Supplemental Documentation for EasyFlux-DL CR6OP and CR1000XOP

The following revisions apply to *EasyFlux-DL Product Manual For CR6 or CR1000X and Open-Path Eddy-Covariance Systems (Revision 03/2022)*.

Online: https://s.campbellsci.com/documents/us/manuals/easyflux-dl-cr6op.pdf

1. Introduction

Make the following additions to the list of supported sensors (in bold):

- Radiation measurement instrument
  - Option 1
    - ♠ CS301 or CS320 pyranometer (qty 0 to 1)
    - ♠ CS310 **or LI190** quantum sensor (qty 0 to 1)
    - ♠ SI-111 infrared radiometer (qty 0 to 1)
- Soil water content reflectometer (qty 0 to 3)
  - Option 1: CS650
  - Option 2: CS655
  - **Option 3: Acclima TDR series**
- **Array of soil sensors (qty 0 to 6)**
  - **Option 1: Acclima TDR series**

3.1 Wiring

3.1.6 Radiation measurements, Option 1

An LI-190 series quantum (PAR) sensor (LI-COR Biosciences) may be used in place of a CS310 quantum sensor. Wire the sensor using the table below and then:

1. Set constant `SENSOR_CS310` to True.
2. Update unique constant `QUNTM_MULT` with the sensor-specific multiplier (µmol/m^2/s/mV).

Sensor	Quantity	Wire Description	Color	VOLT116 terminal
LI-190 series quantum sensor	0 or 1	Signal	Red	**Diff 8H**
		Signal reference	Black	**Diff 8L**
		Signal ground (-R series)	White	**AG**
		Shield	Clear	**AG**

3.1.10 Soil water content reflectometers

This version of ***EasyFlux DL OP*** supports three models of soil water content reflectometers: Campbell Scientific CS650 or CS655, or Acclima TDR series sensors. Up to three sensors of any one model may be selected, or zero

sensors may be selected. The default wiring for CS650 and CS655 is shown in Table 3-11 (p. 13). The default wiring for TDR series is substantially identical and shown in the table below.

Sensor	Quantity	Wire Description	Color	CR6 terminal	CR1000X terminal
TDR #1/#2/#3 (Addresses 4/5/6)	0 to 3	SDI-12 data	Blue	**U3** [1]	**C3** [1]
		SDI-12 power	Red	**+12 V** [2]	**+12 V** [2]
		SDI-12 reference	White	**G**	**G**

3.1.11 Array of soil sensors, Option 1

This version of ***EasyFlux DL OP*** supports from zero to six additional Acclima TDR series sensors, for soil measurements independent of energy balance calculations (e.g. vertical profiling). Sensors are queried from a separate scan and data is optionally output to separate data table *Flux_Extra*. The sensor SDI-12 addresses must be sequential and the starting address and quantity must be specified using unique program constants.

By default, sensor quantity is 3 and sequential SDI-12 addresses are 7, 8, 9. Data field output labels (from 1 up to 6) correspond to these addresses, from low to high. The default wiring uses the same SDI-12 input channel as soil water content reflectometers:

Sensor	Quantity	Wire Description	Color	CR6 terminal	CR1000X terminal
TDR #1..6	0 to 6	SDI-12 data	Blue	**U3** [1]	**C3** [1]
		SDI-12 power	Red	**+12 V** [2]	**+12 V** [2]
		SDI-12 reference	White	**G**	**G**

4. Operation

4.4 Output tables

> **NOTE:** the program constant to combine tables is `ONE_FL_TABLE` (minor typo in user guide).

A seventh data table (**Flux_Extra**) contains data fields from supplemental sensors, such as soil profile measurements. If the constant `ONE_FL_TABLE` is set to True, then output table **Flux_CSFormat** will also contain data fields normally reported in **Flux_Notes** and **Flux_Extra**, and those tables will not be created.

