321-703-DBW-A	3321-712-DBW-A
		3321-325-RBW-A	3321-606-RBW-A	3321-612-RBW-A	3321-703-RBW-A	3321-712-RBW-A
		3321-325-XBW-A	3321-606-XBW-A	3321-612-XBW-A	3321-703-XBW-A	3321-712-XBW-A
Dual Port	STD range	3322-325-DB-A	3322-606-DB-A	3322-612-DB-A	3322-703-DB-A	3322-712-DB-A
		3322-325-RB-A	3322-606-RB-A	3322-612-RB-A	3322-703-RB-A	3322-712-RB-A
		3322-325-XB-A	3322-606-XB-A	3322-612-XB-A	3322-703-XB-A	3322-712-XB-A
	Ext range	3322-325-DBW-A	3322-606-DBW-A	3322-612-DBW-A	3322-703-DBW-A	3322-712-DBW-A
		3322-325-RBW-A	3322-606-RBW-A	3322-612-RBW-A	3322-703-RBW-A	3322-712-RBW-A
		3322-325-XBW-A	3322-606-XBW-A	3322-612-XBW-A	3322-703-XBW-A	3322-712-XBW-A