Dynamax

Flow10
Sap Flow System
Quick Start Guide

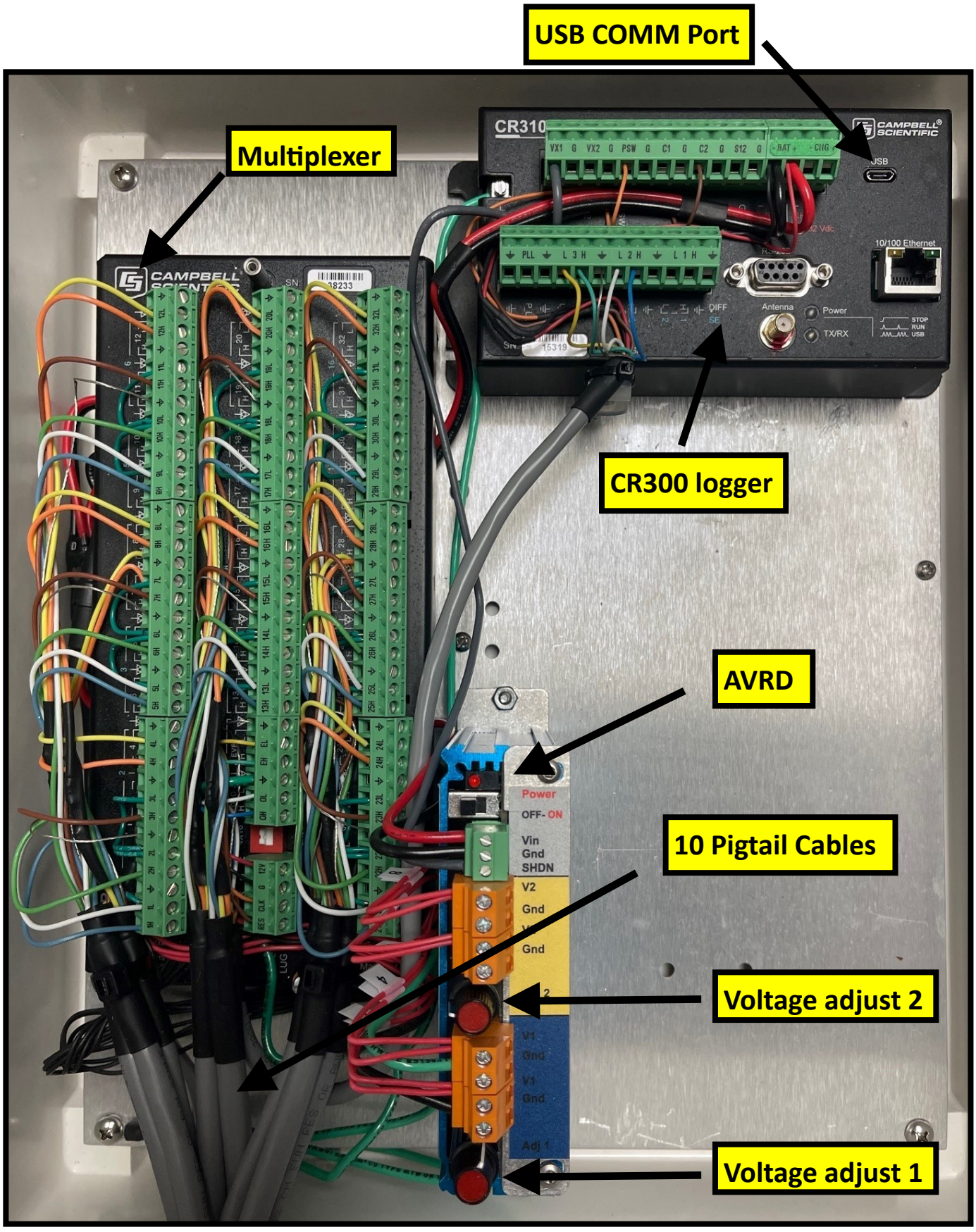
Dynamax

INTRODUCTION

Sap Flow measurements are made easier and more affordable by the Dynamax Flow10 system. This new product integrates all the necessary electronics, software and sensors into a complete solution. The Flow10's main system with CR300 data logger, multiplexer and AVRD to power the sensors with variable voltage can read up to 10 Dynagage/Exo-skin sensors. Field or greenhouse sap flow measurement is accomplished with Flow10 in a more affordable package.

