NEON SENSOR COMMAND, CONTROL AND CONFIGURATION (C3) DOCUMENT: SUNA NITRATE ANALYZER, WADEABLE STREAMS

PREPARED BY	ORGANIZATION	DATE
Jesse Vance	AQU	07/19/2016
Kaelin Cawley	AQU	05/09/2017

APPROVALS	ORGANIZATION	APPROVAL DATE
Greg Holling	CI	08/10/2017
Laura Leyba-Newton	ENG	08/22/2017

RELEASED BY	ORGANIZATION	RELEASE DATE
Judy Salazar	CM	08/23/2017

See configuration management system for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	11/02/2016	ECO-03745	Initial Release
B	08/23/2017	ECO-04759	Update table of configuration parameters and number of dark frames reported

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1 DESCRIPTION

1.1 Purpose

This document specifies the command, control, and configuration details for operating a NEON sensor used for instrumental observations.   It includes a detailed discussion of all necessary requirements for operational control parameters, conditions/constraints, set points, and any necessary error handling. All Level 0 Data Products generated by the sensor should be identified.

1.2 Scope

This document specifies the command, control, and configuration that are needed for operating this sensor. It does not provide implementation details, except for cases where these stem directly from the sensor conditions as described here.

A complete set of the Level 0 data products generated in this document can be found in appendix.

The SUNA Nitrate Analyzer assembly will consist of following Data Generating Device (DGD) based on Data Generating Device DGD List and Hierarchies doc (AD [05]):

DGD Agile PN	DGD Agile Description
0329950000	Sensor, SUNA Nitrate with Integrate Wiper

Further detailed sensor info under each DGD is as following:

1. Under 0329950000:
   a. Firmware shall be maintained to the current release during annual maintenance plans.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 APPLICABLE DOCUMENTS

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD [01]	NEON.DOC.000001	NEON Observatory Design (NOD) Requirements
AD [02]	NEON.DOC.000291	NEON Configured Sensor List

AD [03]	NEON.DOC.005003	NEON Scientific Data Products Catalog
AD [04]	NEON.DOC.005005	NEON Level 0 Data Products Catalog
AD [05]	NEON.DOC.001104	Data Generating Device DGD List and Hierarchies
AD [06]	NEON.DOC.002181	ATBD Nitrate

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	SUNA Manual, Rev. E, SAT-DN-00628	

2.3 Acronyms

Acronym	Explanation
AIS	Aquatic Instrument System
ATBD	Algorithm Theoretical Basis Document
C^3	Command, Control, and Configuration Document
SOP	Standard Operating Procedures
QA/QC	Quality Assurance/Quality Control
TIS	Terrestrial Instrument System
L0	Level 0
L1	Level 1
ENG	NEON Engineering group
CI	NEON Cyberinfrastructure group

DPS	NEON Data Products group
SUNA	Submersible Ultraviolet Nitrate Analyzer
CVAL	NEON Calibration, Validation, and Audit Laboratory

3   SUNA NITRATE ANALYZER INTRODUCTION (0329950000)

The sensor configuration and sensor command and control described herein are related to the nitrate in surface water data product. A description of how sensor readings shall be converted to L1 DPs is presented in the associated ATBD (AD[06]). The AIS assembly used to generate this data product consists of a Satlantic, SUNA V2 nitrate analyzer placed in a PVC enclosure, which maintains flow through the optics of the sensor while mitigating against sediment deposition, fouling and impacts from debris in the stream. It is assumed that communication and control of the sensor will be executed via RS-232. The sensor may be queried to change settings or perform a "selftest" for error handling. Under the full ASCII output, the sensor generates 286 (0-285) data streams. NEON software has been developed to allow for these 286 data streams to be compressed to a single binary stream which may be parsed out during the ingest process. This scheme is described in Eq.1.

Equation 1   Stream#0= {0: <value>, 1: <value>,…285:<value>}

The L0 data products resulting from this sensor are listed in Table 2 of Section 4 and under Section 7.1 in the appendix. The identification for each of the compressed data fields (e.g. the field numbers in Equation 1) are listed in Table 3 of Section 4.

