SDI12 BUS

90-degree turbidity with depth and temperature

180-degree backscatter turbidity

Application note

NEP 5000 SDI-12 option with Campbell Scientific logger

Version: 20221009
Status: Final
Confidentiality: Not confidential
Date: 09 October 2022
Author: Vic Grosjean

Document history

The Observator range is in continuous development and so specifications may be subject to change without prior notice. When in doubt about the accuracy of this document, contact the Observator Group.

Reference documents

Type of document / tool	Product type and name (incl. url)
Software	NEP-5000
CFG files	NEP-5000
Datasheet	NEP-5000
Manual	NEP-5000
Application notes	NEP-5000-SDI-12 option with Campbell logger
	NEP-5000-SDI-12 option for H-522+ & H-500XL loggers
	NEP-5000-SDI-12 option with Hydrospider logger
	NEP-5000-SDI-12, RS485 and analogue: wiper operations
	NEP-5000 multi-point calibration
	NEP-5000 firmware updating procedure
	Pressure calibration
	Shroud installation
	Temperature calibration
	Wiper replacement
Videos	NEP-5000

Revision history

Date	Amendments	Company, position
2019-01-16	Initial document creation	Observator Australia, Document Controller
2019-03-17	Update links & add reference documents	Observator Australia, Document Controller
2019-07-02	Quality review	Observator Australia, Operation Manager
2020-01-30	Updated document format	Observator Australia, Document Controller
2022-10-09	Update video links	Observator Australia, Document Controller

Procedure sign-off:

Date	Company, position	Status
2019-03-09	Observator Australia, Document Controller	Finished
2019-12-06	Observator Australia, Managing Director	Approved
2020-03-05	Observator Group, Communication Officer	Approved

Distribution list

Date	Company, position

Summary

This document describes the integration of the NEP-5000 family sensors with the Campbell Scientific loggers using the SDI-12 protocol.

The NEP-5000 family of sensors offers a comprehensive list of functions using its build in SDI-12 interface. Configuration of the NEP-5000 sensor using its Personal Computer (PC) configuration software and implementation of the Campbell scripting, will be discussed in the following scenarios.

Chapter 1: "Basic operations"

- **Section 1.1:** "Simple reading of turbidity (general use)"

- **Section 1.2:** "Reading of turbidity using auto-range feature after an optical wipe (recommended option)"

Chapter 2: "Advanced operations"

- **Section 2.1:** "Reading the statistical view of turbidity in a fixed period of time"

- **Section 2.2:** "Reading of turbidity using a 180º backscatter sensor in conjunction with a 90º sensor (two types of turbidity sensors on the same SDI-12 bus)"

- **Section 2.3:** "Reading of turbidity temperature, and pressure (depth) using NEP-5000 pressure and depth sensor option"

Important note: All examples and procedures that are discussed in this document are best applied to firmware version C2.027 and above.

Important note: End users may request NEP-5000 settings from the factory according to above scenarios during the time of ordering.

Important Note: All sensor configurations that are described below require the user to connect to the sensor calibration software. Please refer to NEP-5000 manual.

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1 Basic operations

1.1 Simple reading of turbidity (general use)

1.1.1 Setting up your NEP-5000 family turbidity sensor for simple turbidity readings (general use)

This setup requires users to have the following:

- NEP-5000 family sensor.

- NEP-5000 calibration module (calibration kit).
  Or request these settings during time of ordering).

- 12V Direct Current (DC) power supply.

- NEP-5000 user manual.

1.1.2 Mode of operation

The logger powers up the sensor using one of its power control switches and waits for the sensor (boot up time allowing total time of about twenty seconds to accommodate the power on wipe feature).

Note: In this scenario the sensor will automatically carry out an optical clean (Wipe) soon after the boot up. Once the twenty seconds of boot up and wipe time has elapsed, the logger issues a measure command (aM!) followed by read command (aD0!) to retrieve the newly measured turbidity value.

1.1.3 Use Personal Computer (PC) configuration software

The sensor configurations that is shown below requires users to connect to the sensor using its calibration software.

