



<i>Title:</i> NEON Sensor Command, Control and Configuration (C3) Document: Soil Heat Flux		<i>Date:</i> 02/03/2020
<i>NEON Doc. #:</i> NEON.DOC.000395	<i>Author:</i> N Pingintha-Durden	<i>Revision:</i> C

## NEON SENSOR COMMAND, CONTROL AND CONFIGURATION (C3) DOCUMENT: SOIL HEAT FLUX

PREPARED BY	ORGANIZATION	DATE
Natchaya Pingintha-Durden	FIU	11/02/2015
Edward Ayres	FIU	01/17/2020

APPROVALS	ORGANIZATION	APPROVAL DATE
Kate Thibault	SCI	01/31/2020

RELEASED BY	ORGANIZATION	RELEASE DATE
Anne Balsley	CM	02/03/2020

See configuration management system for approval history.

The National Ecological Observatory Network is a project solely funded by the National Science Foundation and managed under cooperative agreement by Battelle. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.



<i>Title:</i> NEON Sensor Command, Control and Configuration (C3) Document: Soil Heat Flux		<i>Date:</i> 02/03/2020
<i>NEON Doc. #:</i> NEON.DOC.000395	<i>Author:</i> N Pingintha-Durden	<i>Revision:</i> C

## Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	05/09/2013	ECO-00425	Initial Release
B	02/29/2016	ECO-03635	Use new C3 template; add DGD number info; update L0 data products
C	02/03/2020	ECO-06373	Self-calibration frequency changed from every 3.25 hours to every 13 hours.



<i>Title:</i> NEON Sensor Command, Control and Configuration (C3) Document: Soil Heat Flux		<i>Date:</i> 02/03/2020
<i>NEON Doc. #:</i> NEON.DOC.000395	<i>Author:</i> N Pingintha-Durden	<i>Revision:</i> C

**TABLE OF CONTENTS**

**1 DESCRIPTION.....1**

1.1 Purpose ..... 1

1.2 Scope..... 1

**2 Related documents and acronyms.....1**

2.1 Applicable Documents ..... 1

2.2 Reference Documents..... 2

2.3 Acronyms ..... 2

**3 Introduction .....2**

**4 Overview of Sensor configuration .....2**

**5 Command and Control.....3**

5.1 Error handling ..... 3

5.2 Automated calibration ..... 3

**6 Assembly integration.....5**

**7 Appendix.....5**

7.1 List of Level 0 data product..... 5

7.2 Assembly schematic drawing..... 5

**8 Bibliography .....5**

**LIST OF TABLES**

Table 1. Sensor configuration settings..... 2

Table 2. Truth table for controlling sensor. .... 3

Table 3. List of Level 0 data product numbers associated with this document ..... 5



<i>Title:</i> NEON Sensor Command, Control and Configuration (C3) Document: Soil Heat Flux		<i>Date:</i> 02/03/2020
<i>NEON Doc. #:</i> NEON.DOC.000395	<i>Author:</i> N Pingintha-Durden	<i>Revision:</i> C

## 1 DESCRIPTION

### 1.1 Purpose

This document specifies the command, control, and configuration details for operating the soil heat flux sensors. 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 HFP01SC: Self-Calibrating Heat Flux Sensor™ will be used to measure soil heat flux, providing the information of how much energy is being stored in and lost from the soil. The sensor capable of operating under the environment extremes found across the NEON site. There is no firmware required for this sensor.

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

The soil heat flux assembly will consist of following Data Generating Device (DGD) based on Data Generating Device DGD List and Hierarchies doc (AD [06]):

DGD Agile PN	DGD Agile Description
CF03900001	Assembly, Soil Heat Flux Splitter 2, 30 Feet

This document specifies the command, control, and configuration that is 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.

## 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.000814	NEON ATBD-Soil Heat Flux
AD [06]	NEON.DOC.001104	Data Generating Device DGD List and Hierarchies

## 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]	HFP01SC Self Calibrating Heat Flux Sensor™ USER MANUAL HFP01SC Manual v0710	
RD [04]	Application and Specification of Heat Flux Sensors Version 9904	

## 2.3 Acronyms

Acronym	Explanation
ATBD	Algorithm Theoretical Basis Document
C <sup>3</sup>	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 INTRODUCTION

The HFP01SC is selected to measure soil heat flux applied in the soil arrays. The related soil heat flux Level 0 data products acquired from soil heat flux assembly are listed in Table 3 in appendix. A description of how sensor readings shall be converted to soil heat flux in units of  $W\ m^{-2}$  is presented in the associated ATBD (AD [05]).

