Spectrafy™
solar spectral sensors

Application Note:

Interfacing SolarSIM-D2 and SolarSIM-G with Campbell Scientific Dataloggers

1. Introduction

This application note describes how to interface the SolarSIM-D2 and the SolarSIM-G with a Campbell Scientific CR6 series datalogger. Three cases are considered:

1. A single SolarSIM-G with a CR6 datalogger
2. A single SolarSIM-D2 with a CR6 datalogger
3. Both the SolarSIM-D2 and SolarSIM-G with a CR6 datalogger

The provided instructions and programs can be easily adapted to other Campbell Scientific dataloggers.

2. Wiring to a datalogger

The SolarSIMs use the RS-485 communication protocol in a half-duplex mode. CR6 series datalogger, as shown in Figure 1, has two half-duplex RS-485 ports, which allows to acquire simultaneous data from both the SolarSIM-D2 and the SolarSIM-G.

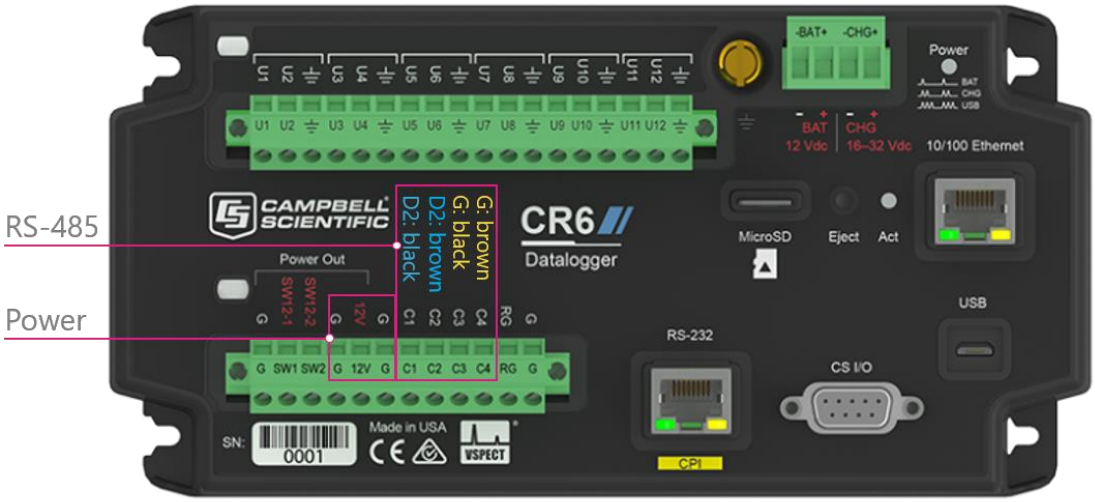

Figure 1. Interfacing with a Campbell Scientific's CR6 series datalogger

The wire colour guide for both the SolarSIM-D2 and the SolarSIM-G is as follows:

Colour	Label	Function
Blue	V_{in}	Input voltage (+12 VDC)
White	GND	Common ground
Black	A-	Negative RS-485 input
Brown	B+	Positive RS-485 input

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a. Wiring the SolarSIM-D2 to CR6

SolarSIM-D2 Wire	CR6 Connection	Function
Blue	12V	12V supply
White	G	Common ground
Black	C1	Negative RS-485 input
Brown	C2	Positive RS-485 input

b. Wiring the SolarSIM-G to CR6

SolarSIM-G Wire	CR6 Connection	Function
Blue	12V	12V supply
White	G	Common ground
Black	C3	Negative RS-485 input
Brown	C4	Positive RS-485 input

3. Datalogger communication

a. Serial port configuration

The serial port for the SolarSIM-D2 and the SolarSIM-G should be configured as follows:

Parameter	Value
Baud rate	9600
Parity	None
Data bits	8
Stop bits	1

b.Serial command for the SolarSIM-D2

Only one serial command is needed to acquire raw data from the SolarSIM-D2:

```
N100_E
```

