NEON SENSOR COMMAND, CONTROL, AND CONFIGURATION: SOIL CO_2 SENSOR

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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.

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LIST OF TABLES AND FIGURES

1 DESCRIPTION

1.1 Purpose

This document specifies the configuration and command and control structure for the soil CO_2 sensors.

1.2 Scope

The Vaisala CARBOCAP® Carbon Dioxide Probe GMP343 Diffusion model 0-20,000 ppm range sensor will be used to make the soil CO_2 profile measurements (AD[01]).This document specifies the command and control that is needed for the soil CO_2 sensors. It does not describe how this will be achieved by ENG or other NEON teams.

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.004605	Class Acquisition Plan - Enterprise Sensor Acquisition
AD[02]	NEON.DOC.005005	NEON Level 0 Data Products Catalog
AD[03]	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
RD [03]		
RD [04]		

2.3 External References

External references contain information pertinent to this document, but are not NEON configuration-controlled. Examples include manuals, brochures, technical notes, and external websites.

ER [01]	Vaisala. 2013. User's Guide: Vaisala CARBOCAP Carbon Dioxide Probe GMP343, Version M210514EN-D. Vaisala Oyj, Helsinki.
ER [02]	
ER [03]	

2.4 Acronyms

Acronym	Explanation
ATBD	Algorithm Theoretical Basis Document
CO_2	Carbon dioxide
FIU	Fundamental Instrument Unit
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
TBD	To be determined

3 INTRODUCTION

The sensor configuration and sensor command and control described here are related to the soil CO_2 profile data product (AD[02]). A description of how sensor readings shall be converted to soil air CO_2 concentration is presented in the associated ATBD (AD[03]).

4 SENSOR CONFIGURATION

The data from the sensor shall be unfiltered, uncompensated, and uncorrected CO_2 concentration (hereafter called *CO2RAWUC*), as well as sensor headspace temperature (T), and error status (ERR) (ER[01]). Sensor configuration settings are shown in the table below.

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	Off
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	Sensor-specific temperature parameter determined by

Parameter	Default setting
compensation value	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
Data acquisition streams	CO_2 concentration (CO2RAWUC): NEON.DOM.SIT.DP0.00093.REV.001.HOR.VER.001; Temperature (T): NEON.DOM.SIT.DP0.00093.REV.002.HOR.VER.001; Error status (Err): NEON.DOM.SIT.DP0.00093.REV.003.HOR.VER.001;
Measurement mode	Run

5 COMMAND AND CONTROL

5.1 Error Handling

All possible sensor error codes are shown in Table A1. When any of these errors occur the CO_2 concentration (NEON.DOM.SIT.DP0.00093.REV.001.HOR.VER.001) and temperature (NEON.DOM.SIT.DP0.00093.REV.002.HOR.VER.001) data streams will be set to zero, 0, and the sensor error flag (NEON.DOM.SIT.DP0.00093.REV.003.HOR.VER.001) will be set to one, 1. When an error occurs the specific sensor error code from Table A1 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 (ER[01]). 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 Heater Control

No control is required at this time. However, if errors are generated due to the lack of control, FIU will develop the command and control structure to determine when the heater should be automatically switched on/off.

When there is (a risk of) condensation on the sensor optics window and mirror, the heater must be turned on to prevent/remove condensation within the sensor headspace. When the risk of condensation occurring is low, the heater shall be turned off to minimize the effect of sensor heating on the soil microclimate. Initially the heater shall be configured as always switched off, since the sensor generates some heat even with the heater off, which we expect will prevent condensation occurring within the sensor headspace.

In case heater control needs to be implemented in the future, FIU has developed a preliminary command and control structure to determine when the heater should be automatically switched on/off (Table 3). It is likely that the criteria for turning the heater on/off would be site and depth specific (and possibly season specific). The criteria will likely depend on soil temperature and soil moisture at the same depth and in the same plot as the soil CO_2 sensor. Each time the heater is switched on or off it must be logged and streamed so that it can be included in the metadata and used to determine the heater flag status.

Table 2. Truth table to control sensor heater

Control parameter	Condition	Data acquisition system action	Output to CI
TBD	TBD	Turn heater off	Heater status
TBD	TBD	Turn heater on	Heater status

APPENDIX A SENSOR ERROR CODES

Codes are as of January 2012.

Table 3. Codes and interpretation of sensor error messages as of January 2012 (ER[01])

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 contamined 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.