Following are some of the features of New Flow10 sapflow logger,

- Integrated CR300 data logger
- Built-in sapflow calculations
- **30MB** Data memory capacity
- Stored data contains one year of daily accumulated and hourly accumulated sapflow data for each sensor.
- In addition short and long form outputs available
- Memory capacity of up to **2 years** for short and long form outputs.
- Status symbols/ codes for each sensor to relay the condition or sensors or cables or any of the settings
- Built-in auto zero to calibrate sensors at predawn
- Power save option at night time with allowance for warm-up time for sensors before valid data can be obtained
- Efficient AVRD to power excitation voltage to Dynagage or Exo-skin sensors
- 10 Dynagage or Exo-skin sensors on basic system, assembled with pigtail cables
- Solar panel and AC power options
- USB port as well as 9-pin RS232 port and 10/100 Ethernet port
- Optional built-in Cellular 4G/LTE capabilities for remote connection


USB COMM Port
Multiplexer
CR300 logger
AVRD
10 Pigtail Cables
Voltage adjust 2
Voltage adjust 1
CR310
CAMPBELL SCIENTIFIC
VX1 G VX2 G PSW G C1 G C2 G S12 G
BAT + CHG -
USB
PLL L 3 H L 2 H L 1 H
10/100 Ethernet
Antenna
Power
TX/RX
STOP
RUN
USB
DIFF
SE
Power
OFF- ON
Vin
Gnd
SHDN
V2
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Gnd
V1
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V1
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FIELD INSTALLATION

A Flow10 system is shipped with all cables attached and ready to use, except the extension cable, battery and solar power connectors. The following steps are important to any system monitoring Dynagages or Exo-skin sensors.

1. Check the AVRD power switch to confirm it is in the off position.

2. Mount the enclosure to a 1.5" diameter pole with the pole mounting hardware provided in the accessories kit, or to a vertical surface with "U" mounting bolts and nuts.

3. Attach the positive battery lead red wire to the (+) battery terminal. Then connect the black wire to the (-) battery terminal. For safety reasons and to prevent the unit from turning on during shipment, the positive lead is wrapped in tape.

4. Attach the green wire to an earth ground. Greenhouse and environmental chambers have earth ground in the wall sockets, so you can plug the banana lead into the ground receptacle (3rd wire). Under no circumstances should the AC power line neutral be used instead of the earth ground. This could easily be confused with the hot wire and lead to a hazardous shock. If you are indoors, and cannot confirm a solid earth ground it is better to have no connection for now.

5. Field installations require that the ground wire is firmly attached to a copper grounding rod. Iron or copper water pipes will also serve as a good grounding point.

6. Hardware stores and electrical shops also stock ground rods for lightning protection on antenna installations as well. The copper rod should be driven into the earth at least four feet.

7. Optional: Plug in the outdoor rated AC battery charger into a 120 VAC outlet, if the system is within 6 ft. of a 120 VAC outlet. If not, plug in the AC Charger into an extension cord.
   ** For installations outside North America, a 220V AC battery charger will be supplied.

8. Put the battery and charger into separate battery boxes. Wiring plugs or plug contacts should not be left exposed to rain or irrigation water.

SOFTWARE INSTALLATION

Flow10 is a completely integrated station capable of reading Dynagage or Exo-skin sap flow sensors. Sensor readings are then stored in datalogger's internal memory. Data from the logger is available for download using data logger support software. Flow10 station is integrated with CR300 datalogger. Hence can be operated using any of the following data logger support software:

- PC400
- LoggerNet

In this manual we explain using PC400 only. Procedures to operate using LoggerNet is very similar to PC400 with slight differences in the interface. For Procedure to connect, program download data using PC400 refer to the following.

