NEON SENSOR COMMAND, CONTROL AND CONFIGURATION (C3) DOCUMENT: SOIL CO$_2$

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See configuration management system for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	04/17/2012	ECO-00382	Initial release
B	04/07/2014	ECO-01716	Updated data product IDs to current format. Other minor clarifications to text. Added nine sensor-specific parameters that need to be recorded for each sensor prior to deployment.
C	8/27/2015	ECO-03128	Default setting for linearization changed to on. Data product IDs updated to current format. Heater control section deleted.
D	1/13/2016	ECO-03567	Updated to new template
E	05/16/2022	ECO-06815	• Revised logo and fine print

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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

The Soil CO$_2$ measurements shall be made using the Vaisala CARBOCAP® Carbon Dioxide Probe GMP343 Diffusion model 0-20,000 ppm range sensor, firmware version SWJ (2.10) (NEON P/N: 0300240000).

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 Soil CO$_2$ 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
CF00550040	Assembly, CO2 Probe and Cable

Further detailed sensor info under each DGD is as following:

1.   Under CF00550040:
    a.   NEON P/N: 0300240000, Sensor GMP343 Carbocap CO2 Probe, Diffusion model 0-20,000 ppm range sensor, firmware version SWJ (2.10)

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Other important parts that are not a DGD:

    a.   NEON P/N: 0300240001, SENSOR ACCESSORY FILTER GMP343, filter
    b.   NEON P/N: CF00550010, Assembly, Soil CO2 inner 2-51cm
    c.   NEON P/N: CF00550051, Assembly, Soil CO2 Outer Pipe 2CM -51CM Depth
    d.   NEON P/N: CF00550061, Assembly, Soil CO2 Inner Pipe 2CM - 51 CM Depth
    ……….

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.011083	Algorithm Theoretical Basis Document: Soil CO$_2$ Concentration

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

2.3   Acronyms

Acronym	Explanation
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
CVAL	NEON Calibration, Validation, and Audit Laboratory

3   ASSEMBLY, CO2 PROBE AND CABLE INTRODUCTION (CF00550040)

Soil CO_2 subsystem data product name and number are Soil CO_2 concentration and NEON.DOM.SITE.DP0.00095.001, respectively. A description of how sensor readings shall be converted to the data product is presented in the associated ATBD (AD[06]).

4   ASSEMBLY, CO2 PROBE AND CABLE OVERVIEW OF SENSOR CONFIGURATION (CF00550040)

The data from the sensor shall be unfiltered, uncompensated, and uncorrected CO2 concentration (rawCO2), as well as sensor headspace temperature (headspaceTemp), and error status (errorStatus) (Vaisala 2013).

Table 1. Sensor configuration settings.

Parameter	Default Setting
Heater	Off
Temperature compensation	Off
Oxygen compensation	Off
Pressure compensation	Off
Relative humidity compensation	Off
Median filter	Off
Averaging filter	Off
Smoothing filter	Off
Linearization	On
Linear correction	Off
Multipoint correction	Off
A2: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
B2: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
C2: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
A3: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
B3: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
C3: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
A4: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
B4: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
C4: Manufacturer specified sensor-specific compensation value	Sensor-specific temperature parameter determined by CVAL and sent to CI data store
CO$_2$ measurement: Acquisition rate	0.1 Hz
Sensor headspace temperature: Acquisition rate	0.1 Hz
Sensor error message: Acquisition rate	0.1 Hz
Measurement mode	Run

5 ASSEMBLY, CO2 PROBE AND CABLE COMMAND AND CONTROL (CF00550040)

5.1 Error Handling

All possible sensor error codes are shown in **Table 2**. When any of these errors occur the CO_2 concentration and temperature data streams shall be set to zero, 0, and the sensor error flag shall be set to one, 1. When an error occurs the specific sensor error code from **Table 2** shall be made available to NEON's Problem Tracking and Resolution system to determine what action is necessary. If an error message occurs (i.e., error status = 1) the sensor must be stopped, queried, have the error state reset, and restarted (Vaisala 2013). At the time of writing it is anticipated that the process to perform these actions will be fully described elsewhere (document TBD).

This document assumes that this sensor auto-resets its error status when the phenomenon causing the error ends. For example, if the temperature is outside the sensors' operating range the error flag will be set to 1 and the CO_2 concentration and temperature data will be set to 0 until the temperature returns to a level within the operating range, at which point the error flag will be set to 0 and the CO_2 concentration and temperature data streams will resume. If this does not occur automatically, a command and control process will be added to this document to ensure quality data continues to be collected after an error flag has occurred.

5.2 Sensor Controls Specification

N/A

6 ASSEMBLY INTEGRATION

N/A

7   APPENDIX

Sensor error codes.

Table 2. Codes and interpretation of sensor error messages (Vaisala 2013).

Error code	Error description	Interpretation	Action
E01	EEPROM checksum failure	Internal transmitter failure	Return the device to Vaisala Service
E02	IR source failure	Internal transmitter failure	Return the device to Vaisala Service.
E03	FPI failure	Internal transmitter failure	Return the device to Vaisala Service.
E04, E05	Heater failure	Internal transmitter failure	Return the device to Vaisala Service.
E06	Temperature measurement failure	Operation temperature is out of allowed range. Analog output: Error level is shown if temperature compensation is enabled. Otherwise, output is normal.	Ensure that the operating temperature is -45...+85 °C (-49...185 °F). In case of constant error, return the device to Vaisala Service.
E07	Measurement signal level too low	Measurement chamber is contaminated or the lamp is degraded.	Clean the optics and the filter according to the instructions in section Cleaning the Optics (Diffusion Model Only) on page 71. In case of constant error, return the device to Vaisala Service.
W01	Watchdog reset occured	Software defect	In case this warning appears frequently, return the device to Vaisala Service.
W02	Stack overflow	Software defect	In case this warning appears frequently, return the device to Vaisala Service.

7.1   List of Level 0 Data Product

Table 3. List of Level 0 data product associated with DPName: Soil CO2 concentration.

DGD Agile PN	DPNumber	fieldName	description	Acquisition frequency (Hz)	dataType	units
CF00550040	NEON.DOM.SITE.DP0.00095.001.01729.HOR.VER.000	rawCO2	Raw CO2 concentration prior to application of the calibration or temperature, pressure, oxygen, and humidity compensations	0.1	real	partsPerMillion
	NEON.DOM.SITE.DP0.00095.001.01730.HOR.VER.000	headspaceTemp	Temperature in the sensor headspace	0.1	real	celsius
	NEON.DOM.SITE.DP0.00095.001.01731.HOR.VER.000	errorStatus	Error status of the sensor	0.1	real	NA

7.2   Assembly Schematic Drawing

N/A

8 BIBLIOGRAPHY

Vaisala. 2013. User's Guide: Vaisala CARBOCAP Carbon Dioxide Probe GMP343, Version M210514EN-D. Vaisala Oyj, Helsinki.