## 4 OVERVIEW OF SENSOR CONFIGURATION

The HFP01SC: Self-Calibrating Heat Flux Sensor™ configurations are presented in

Table 1.

**Table 1.** Sensor configuration settings.

Parameter	Default Setting
Heater	Off
Soil heat flux sensor voltage ( $V_s$ ): Acquisition rate	0.1 Hz

Voltage across the current sensing resistor ( $V_{cur}$ ):	0.1 Hz
Acquisition rate	

## 5 COMMAND AND CONTROL

### 5.1 Error handling

Given that the soil heat flux sensor has no built-in error handling, no command and control interface is required for the sensor.

### 5.2 Automated calibration

The HFP01SC is a combination of a heat flux sensor and a film heater. The automated calibration is performed by activating the film heater that is mounted on top, resulting in a new calibration factor. The calibration cycle shall be carried out every 13 hours. The calibration heater shall be turned on for 3 minutes at the start of calibration cycle. While the calibration heater is turned on, the voltage output of sensor ( $V_s$ : NEON.DOM.SITE.DP0.00040.001.01798.HOR.VER.000) and the voltage across the current sensing resistor ( $V_{cur}$ : NEON.DOM.SITE.DP0.00040.001.01800.HOR.VER.000) are measured. The  $V_s$  and  $V_{cur}$  at time of 0, 180, and X second after the calibration heater is turned on will be used in calculating the new sensor sensitivity; where X is the time required for the effect of the heater on the measurements to dissipate, which is specified in the CI database. A description of how to calculate sensor sensitivity is presented in the associated ATBD (AD [06]). Table 2 specifies the command and control structure for the heater.

**Table 2.** Truth table for controlling sensor.

Control parameter(s)	Condition	Data acquisition system action	Output to CI
Automated Calibration	every 13 hours	Turn calibration heater on  Measure sensor voltage and voltage across the current sensing resistor	Calibration Heater flags (NEON.DOM.SITE.DP0.00040.001.01799.HOR.VER.000) $V_s$ (NEON.DOM.SITE.DP0.00040.001.01798.HOR.VER.000) $V_{cur}$ (NEON.DOM.SITE.DP0.00040.001.01800.HOR.VER.000)
Automated Calibration	calibration heater on for 3 minutes	Turn calibration heater off  Measure sensor voltage and voltage across the current sensing resistor	Calibration Heater flags (NEON.DOM.SITE.DP0.00040.001.01799.HOR.VER.000) $V_s$ (NEON.DOM.SITE.DP0.00040.001.01798.HOR.VER.000) $V_{cur}$



neon  
Operated by Battelle

<i>Title:</i> NEON Sensor Command, Control and Configuration (C3) Document: Soil Heat Flux		<i>Date:</i> 02/03/2020
<i>NEON Doc. #:</i> NEON.DOC.000395	<i>Author:</i> N Pingintha-Durden	<i>Revision:</i> C

			(NEON.DOM.SITE.DP0.00040.001.018 00.HOR.VER.000)
--	--	--	---



<i>Title:</i> NEON Sensor Command, Control and Configuration (C3) Document: Soil Heat Flux		<i>Date:</i> 02/03/2020
<i>NEON Doc. #:</i> NEON.DOC.000395	<i>Author:</i> N Pingintha-Durden	<i>Revision:</i> C

## 6 ASSEMBLY INTEGRATION

NA

## 7 APPENDIX

### 7.1 List of Level 0 data product

**Table 3.** List of Level 0 data product numbers associated with this document

DGD Agile PN	DPNumber	fieldName	description	Acquisition frequency (Hz)	dataType	units
CF03900001	NEON.DOM.SITE.DP0.00040.001.01798.HOR.VER.000	SHFVoltage	Soil heat flux sensor voltage	0.1	real	volt
	NEON.DOM.SITE.DP0.00040.001.01799.HOR.VER.000	SHFCalHeaterFlag	Calibration heater flag indicating whether the heater was operational to perform a self-calibration, (1 = on, 0 = off)	0.1	integer	NA
	NEON.DOM.SITE.DP0.00040.001.01800.HOR.VER.000	curVoltage	Voltage across the current sensing resistor	0.1	real	volt

### 7.2 Assembly schematic drawing

NA





**neon**  
Operated by Battelle

<i>Title:</i> NEON Sensor Command, Control and Configuration (C3) Document: Soil Heat Flux		<i>Date:</i> 02/03/2020
<i>NEON Doc. #:</i> NEON.DOC.000395	<i>Author:</i> N Pingintha-Durden	<i>Revision:</i> C

## 8 BIBLIOGRAPHY

NA