For **Table 4-5: Data output tables**, insert this additional row:

Table name	Description	Recording interval	Memory on CR6 or CR1000X CPU	Memory on microSD card
Flux_Extra	Additional statistical data not included in other *Flux* tables	OUTPUT_INTERVAL (default 30 min)	NUM_DAY_CPU (default 7 days)	Broken up into 30-day files; see Table 4-4

For **Table 4-9: Data fields in the Flux_AmeriFluxFormat output table**:

- In the *Data field included* column, replace all references to "CS65X" with "CS65X or TDR".

For **Table 4-10: Data fields in the Flux_CSFormat output table**:

Change Type	Data Field Name	Units	Description	Data Field Included
Update row	TS_1_1_x	deg C	Average soil temperature; x of 1 to 3 is an index for the number of soil temperature measurements made	If TCAV, CS65X or TDR is used (if both, TCAV temperature is used)
Update row	SWC_1_1_x	% [3]		
Insert 3 rows after CS65x_ec_1_1_x	TDR_E_1_1_x	unitless	Soil permittivity; x of 1 to 3 is an index for the number of soil sensors	If TDR is used
	TDR_bulkEC_1_1_x	dS m-1	Soil bulk electrical conductivity; x of 1 to 3 is an index for the number of soil sensors	If TDR is used
	TDR_poreEC_1_1_x	dS m-1	Soil pore water electrical conductivity; x of 1 to 3 is an index for the number of soil sensors	If TDR is used

Insert new table, **Table 4-11: Data fields in the Flux_Extra output table:**

Data Field Name	Units	Description	Data Field Included
SWC_2_2_x	%	Soil volumetric water content; x of 1 to 6 is an index for the number of soil sensors	If PROFILE_TDR is used
TS_TDR_2_2_x	deg C	Soil temperature; x of 1 to 6 is an index for the number of soil sensors	IF_PROFILE_TDR is used
TDR_E_2_2_x	unitless	Soil permittivity; x of 1 to 6 is an index for the number of soil sensors	If PROFILE_TDR is used
TDR_bulkEC_2_2_x	dS m-1	Soil bulk electrical conductivity; x of 1 to 6 is an index for the number of soil sensors	If PROFILE_TDR is used
TDR_poreEC_2_2_x	dS m-1	Soil pore water electrical conductivity; x of 1 to 6 is an index for the number of soil sensors	If PROFILE_TDR is used

Another new table, **Biomet**, contains 5-minute statistics for most sensor data, excluding flux outputs and intermediate processing values. Corresponding field names are obtained from the same data sources and receive the same quality control in processing. Field names are conditionally included only when the relevant sensor(s) is activated. The following table summarizes available data fields.

Description	Sensor(s)	Fields Included
Air temp/RH, e and e_{sat}	Sonic/IRGA	Always

Air temp/RH, e and e_{sat}	T/RH probe	If T_RH or HYGRO is used
Air pressure & VPD	IRGA	Always
Sonic temperature and wind-related	Sonic anemometer	Always
CO2 & H2O densities and signal strengths	IRGA	Always
Fine-wire temperature	Fine-wire thermocouple	If FW is used
Precipitation	Rain gage	If TE525 is used
Albedo, components of radiation and sensor body temperatures	Component radiometer or pyranometer	If CNR4, NR01, SN500, CS301 or CS320 is used
Photosynthetic flux	Quantum (PAR) sensor	If CS310 is used
Canopy temperature	Infrared thermometer	If SI111 is used
Soil temperature	Soil thermocouples or reflectometers	If TCAV, CS650, CS655 or TDR is used
Soil water content	Soil reflectometers	If CS650, CS655 or TDR is used
Soil heat flux	Heat flux plates	If HFP01 or HFPSC is used

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1. Multi-circuit spring-clamp terminal blocks are recommended for multiplexing wires to the logger terminals.□□□□
2. Powering sensor(s) from the datalogger's +12V source instead of 12V terminal is recommended.□□□□
3. Minor typo in user guide.□