4   SUNA NITRATE ANALYZER OVERVIEW OF SENSOR CONFIGURATION (0329950000)

Sensor configuration settings are shown in Table 1. The sampling frequency shall be initially set to 15 min in order to capture the natural variability in the environment while minimizing the costs of maintenance and consumables. We will waive the requirements <Draft.N3> that nitrate be measured with a frequency of 1 min +/-until technology develops to allow for optimization of lamp life.

The wiper shall be configured on so that it clears the optics at the beginning of each measurement. This cycle takes approximately 30 seconds. The sensor takes approximately 15 seconds to warm up coming out of standby/sleep mode. Once a measurement is engaged, the sensor will take 10 measurements without the lamp engaged, although only one dark frame will be transmitted from the instrument, to provide the background current as a reference and correction factor. Then the sensor shall take 50 samples at between 0.5 - .667 Hz before returning to standby/sleep mode.

The lamp used as the light source for the UV detector has a supported lifespan of 900 hours. The sampling strategy as stated will result in a usage according to Equation 2.

Equation 2

$$\left(15 \; second \; warm \; up + 50\left(\frac{samples}{measurement}\right) \times 1.4\left(\frac{seconds}{sample}\right)\right) \times$$

$$4\left(\frac{measurements}{hour}\right) \times 24\left(\frac{hours}{day}\right) \times \frac{1}{900\left(\frac{replacement}{hours}\right)} \; = $$

$$397 \; days \; between \; reommended \; replacement$$

Table 1. Sensor configuration settings.

Parameter Code	Value
PATHLGTH	10mm
INTWIPER	Available
EXTPPORT	Missing
SUPRCAPS	Available
PWRSVISR	Available
USBSWTCH	Available
RELAYBRD	Missing
INTDATLG	Available
APFIFACE	Missing
SCHDLING	Available
STUPSTUS	Done
BAUDRATE	57600
MSGLEVEL	Info
MSGFSIZE	2
DATFSIZE	5

OUTFRTYP	Full_ASCII
LOGFRTYP	Full_ASCII
OUTDRKFR	Output
LOGDRKFR	Output
LOGFTYPE	Daily
AFILEDUR	60
ACQCOUNT	6
CNTCOUNT	298
DCMINNO3	-5
DCMAXNO3	100
WDAT_LOW	217
WDAT_HGH	250
SDI12ADD	48
DATAMODE	Real
OPERMODE	Periodic
OPERCTRL	Samples
EXDEVTYP	Wiper
EXDEVPRE	30
EXDEVRUN	Off
EXDVIVAL	0
COUNTDWN	15
FIXDDURA	60

PERDIVAL	15m
PERDOFFS	0
PERDDURA	130
PERDSMPL	50
POLLTOUT	15
APFATOFF	10
STBLTIME	10
SKPSLEEP	Off
LAMPTOFF	35
SPINTPER	250
DRKAVERS	1
LGTAVERS	1
DRKSMPLS	10
LGTSMPLS	50
DRKDURAT	2
LGTDURAT	58
TEMPCOMP	Off
SALINFIT	Off
BRMTRACE	Off
BL_ORDER	1
FITCONCS	1
DRKCORMT	SpecAverage

A_CUTOFF	10
INTPRADJ	Off
INTPRFAC	1
INTADSTP	20
INTADMAX	20
WFIT_LOW	217
WFIT_HGH	240

Table 2. L0 data streams from SUNA Nitrate Analyzer **(**0329950000**)** at a frequency of 1 dark frame and 50 light frames per 15 minutes

fieldName	description	Units
rawNitrateSingleCompressedStream	Single compressed data stream from SUNA to be parsed at NEON headquarters	NA

Table 3. Data fields and position that are captured with the SUNA and placed into the compressed L0 data stream identified in Table 2 above.

L0 Data Stream Field Position	Full ASCII Data Fields
0	Light Frame/Dark Frame
1	Date field (numeric)
2	Time field (numeric)
3	Nitrate concentration as micromolar
4	Nitrogen in nitrate as mg/L
5	Absorbance at 254 nm
6	Absorbance at 350 nm
7	Bromide trace