- Turbidity measuring range = auto or desired single range.
  In calibration software under "Sensor Stage" > "Sensor calibration".

- Data acquisition time = four seconds or more if auto range is selected or two seconds when single range is selected.
  In calibration software under "Output Stage" > "SDI-12 tab".

- SDI-12 address = 0 (default) or any desired address.

- Communication protocol of the sensor = SDI-12.

To commit above settings to permanent memory, please press set followed by save calibration

- Wiper operation set to power on wipe.
  In calibration software under "Wiper Control".

1.1.4 Script to be used for simple turbidity readings (general use) – Campbell Scientific logger

```
'CR200/CR200X Series
'Declare Variables and Units
Public BattV
Public SDI12(1)
Public SDI12_2(1)

Alias SDI12(1)=Turbidity
Alias SDI12_2(1)=Wipe_stats

Units BattV=Volts
Units Turbidity=NTU
Units Wipe_stats=Units

'Define Data Tables
DataTable(Table1,True,-1)
    DataInterval(0,2,Min)
    Sample(1,Turbidity)
    Sample(1,Wipe_stats)
EndTable

DataTable(Table2,True,-1)
    DataInterval(0,2,Min)
    Minimum(1,BattV,False,False)
EndTable

'Main Program
BeginProg
    'Main Scan set 40 second. User may select appropriate logging time.
    Scan(40,Sec)
        'Default CR200 Series Datalogger Battery Voltage measurement 'BattV'
        Battery(BattV)
        SWBatt(1) ' Power ON. This command is unique to each logger's model number.
        Delay(16,Sec)
        'Generic SDI-12 Sensor measurements 'Turbidity'
        SDI12Recorder(SDI12(),"0M!",1,0)
        'Call Data Tables and Store Data
        CallTable Table1
        CallTable Table2
        SWBatt(0) ' Power OFF. This command is unique to each logger's model number.
    NextScan
EndProg
```

1.2 Reading of turbidity using auto-range feature after an optical wipe (recommended option)

1.2.1 Setting up your NEP-5000 family turbidity sensor for stable turbidity readings and allowing wiper to control via SDI-12

This setup requires users to have the following:

- NEP-5000 family sensor.

- NEP-5000 calibration module (calibration kit).
  Or request these settings during time of ordering).

- 12V DC power supply.

- NEP-5000 user manual.

1.2.2 Mode of operation

The logger powers up the sensor using one of its power control switches and waits for the sensor (boot up time of four seconds).

After the boot up delay has elapsed, the logger will send a SDI-12 wipe command (0M1!) followed by sixteen seconds of wipe completion delay. Once the wipe completion delay has elapsed, the logger issues a measure command (aM!) followed by the read command (aD0!) to retrieve the newly measured turbidity value.

1.2.3 Use PC configuration software

The sensor configurations shown below requires users to connect to the sensor using its calibration software.

- Turbidity measuring range = auto or desired single range.
  In calibration software under "Sensor Stage" > "Sensor calibration".

- Data acquisition time = four seconds or more if auto range is selected or two seconds when single range is selected.
  In calibration software under "Output Stage" > "SDI-12 tab".

- SDI-12 address = 0 (default) or any desired address.

- Communication protocol of the sensor = SDI-12.

OR

Auto-Range

Single Range

- Wiper operation set not (untick) to power on wipe.
  In calibration software under "Wiper Control".