In return, the SolarSIM-D2 sends an ASCII string with the ambient pressure and temperature, the internal temperature and relative humidity, and six channel voltages. The following ASCII string is a sample output:

N110_1013.120,2500.000,2600.000,1050.000,2500.032,4999.999,
0000.001,1274.004,2746.321,3291.214/r/n

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This string can be parsed as:

N"serial number"_ "P_{out} x 10" , "(Tout + 50) x 75" , "(T_{in} + 50) × 75" , "H_{in} x 100" , "V1", "V2" , "V3" , "V4" , "V5" , "V6""end of line character"

where:

P_{out} = ambient atmospheric pressure
T_{out} = ambient temperature
T_{in} = internal SolarSIM-D2 temperature
H_{in} = internal SolarSIM-D2 relative humidity

The example string is further parsed in the table below:

Parameter	Symbol	Value	Units
Ambient pressure	P_{out}	101.312	kPa
Ambient temperature	T_{out}	-16.67	℃
Internal temperature	T_{in}	-15.33	℃
Internal humidity	H_{in}	10.50	%
Voltage channel 1	V_1	2500.032	mV
Voltage channel 2	V_2	4999.999	mV
Voltage channel 3	V_3	0.001	mV
Voltage channel 4	V_4	1274.004	mV
Voltage channel 5	V_5	2746.321	mV
Voltage channel 6	V_6	3291.214	mV

c. Serial command for the SolarSIM-G

Only one serial command is needed to acquire raw data from the SolarSIM-G:

```
N1000_E
```

In return, the SolarSIM-G sends an ASCII string with the ambient temperature, pressure and relative humidity, the internal temperature and relative humidity, and nine channel voltages. The following ASCII string is a sample output:

N1010_2500.000,1013.120,4750.000,2600.000,1050.000,2500.032,4999.999,
0000.001,1274.004,2746.321,3291.214, 3924.385,1900.500,0500.123/r/n

This string can be parsed as:

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N"serial number"_"(Tout + 50) x 75" , "P_{out} x 10" , "H_{out} x 100" , "(T_{in} + 50) × 75" , "H_{in} x 100" , "V1", "V2" , "V3" , "V4" , "V5" , "V6" , "V7" , "V8" , "V9""end of line character"

where:

T_{out} = ambient temperature
P_{out} = ambient atmospheric pressure
H_{out} = ambient relative humidity
T_{in} = internal SolarSIM-G temperature
H_{in} = internal SolarSIM-G relative humidity

The aforementioned example string is parsed in the table below:

Parameter	Symbol	Value	Units
Ambient temperature	T_{out}	-16.67	℃
Ambient pressure	P_{out}	101.312	kPa
Ambient humidity	H_{out}	47.50	%
Internal temperature	T_{in}	-15.33	℃
Internal humidity	H_{in}	10.50	%
Voltage channel 1	V_1	2500.032	mV
Voltage channel 2	V_2	4999.999	mV
Voltage channel 3	V_3	0.001	mV
Voltage channel 4	V_4	1274.004	mV
Voltage channel 5	V_5	2746.321	mV
Voltage channel 6	V_6	3291.214	mV
Voltage channel 7	V_7	3924.385	mV
Voltage channel 8	V_8	1900.500	mV
Voltage channel 9	V_9	500.123	mV

4. CRBasic Code

a. For the SolarSIM-D2

```
'Description: Acquires raw data from the SolarSIM-D2
'Datalogger:  CR6 from Campbell Scientific
'Author:      Spectrafy Inc.
'Date:        February 20, 2020

'Defines user constants
Const Timezone     = -5 'hrs
Const DAQRate      = 60 's
Const SamplingRate = 5  's
```


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```
'Defines program constants
Const TerminationCharacter = CHR(10) + CHR(13)
Const SerialCommand = "N100_E" + TerminationCharacter

'Declares public variables
Public SerialData As String *256
Public OutputData(10)