PC400 Installation

PC400 Logger utilities software and user manual can be downloaded for FREE from the following link: **https://www.campbellsci.com/pc400**

1. Right click "PC400_4.7.exe" and select "Run as Administrator".

2. Follow the prompt to continue installation.

3. Fill in "User Name", "Company", and "CD Key". This key can be obtained during the download procedure (an email with download link and CD key to your mailbox).

4. Continue with the installation until it is completed.

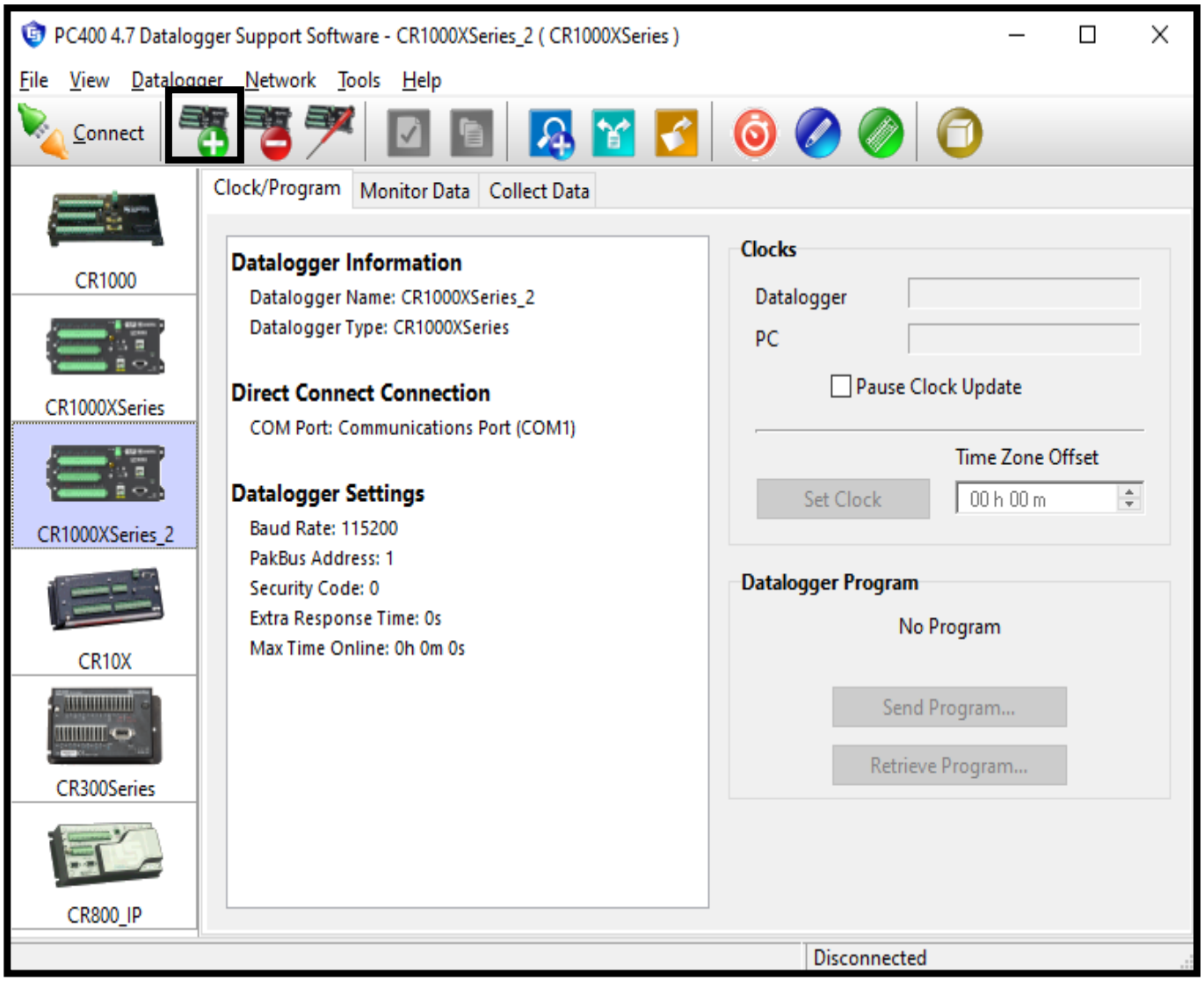
Working Directory Location

PC400 install wizard prompts for working directory location. By default, working directory is **C:\CampbellSci\PC400**

COMMUNICATION SETUP

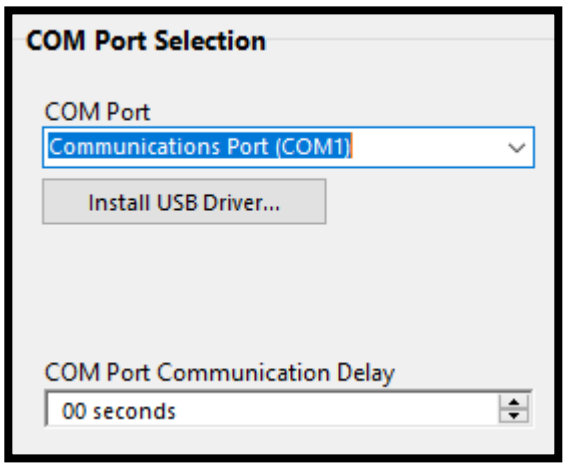
Launch PC400 software from the desktop icon or from the start menu. This opens the main PC400 window along with tool bars for PC400 components.

To setup/ modify station on PC400, click on “Add Logger” icon. This will launch new station setup window.



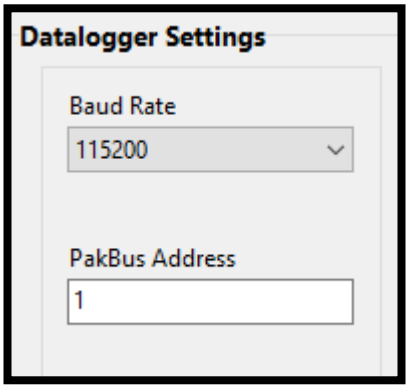
- If this first time using software or to add a new logger station to the software setup click on **Add** button. **PC400 offers a easy to use step-by-step EzSetup wizard** that will guide through adding stations and connecting to logger features. If the station is already added in the list, proceed with connect to logger in the next section.

- Click **Next** to start the wizard.
- Select Data logger type **CR300Series.**
- Type data logger name in the text field.
- Click **Next** to proceed to next setup process.
- Select connection type , typically "Direct Connect" for USB; then click **Next** to proceed.



- Select COM port from the list. If this is the first time ever connected a Campbell logger through USB, click "Install USB Driver"; click **Next** to proceed.

- In Datalogger Settings, set "Baud Rate" to 115200; set PakBus Address (default to 1 unless otherwise noted); click **Next** to proceed.
- Maintain "Datalogger Security Settings" to be disabled unless otherwise noted; click **Next** to proceed.
- After reviewing "Communication Setup Summary", click **Finish** to complete.



SYSTEM OPERATION

Connect to FLOW10

- At the main screen, highlight the station name and click ***Connect*** to establish communication to datalogger while connected with USB cable. If successful, main connect screen will display ***Disconnect*** and ***Connection Time***, see below.