1.2.4 Script to be used for PC configuration software using auto-range after an optical wipe (recommended option)

```
'CR200/CR200X Series
'Declare Variables and Units
Public BattV
Public SDI12(1)
Public SDI12_2(1)

Alias SDI12(1)=Turbidity
Alias SDI12_2(1)=Wipe_stats

Units BattV=Volts
Units Turbidity=NTU
Units Wipe_stats=Units

'Define Data Tables
DataTable(Table1,True,-1)
    DataInterval(0,2,Min)
    Sample(1,Turbidity)
    Sample(1,Wipe_stats)
EndTable

DataTable(Table2,True,-1)
    DataInterval(0,2,Min)
    Minimum(1,BattV,False,False)
EndTable

'Main Program
BeginProg
    'Main Scan set 40 second. User may select appropriate logging time.
    Scan(40,Sec)
        'Default CR200 Series Datalogger Battery Voltage measurement 'BattV'
        Battery(BattV)
        SWBatt(1) ' Power ON. This command is unique to each logger's model number.
        Delay(4,Sec)
        'Generic SDI-12 Sensor measurements 'Wipe_stats'
        SDI12Recorder(SDI12_2(),"0M1!",1,0)
        Delay(1,Sec)
        'Generic SDI-12 Sensor measurements 'Turbidity'
        SDI12Recorder(SDI12(),"0M!",1,0)

        'Call Data Tables and Store Data
        CallTable Table1
        CallTable Table2
        SWBatt(0) ' Power OFF. This command is unique to each logger's model number.
    NextScan
EndProg
```

2   Advanced operations

2.1   Reading the statistical view of turbidity in a fixed period of time

2.1.1   Setting up your NEP-5000 family turbidity sensor for long exposure turbidity readings (advanced use)

This setup requires users to have the following:

- NEP-5000 family sensor.

- NEP-5000 calibration module (calibration kit).
  Or request these settings during time of ordering.

- 12V DC power supply.

- NEP-5000 user manual.

2.1.2   Mode of operation

The logger powers up the sensor using one of its power control switches. Wait for the sensor (boot up time of about four seconds).

After the boot up delay has elapsed, the logger will send a SDI-12 wipe command (0M1!), followed by 16 seconds of wipe completion delay. Once the sixteen seconds of wipe completion time has elapsed the logger issues a statistical data measure command (aM6!) followed by read command (aD0! and aD1!) to retrieve the newly measured statistical turbidity measurements.

2.1.3   Use PC configuration software

The sensor configurations shown below requires users to connect to the sensor using its calibration software.

- Turbidity measuring range = auto or desired single range.
  In calibration software under "Sensor Stage" > "Sensor calibration".

- Data acquisition time = four seconds or more if auto range is selected or two seconds when single range is selected.
  In calibration software under "Output Stage" > "SDI-12 tab".

- SDI-12 address = 0 (default) or any desired address.

- Communication protocol of the sensor = SDI-12.

- Select the correct statistical settings that suits your needs.

  There are mainly two parts to consider when selecting the appropriate statistical settings for your requirements. There are two parameters (settings) displays in the PC configuration software (under sensor stage > sensor operating parameters).

  > The first parameter setting "Sample acquisition time" describes the data accusation time of each measurement when populating statistical data set before calculating its final results.

  > The second parameter setting "Number of samples" describes number of samples that the user requires before making a final statistical calculation.

- Selecting optimal "Sample acquisition time".

  When selecting a data acquisition time, one of the main considerations is whether you wish to have ranging options that are in auto-range or single range.

  When selecting auto range, the user must allow enough time for the sensor to select ranges. The default and recommended value for auto range is four seconds.

  When selecting single range, the user must use one seconds and up to four seconds. The recommended value for single range is two seconds.

- Selecting optimal "Number of samples".

  When selecting this setting the user must consider how longer turbidity observation is required. Final statistical sample time (total measurement time) is calculated by "Sample acquisition time" multiplied by "Number of samples". Hence above example takes about 2x5=10s and 4x5=20 seconds respectively to complete the full statistical estimate by the sensor to execute (aM6!) command.

2.1.4   SDI-12 Procedure and commands to retrieve the statistical values

- Send (aM6!) to invoke the measurement.
- The sensor must respond as a0066<CR><LF>.
  - 0006 as 6 second as measurement duration. This value may change according to the statistical package settings.
  - The last value (6) is the response mentioning the number of parameters to read.