'Declares data table column names
Alias OutputData(1)  = AmbientPressure      'kPa
Alias OutputData(2)  = AmbientTemperature   'C
Alias OutputData(3)  = InternalTemperature  'C
Alias OutputData(4)  = InternalHumidity     '%
Alias OutputData(5)  = ChannelVoltage1      'mV
Alias OutputData(6)  = ChannelVoltage2      'mV
Alias OutputData(7)  = ChannelVoltage3      'mV
Alias OutputData(8)  = ChannelVoltage4      'mV
Alias OutputData(9)  = ChannelVoltage5      'mV
Alias OutputData(10) = ChannelVoltage6      'mV

'Defines data table
DataTable (Spectrafy_D2,1,-1)       'Autoallocates table size
  DataInterval (0,DAQRate,Sec,10)   'Sets the DAQ rate
  Sample(1,Timezone,FP2)            'Stores timezone
  FieldNames("Timezone")            'Names "Timezone" column
  Average(10, OutputData(),IEEE4,0) 'Stores raw data
EndTable

'Executes main program
BeginProg
  'Initializes serial port
  SerialOpen (ComC1,9600,0,0,256,4)  'RS-485 communication on port "ComC1"
                                     'Black wire (A-) to C1 terminal
                                     'Brown wire (B+) to C2 terminal
                                     'Baud rate: 9600 bps
                                     'Buffer size: 256 bytes
                                     'Mode: 4 (half-duplex RS485)
  'Sets a 5 s scan interval
  Scan (5,Sec,0,0)

      'Transmits the broadcast command
            SerialOut (ComC1,SerialCommand,"",0,0)

            'Receives serial data with a 1000 ms timeout
            SerialIn (SerialData,ComC1,100,TerminationCharacter,256)

      'Clears the serial buffer
            SerialFlush (ComC1)

      'Removes the header from the serial data
```


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```
            SerialData = Mid(SerialData,6,256)

      'Parses the serial data into numeric values
            SplitStr (OutputData(),SerialData,"",10,0)

      'Converts raw data into meteorological data
      AmbientPressure = AmbientPressure / 10.0
            AmbientTemperature = (AmbientTemperature / 75.0) - 50.0
            InternalTemperature = (InternalTemperature / 75.0) - 50.0
      InternalHumidity = InternalHumidity / 100.0

      'Passes raw data to "Spectrafy" table
            CallTable Spectrafy_D2
  NextScan
EndProg
```

b. For the SolarSIM-G

```
'Description: Acquires raw data from the SolarSIM-G
'Datalogger:  CR6 from Campbell Scientific
'Author:      Spectrafy Inc.
'Date:        February 20, 2020

'Defines user constants
Const Timezone     = -5 'hrs
Const DAQRate      = 60 's
Const SamplingRate = 5  's

'Defines program constants
Const TerminationCharacter = CHR(10) + CHR(13)
Const SerialCommand = "N1000_E" + TerminationCharacter

'Declares public variables
Public SerialData As String *256
Public OutputData(14)

'Declares data table column names
Alias OutputData(1)  = AmbientTemperature   'C
Alias OutputData(2)  = AmbientPressure      'kPa
Alias OutputData(3)  = AmbientHumidity      '%
Alias OutputData(4)  = InternalTemperature  'C
Alias OutputData(5)  = InternalHumidity     '%
Alias OutputData(6)  = ChannelVoltage1      'mV
Alias OutputData(7)  = ChannelVoltage2      'mV
Alias OutputData(8)  = ChannelVoltage3      'mV
Alias OutputData(9)  = ChannelVoltage4      'mV
Alias OutputData(10) = ChannelVoltage5      'mV
Alias OutputData(11) = ChannelVoltage6      'mV
```


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```
Alias OutputData(12) = ChannelVoltage7      'mV
Alias OutputData(13) = ChannelVoltage8      'mV
Alias OutputData(14) = ChannelVoltage9      'mV

'Defines data table
DataTable (Spectrafy_G,1,-1)      'Autoallocates table size
  DataInterval (0,DAQRate,Sec,10) 'Sets the DAQ rate
  Sample (1,Timezone,FP2)         'Stores timezone
  FieldNames("Timezone")          'Names "Timezone" column
  Average (14,OutputData,IEEE4,0) 'Stores raw data
EndTable