8	Spec Average or SW Average(Dark Correction Method)
9	Dark Signal Average (average dark intensity)
10	Integration Time Factor
11	spectrometer intensity at wavelength 189.29 nm
12	spectrometer intensity at wavelength 190.08 nm
13	spectrometer intensity at wavelength 190.87 nm
14	spectrometer intensity at wavelength 191.67 nm
15	spectrometer intensity at wavelength 192.46 nm
16	spectrometer intensity at wavelength 193.26 nm
17	spectrometer intensity at wavelength 194.05 nm
18	spectrometer intensity at wavelength 194.85 nm
19	spectrometer intensity at wavelength 195.64 nm
20	spectrometer intensity at wavelength 196.44 nm
21	spectrometer intensity at wavelength 197.23 nm
22	spectrometer intensity at wavelength 198.03 nm
23	spectrometer intensity at wavelength 198.83 nm
24	spectrometer intensity at wavelength 199.62 nm
25	spectrometer intensity at wavelength 200.42 nm
26	spectrometer intensity at wavelength 201.22 nm
27	spectrometer intensity at wavelength 202.02 nm
28	spectrometer intensity at wavelength 202.81 nm
29	spectrometer intensity at wavelength 203.61 nm
30	spectrometer intensity at wavelength 204.41 nm
31	spectrometer intensity at wavelength 205.21 nm
32	spectrometer intensity at wavelength 206.01 nm
33	spectrometer intensity at wavelength 206.81 nm
34	spectrometer intensity at wavelength 207.61 nm
35	spectrometer intensity at wavelength 208.41 nm
36	spectrometer intensity at wavelength 209.21 nm
37	spectrometer intensity at wavelength 210.01 nm
38	spectrometer intensity at wavelength 210.81 nm
39	spectrometer intensity at wavelength 211.61 nm
40	spectrometer intensity at wavelength 212.41 nm
41	spectrometer intensity at wavelength 213.21 nm
42	spectrometer intensity at wavelength 214.01 nm
43	spectrometer intensity at wavelength 214.82 nm

44	spectrometer intensity at wavelength 215.62 nm
45	spectrometer intensity at wavelength 216.42 nm
46	spectrometer intensity at wavelength 217.22 nm
47	spectrometer intensity at wavelength 218.03 nm
48	spectrometer intensity at wavelength 218.83 nm
49	spectrometer intensity at wavelength 219.63 nm
50	spectrometer intensity at wavelength 220.43 nm
51	spectrometer intensity at wavelength 221.24 nm
52	spectrometer intensity at wavelength 222.04 nm
53	spectrometer intensity at wavelength 222.85 nm
54	spectrometer intensity at wavelength 223.65 nm
55	spectrometer intensity at wavelength 224.46 nm
56	spectrometer intensity at wavelength 225.26 nm
57	spectrometer intensity at wavelength 226.06 nm
58	spectrometer intensity at wavelength 226.87 nm
59	spectrometer intensity at wavelength 227.68 nm
60	spectrometer intensity at wavelength 228.48 nm
61	spectrometer intensity at wavelength 229.29 nm
62	spectrometer intensity at wavelength 230.09 nm
63	spectrometer intensity at wavelength 230.9 nm
64	spectrometer intensity at wavelength 231.71 nm
65	spectrometer intensity at wavelength 232.51 nm
66	spectrometer intensity at wavelength 233.32 nm
67	spectrometer intensity at wavelength 234.13 nm
68	spectrometer intensity at wavelength 234.93 nm
69	spectrometer intensity at wavelength 235.74 nm
70	spectrometer intensity at wavelength 236.55 nm
71	spectrometer intensity at wavelength 237.36 nm
72	spectrometer intensity at wavelength 238.16 nm
73	spectrometer intensity at wavelength 238.97 nm
74	spectrometer intensity at wavelength 239.78 nm
75	spectrometer intensity at wavelength 240.59 nm
76	spectrometer intensity at wavelength 241.4 nm
77	spectrometer intensity at wavelength 242.21 nm
78	spectrometer intensity at wavelength 243.01 nm
79	spectrometer intensity at wavelength 243.82 nm