- The logger waits an appropriate time according to the above response.
- The logger sends (aDx!) commands until all the parameters are received.
  - (aD0!) will provide the last instant turbidity value.
  - (aD1!) will provide:
    - (aD1!) return a+TT.TT+MMMM.MM+AAAA.AA+LLLL.LL+SSSS.SS<CR><LF>
    - Note that.
      - TT.TT= temperature
      - MMMM.MM = median
      - AAAA.AA=average
      - LLLL.LL = minimum value
      - SSSS.SS = maximum Value

- End of the statically reading.

2.1.5 Script to be used for reading statistical view of turbidity in fixed periods of time – for Campbell logger

```
'CR200/CR200X Series
'CR200/CR200X Series

'Declare Variables and Units
Dim N_2
Public BattV
Public SDI12(1)
Public SDI12_2(6)

Alias SDI12(1)=Wiper_stat
Alias SDI12_2(1)=Turbidity
Alias SDI12_2(2)=Temperatur
Alias SDI12_2(3)=Median
Alias SDI12_2(4)=Average
Alias SDI12_2(5)=Minimum
Alias SDI12_2(6)=Maximum

Units BattV=Volts
Units Wiper_stat=stats
Units Turbidity=NTU
Units Temperatur=C
Units Median=NTU
Units Average=NTU
Units Minimum=NTU
Units Maximum=NTU

'Define Data Tables
DataTable(Table1,True,-1)
    DataInterval(0,2,Min)
    Sample(1,Wiper_stat)
    Sample(1,Turbidity)
EndTable

DataTable(Table2,True,-1)
    DataInterval(0,1440,Min)
    Minimum(1,BattV,False,False)
EndTable

'Main Program
BeginProg
    'Main Scan set 60 seconds. User may select appropriate logging time.
    Scan(60,Sec)
        'Default CR200 Series Datalogger Battery Voltage measurement 'BattV'
        Battery(BattV)
        SWBatt(1) ' Power ON. This command is unique to each logger's model number.
        Delay(4,Sec)
        'Generic SDI-12 Sensor measurements 'Wiper_stat'
        SDI12Recorder(SDI12(),"0M1!",1,0)

        Delay(1,Sec)

        'Generic SDI-12 Sensor measurements 'Turbidity', 'Temperatur', 'Median',
        'Average', 'Minimum', and 'Maximum'
        SDI12Recorder(SDI12_2(),"0M6!",1,0)

        'Call Data Tables and Store Data
        CallTable Table1
        CallTable Table2

        SWBatt(0) ' Power OFF. This command is unique to each logger's model number.
    NextScan
EndProg
```

2.2 Reading of turbidity using a 180⁰ backscatter sensor in conjunction with a 90⁰ sensor (two types of turbidity sensors on the same SDI-12 bus)

2.2.1 Setting up two NEP-5000 family turbidity sensors (1800 & 900) for automatic measurement (using 6 ranges) providing seamless, high accuracy and stable measurements between 0NTU and 30,000NTU

The logger script will manage the transition between 900 and 1800 sensors.

> Note: Both sensors are configured to be operated in the auto-range mode.
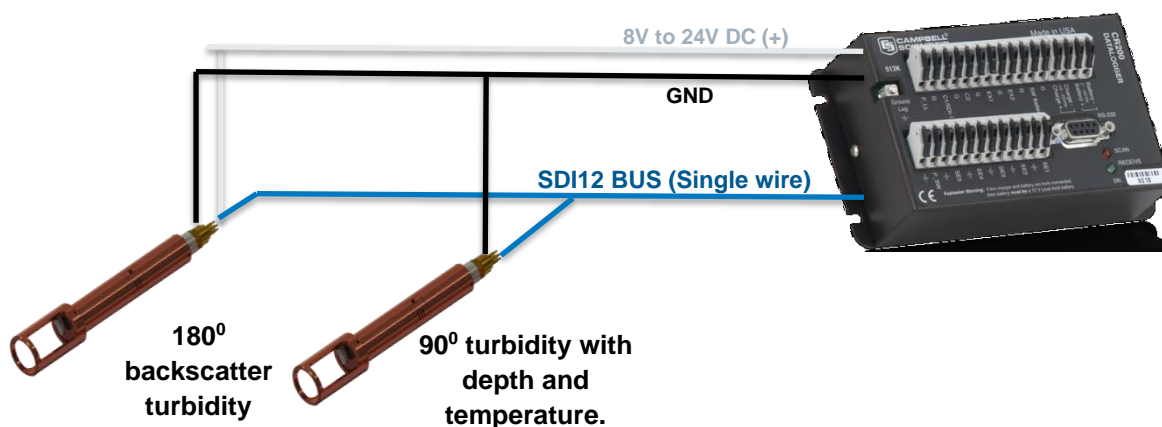
This setup requires users to have the following:

- NEP-5000 family sensor.

- NEP-5000 calibration module (calibration kit).
  Or request these settings during time of ordering).

- 12V DC power supply.

- NEP-5000 user manual.
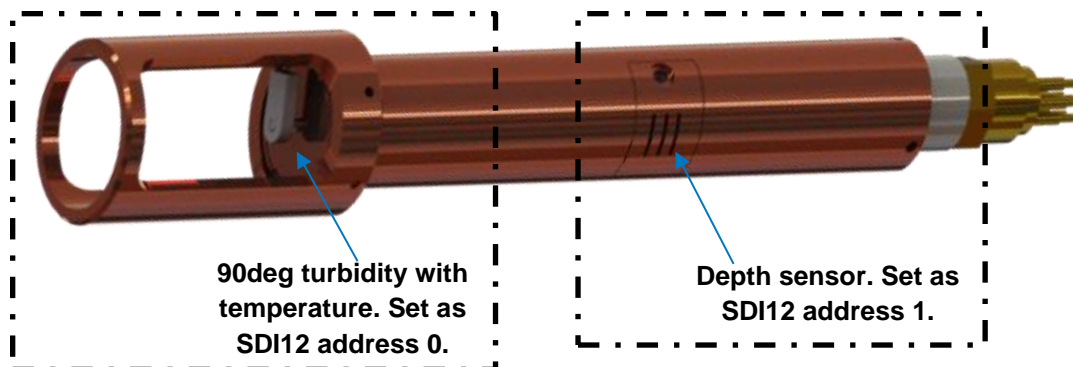
2.2.2 Mode of operation

The logger powers up both sensors using one of its power control switches and waits for both sensors to boot up (four-six seconds).

Once both sensors finish booting up, then the logger will send a SDI-12 wipe command to both sensors using two addresses (0M1!) and (1M1!). When seconds of wipe completion time has elapsed, the logger issues a measures commands (0M!) and (1M!) to both sensors and then retrieves both sensor data using (0D1!) and (1D1!).

Both results are then logically compared. If a 900-sensor result is larger than the sensors top range maximum, then it is assumed that the 900-sensor has clipped and the 1800 result may be put forward as the final result. Otherwise the 900-sensor result is put forward as the final turbidity value. Note that both sensors are configured to be operated in the auto-range mode.

2.3 Reading of turbidity temperature, and pressure (depth) using NEP-5000 pressure and depth sensor option

2.3.1 Setting up your NEP-5000 family turbidity sensor with pressure option acquire turbidity, depth and temperature from the sensor

90deg turbidity with temperature. Set as SDI12 address 0.

Depth sensor. Set as SDI12 address 1.

This setup requires users to have the following:

- NEP-5000 family sensor.

- NEP-5000 calibration module (calibration kit).
  Or request these settings during time of ordering).

- 12V DC power supply.

- NEP-5000 user manual.

2.3.2 Mode of operation

The logger powers up the sensor using one of its power control switches and waits for the sensor to boot up in time of about four seconds.

Once the sensor has finish booting up the logger will send SDI12 wipe command (0M1!).

Once the sixteen seconds of wipe completion time has elapsed, the logger issues a statistical data measure command (aM6!) followed by data read command (aD0!) and (aD1!). This retrieves the newly measured statistical turbidity measurement data including liquids temperature.

To access the depth measurements, the logger may issue single measure command to the second address and then (aD0!) to retrieve newly measured depth measurement.

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