'Executes main program
BeginProg
  'Initializes serial port
  SerialOpen (ComC3,9600,0,0,256,4)  'RS-485 communication on port "ComC3"
                                     'Black wire (A-) to C3 terminal
                                     'Brown wire (B+) to C4 terminal
                                     'Baud rate: 9600 bps
                                     'Buffer size: 256 bytes
                                     'Mode: 4 (half-duplex RS485)
  'Sets a 5 s scan interval
  Scan (SamplingRate,Sec,0,0)

      'Transmits the broadcast command
            SerialOut (ComC3,SerialCommand,"",0,0)

            'Receives serial data with a 1000 ms timeout
            SerialIn (SerialData,ComC3,100,TerminationCharacter,256)

      'Clears the serial buffer
            SerialFlush (ComC3)

      'Removes the header from the serial data
            SerialData = Mid(SerialData,7,256)

      'Parses the serial data into numeric values
            SplitStr (OutputData(),SerialData,"",14,0)

      'Converts raw data into meteorological data
       AmbientTemperature = (AmbientTemperature / 75.0) - 50.0
       AmbientPressure = AmbientPressure / 10.0
       AmbientHumidity = AmbientHumidity / 100.0
       InternalTemperature = (InternalTemperature / 75.0) - 50.0
       InternalHumidity = InternalHumidity / 100.0

      'Passes raw data to "Spectrafy" table
            CallTable Spectrafy_G
  NextScan
EndProg
```


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c. For the SolarSIM-D2 and the SolarSIM-G

```
'Description: Acquires raw data from the SolarSIM-G
'Datalogger:  CR6 from Campbell Scientific
'Author:      Spectrafy Inc.
'Date:        February 20, 2020

'Defines user constants
Const Timezone     = -5 'hrs
Const DAQRate      = 60 's
Const SamplingRate = 5  's

'Defines program constants
Const TerminationCharacter = CHR(10) + CHR(13)
Const SerialCommand_G =  "N1000_E" + TerminationCharacter
Const SerialCommand_D2 = "N100_E"  + TerminationCharacter

'Declares public variables
Public SerialData As String *256
Public OutputData_G(14)
Public OutputData_D2(10)

'Declares data table column names for the SolarSIM-G
Alias OutputData_G(1)  = AmbientTemperature_G     'C
Alias OutputData_G(2)  = AmbientPressure_G        'kPa
Alias OutputData_G(3)  = AmbientHumidity_G        '%
Alias OutputData_G(4)  = InternalTemperature_G    'C
Alias OutputData_G(5)  = InternalHumidity_G       '%
Alias OutputData_G(6)  = ChannelVoltage1_G        'mV
Alias OutputData_G(7)  = ChannelVoltage2_G        'mV
Alias OutputData_G(8)  = ChannelVoltage3_G        'mV
Alias OutputData_G(9)  = ChannelVoltage4_G        'mV
Alias OutputData_G(10) = ChannelVoltage5_G        'mV
Alias OutputData_G(11) = ChannelVoltage6_G        'mV
Alias OutputData_G(12) = ChannelVoltage7_G        'mV
Alias OutputData_G(13) = ChannelVoltage8_G        'mV
Alias OutputData_G(14) = ChannelVoltage9_G        'mV