80	spectrometer intensity at wavelength 244.63 nm
81	spectrometer intensity at wavelength 245.44 nm
82	spectrometer intensity at wavelength 246.25 nm
83	spectrometer intensity at wavelength 247.06 nm
84	spectrometer intensity at wavelength 247.87 nm
85	spectrometer intensity at wavelength 248.68 nm
86	spectrometer intensity at wavelength 249.49 nm
87	spectrometer intensity at wavelength 250.3 nm
88	spectrometer intensity at wavelength 251.11 nm
89	spectrometer intensity at wavelength 251.92 nm
90	spectrometer intensity at wavelength 252.73 nm
91	spectrometer intensity at wavelength 253.55 nm
92	spectrometer intensity at wavelength 254.36 nm
93	spectrometer intensity at wavelength 255.17 nm
94	spectrometer intensity at wavelength 255.98 nm
95	spectrometer intensity at wavelength 256.79 nm
96	spectrometer intensity at wavelength 257.6 nm
97	spectrometer intensity at wavelength 258.41 nm
98	spectrometer intensity at wavelength 259.23 nm
99	spectrometer intensity at wavelength 260.04 nm
100	spectrometer intensity at wavelength 260.85 nm
101	spectrometer intensity at wavelength 261.66 nm
102	spectrometer intensity at wavelength 262.48 nm
103	spectrometer intensity at wavelength 263.29 nm
104	spectrometer intensity at wavelength 264.1 nm
105	spectrometer intensity at wavelength 264.91 nm
106	spectrometer intensity at wavelength 265.73 nm
107	spectrometer intensity at wavelength 266.54 nm
108	spectrometer intensity at wavelength 267.35 nm
109	spectrometer intensity at wavelength 268.17 nm
110	spectrometer intensity at wavelength 268.98 nm
111	spectrometer intensity at wavelength 269.79 nm
112	spectrometer intensity at wavelength 270.61 nm
113	spectrometer intensity at wavelength 271.42 nm
114	spectrometer intensity at wavelength 272.23 nm
115	spectrometer intensity at wavelength 273.05 nm

116	spectrometer intensity at wavelength 273.86 nm
117	spectrometer intensity at wavelength 274.68 nm
118	spectrometer intensity at wavelength 275.49 nm
119	spectrometer intensity at wavelength 276.31 nm
120	spectrometer intensity at wavelength 277.12 nm
121	spectrometer intensity at wavelength 277.93 nm
122	spectrometer intensity at wavelength 278.75 nm
123	spectrometer intensity at wavelength 279.56 nm
124	spectrometer intensity at wavelength 280.38 nm
125	spectrometer intensity at wavelength 281.19 nm
126	spectrometer intensity at wavelength 282.01 nm
127	spectrometer intensity at wavelength 282.82 nm
128	spectrometer intensity at wavelength 283.64 nm
129	spectrometer intensity at wavelength 284.45 nm
130	spectrometer intensity at wavelength 285.27 nm
131	spectrometer intensity at wavelength 286.08 nm
132	spectrometer intensity at wavelength 286.9 nm
133	spectrometer intensity at wavelength 287.71 nm
134	spectrometer intensity at wavelength 288.53 nm
135	spectrometer intensity at wavelength 289.35 nm
136	spectrometer intensity at wavelength 290.16 nm
137	spectrometer intensity at wavelength 290.98 nm
138	spectrometer intensity at wavelength 291.79 nm
139	spectrometer intensity at wavelength 292.61 nm
140	spectrometer intensity at wavelength 293.42 nm
141	spectrometer intensity at wavelength 294.24 nm
142	spectrometer intensity at wavelength 295.06 nm
143	spectrometer intensity at wavelength 295.87 nm
144	spectrometer intensity at wavelength 296.69 nm
145	spectrometer intensity at wavelength 297.51 nm
146	spectrometer intensity at wavelength 298.32 nm
147	spectrometer intensity at wavelength 299.14 nm
148	spectrometer intensity at wavelength 299.95 nm
149	spectrometer intensity at wavelength 300.77 nm
150	spectrometer intensity at wavelength 301.59 nm
151	spectrometer intensity at wavelength 302.4 nm