'Declares data table column names for the SolarSIM-D2
Alias OutputData_D2(1)  = AmbientPressure_D2      'kPa
Alias OutputData_D2(2)  = AmbientTemperature_D2   'C
Alias OutputData_D2(3)  = InternalTemperature_D2  'C
Alias OutputData_D2(4)  = InternalHumidity_D2     '%
Alias OutputData_D2(5)  = ChannelVoltage1_D2      'mV
Alias OutputData_D2(6)  = ChannelVoltage2_D2      'mV
Alias OutputData_D2(7)  = ChannelVoltage3_D2      'mV
Alias OutputData_D2(8)  = ChannelVoltage4_D2      'mV
Alias OutputData_D2(9)  = ChannelVoltage5_D2      'mV
Alias OutputData_D2(10) = ChannelVoltage6_D2      'mV
```


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```
'Defines data table for SolarSIM-G
DataTable (Spectrafy_G,1,-1)      'Autoallocates table size
  DataInterval (0,DAQRate,Sec,10) 'Sets the DAQ rate
  Sample (1,Timezone,FP2)         'Stores timezone
  FieldNames("Timezone")          'Names "Timezone" column
  Average (14,OutputData_G,IEEE4,0) 'Stores raw data
EndTable

'Defines data table for SolarSIM-D2
DataTable (Spectrafy_D2,1,-1)     'Autoallocates table size
  DataInterval (0,DAQRate,Sec,10) 'Sets the DAQ rate
  Sample (1,Timezone,FP2)         'Stores timezone
  FieldNames("Timezone")          'Names "Timezone" column
  Average (10,OutputData_D2,IEEE4,0) 'Stores raw data
EndTable

'Executes main program
BeginProg
  'Initializes serial port for the SolarSIM-G
  SerialOpen (ComC3,9600,0,0,256,4)  'RS-485 communication on port "ComC3"
                                     'Black wire (A-) to C3 terminal
                                     'Brown wire (B+) to C4 terminal
                                     'Baud rate: 9600 bps
                                     'Buffer size: 256 bytes
                                     'Mode: 4 (half-duplex RS485)

  'Initializes serial port for the SolarSIM-D2
  SerialOpen (ComC1,9600,0,0,256,4)  'RS-485 communication on port "ComC1"
                                     'Black wire (A-) to C3 terminal
                                     'Brown wire (B+) to C4 terminal
                                     'Baud rate: 9600 bps
                                     'Buffer size: 256 bytes
                                     'Mode: 4 (half-duplex RS485)

'----------------------------SolarSIM-G---------------------------------
  'Sets a 5 s scan interval
  Scan (SamplingRate,Sec,0,0)

      'Transmits the broadcast command
            SerialOut (ComC3,SerialCommand_G,"",0,0)

            'Receives serial data with a 1000 ms timeout
            SerialIn (SerialData,ComC3,100,TerminationCharacter,256)

      'Clears the serial buffer
            SerialFlush (ComC3)

      'Removes the header from the serial data
            SerialData = Mid(SerialData,7,256)
```


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```
      'Parses the serial data into numeric values
            SplitStr (OutputData_G(),SerialData,"",14,0)

      'Converts raw data into meteorological data
       AmbientTemperature_G = (AmbientTemperature_G / 75.0) - 50.0
       AmbientPressure_G = AmbientPressure_G / 10.0
       AmbientHumidity_G = AmbientHumidity_G / 100.0
       InternalTemperature_G = (InternalTemperature_G / 75.0) - 50.0
       InternalHumidity_G = InternalHumidity_G / 100.0

      'Passes raw SolarSIM-G data to "Spectrafy" table
        CallTable Spectrafy_G

'----------------------------SolarSIM-D2--------------------------------
      'Transmits the broadcast command
            SerialOut (ComC1,SerialCommand_D2,"",0,0)

            'Receives serial data with a 1000 ms timeout
            SerialIn (SerialData,ComC1,100,TerminationCharacter,256)

      'Clears the serial buffer
            SerialFlush (ComC1)

      'Removes the header from the serial data
            SerialData = Mid(SerialData,6,256)

      'Parses the serial data into numeric values
            SplitStr (OutputData_D2(),SerialData,"",10,0)

      'Converts raw data into meteorological data
      AmbientPressure_D2 = AmbientPressure_D2 / 10.0
            AmbientTemperature_D2 = (AmbientTemperature_D2 / 75.0) - 50.0
            InternalTemperature_D2 = (InternalTemperature_D2 / 75.0) - 50.0
      InternalHumidity_D2 = InternalHumidity_D2 / 100.0

     'Passes raw SolarSIM-D2 data to "Spectrafy" table
       CallTable Spectrafy_D2
      NextScan

EndProg
```


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5. Support

If you have any questions regarding your specific application, don't hesitate to contact Spectrafy at info@spectrafy.com.

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