152	spectrometer intensity at wavelength 303.22 nm
153	spectrometer intensity at wavelength 304.04 nm
154	spectrometer intensity at wavelength 304.85 nm
155	spectrometer intensity at wavelength 305.67 nm
156	spectrometer intensity at wavelength 306.49 nm
157	spectrometer intensity at wavelength 307.3 nm
158	spectrometer intensity at wavelength 308.12 nm
159	spectrometer intensity at wavelength 308.93 nm
160	spectrometer intensity at wavelength 309.75 nm
161	spectrometer intensity at wavelength 310.57 nm
162	spectrometer intensity at wavelength 311.38 nm
163	spectrometer intensity at wavelength 312.2 nm
164	spectrometer intensity at wavelength 313.02 nm
165	spectrometer intensity at wavelength 313.83 nm
166	spectrometer intensity at wavelength 314.65 nm
167	spectrometer intensity at wavelength 315.47 nm
168	spectrometer intensity at wavelength 316.28 nm
169	spectrometer intensity at wavelength 317.1 nm
170	spectrometer intensity at wavelength 317.92 nm
171	spectrometer intensity at wavelength 318.73 nm
172	spectrometer intensity at wavelength 319.55 nm
173	spectrometer intensity at wavelength 320.37 nm
174	spectrometer intensity at wavelength 321.18 nm
175	spectrometer intensity at wavelength 322 nm
176	spectrometer intensity at wavelength 322.82 nm
177	spectrometer intensity at wavelength 323.63 nm
178	spectrometer intensity at wavelength 324.45 nm
179	spectrometer intensity at wavelength 325.27 nm
180	spectrometer intensity at wavelength 326.08 nm
181	spectrometer intensity at wavelength 326.9 nm
182	spectrometer intensity at wavelength 327.72 nm
183	spectrometer intensity at wavelength 328.53 nm
184	spectrometer intensity at wavelength 329.35 nm
185	spectrometer intensity at wavelength 330.17 nm
186	spectrometer intensity at wavelength 330.98 nm
187	spectrometer intensity at wavelength 331.8 nm

188	spectrometer intensity at wavelength 332.62 nm
189	spectrometer intensity at wavelength 333.43 nm
190	spectrometer intensity at wavelength 334.25 nm
191	spectrometer intensity at wavelength 335.06 nm
192	spectrometer intensity at wavelength 335.88 nm
193	spectrometer intensity at wavelength 336.7 nm
194	spectrometer intensity at wavelength 337.51 nm
195	spectrometer intensity at wavelength 338.33 nm
196	spectrometer intensity at wavelength 339.14 nm
197	spectrometer intensity at wavelength 339.96 nm
198	spectrometer intensity at wavelength 340.78 nm
199	spectrometer intensity at wavelength 341.59 nm
200	spectrometer intensity at wavelength 342.41 nm
201	spectrometer intensity at wavelength 343.22 nm
202	spectrometer intensity at wavelength 344.04 nm
203	spectrometer intensity at wavelength 344.85 nm
204	spectrometer intensity at wavelength 345.67 nm
205	spectrometer intensity at wavelength 346.48 nm
206	spectrometer intensity at wavelength 347.3 nm
207	spectrometer intensity at wavelength 348.12 nm
208	spectrometer intensity at wavelength 348.93 nm
209	spectrometer intensity at wavelength 349.75 nm
210	spectrometer intensity at wavelength 350.56 nm
211	spectrometer intensity at wavelength 351.38 nm
212	spectrometer intensity at wavelength 352.19 nm
213	spectrometer intensity at wavelength 353.01 nm
214	spectrometer intensity at wavelength 353.82 nm
215	spectrometer intensity at wavelength 354.63 nm
216	spectrometer intensity at wavelength 355.45 nm
217	spectrometer intensity at wavelength 356.26 nm
218	spectrometer intensity at wavelength 357.08 nm
219	spectrometer intensity at wavelength 357.89 nm
220	spectrometer intensity at wavelength 358.71 nm
221	spectrometer intensity at wavelength 359.52 nm
222	spectrometer intensity at wavelength 360.33 nm
223	spectrometer intensity at wavelength 361.15 nm

224	spectrometer intensity at wavelength 361.96 nm
225	spectrometer intensity at wavelength 362.78 nm
226	spectrometer intensity at wavelength 363.59 nm
227	spectrometer intensity at wavelength 364.4 nm
228	spectrometer intensity at wavelength 365.22 nm
229	spectrometer intensity at wavelength 366.03 nm
230	spectrometer intensity at wavelength 366.84 nm
231	spectrometer intensity at wavelength 367.65 nm
232	spectrometer intensity at wavelength 368.47 nm
233	spectrometer intensity at wavelength 369.28 nm
234	spectrometer intensity at wavelength 370.09 nm
235	spectrometer intensity at wavelength 370.91 nm
236	spectrometer intensity at wavelength 371.72 nm
237	spectrometer intensity at wavelength 372.53 nm
238	spectrometer intensity at wavelength 373.34 nm
239	spectrometer intensity at wavelength 374.15 nm
240	spectrometer intensity at wavelength 374.97 nm
241	spectrometer intensity at wavelength 375.78 nm
242	spectrometer intensity at wavelength 376.59 nm
243	spectrometer intensity at wavelength 377.4 nm
244	spectrometer intensity at wavelength 378.21 nm
245	spectrometer intensity at wavelength 379.02 nm
246	spectrometer intensity at wavelength 379.83 nm
247	spectrometer intensity at wavelength 380.64 nm
248	spectrometer intensity at wavelength 381.45 nm
249	spectrometer intensity at wavelength 382.27 nm
250	spectrometer intensity at wavelength 383.08 nm
251	spectrometer intensity at wavelength 383.89 nm
252	spectrometer intensity at wavelength 384.7 nm
253	spectrometer intensity at wavelength 385.51 nm
254	spectrometer intensity at wavelength 386.32 nm
255	spectrometer intensity at wavelength 387.13 nm
256	spectrometer intensity at wavelength 387.93 nm
257	spectrometer intensity at wavelength 388.74 nm
258	spectrometer intensity at wavelength 389.55 nm
259	spectrometer intensity at wavelength 390.36 nm

260	spectrometer intensity at wavelength 391.17 nm
261	spectrometer intensity at wavelength 391.98 nm
262	spectrometer intensity at wavelength 392.79 nm
263	spectrometer intensity at wavelength 393.6 nm
264	spectrometer intensity at wavelength 394.4 nm
265	spectrometer intensity at wavelength 395.21 nm
266	spectrometer intensity at wavelength 396.02 nm
267	Temperature of sensor
268	Spectrometer temperature
269	Lamp temperature
270	Cumulative lamp time
271	Relative humidity
272	Main voltage
273	Lamp voltage
274	Internal voltage
275	Main current
276	Fit aux 1
277	Fit aux 2
278	Fit base 1
279	Fit base 2
280	Fit RMSE
281	CTD Time
282	CTD Salinity
283	CTD Temperature
284	CTD Pressure
285	Check sum of data stream

5   SUNA NITRATE ANALYZER, LAKE COMMAND AND CONTROL (0329950000)

5.1   Error handling

This sensor does not report errors as part of the data output stream. Rather in the event of a failure or erroneous data outputs the status of the sensor may be queried. If values in the data stream do not pass automated quality control tests as described in AD[05], including internal humidity and power levels, those data may generate a flag which requires a self-test be performed by using the command

<selftest>. The self-test will generate a $Ok for all components which pass; while all components which fail will be terminated by (!). The sensor status will determine what action needs to be taken to address a reported error.

5.2   Sensor controls specification

5.3   Rationale for wipers

Biofouling is anticipated to occur at all aquatic sites in the NEON Domains to varying degrees. Biofouling may result in the accumulation of multiple species of aquatic organisms adhering to the surface of the sensor, having deleterious effects on measurements. Wipers are required to remove biofouling from optical lenses of the sensors. The wiper is integrated into the sensor and will perform a wipe prior to every measurement. The external device run time will be set to 30 seconds as described above. This will allow the wiper to complete a cleaning of the optics prior to data acquisition.

6   ASSEMBLY INTEGRATION

NA

7   APPENDIX

7.1   List of Level 0 data product

Table 4. List of Level 0 data product associated with DPName: Nitrate in Surface Water.

DGD Agile PN	DPNumber	fieldName	description	Acquisition frequency (Hz)	dataType	units
0329950000	NEON.DOM.SITE.DP0.20033.001. 02242.HOR.VER.000	rawNitrateSingleCompressedStream	Single compressed data stream from SUNA to be parsed at NEON headquarters	1 dark frame and 50 light frames per 15 minutes	String	NA

7.2   Assembly schematic drawing

NA

8   BIBLIOGRAPHY

Satlantic. (2014) SUNA Manual for SUNA running firmware version 2.5 or later. Satlatnic LP, Halifax, Nova Scotia. pp. 72, Manual Number SAT-DN-00628, Rev. E.