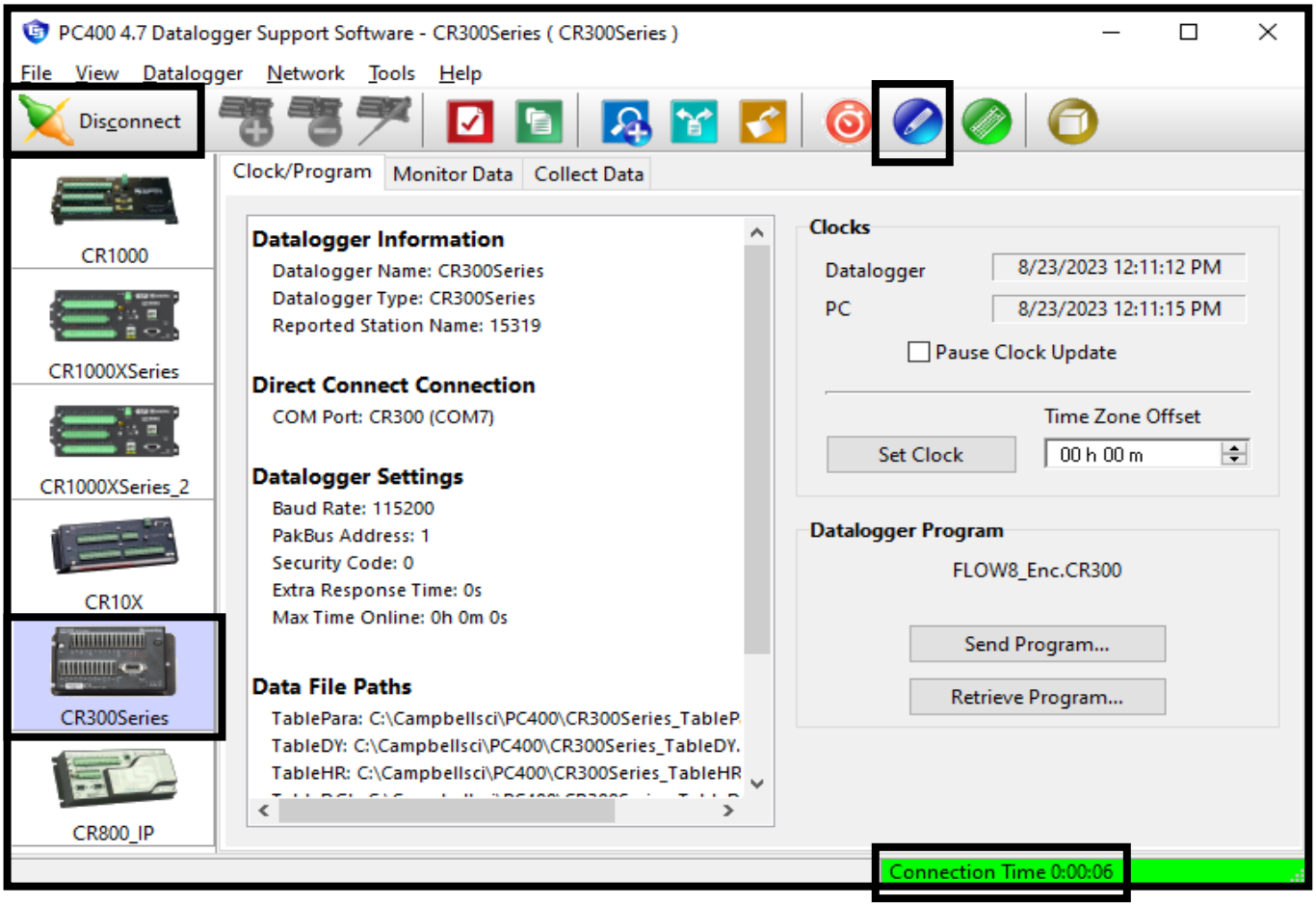
- At the ***Clock/Program*** tab, click ***Set Clock*** to sync datalogger with PC time.

Program Logger

- Click ***Send Program*** to upload new/updated program(s) to datalogger. System's original programs come in a USB memory stick. Read the "MUST READ FIRSTxxxxx" files before modifying or uploading them. Refer to ***UPLOAD PROGRAMS*** to datalogger on page 16 for detailed steps.

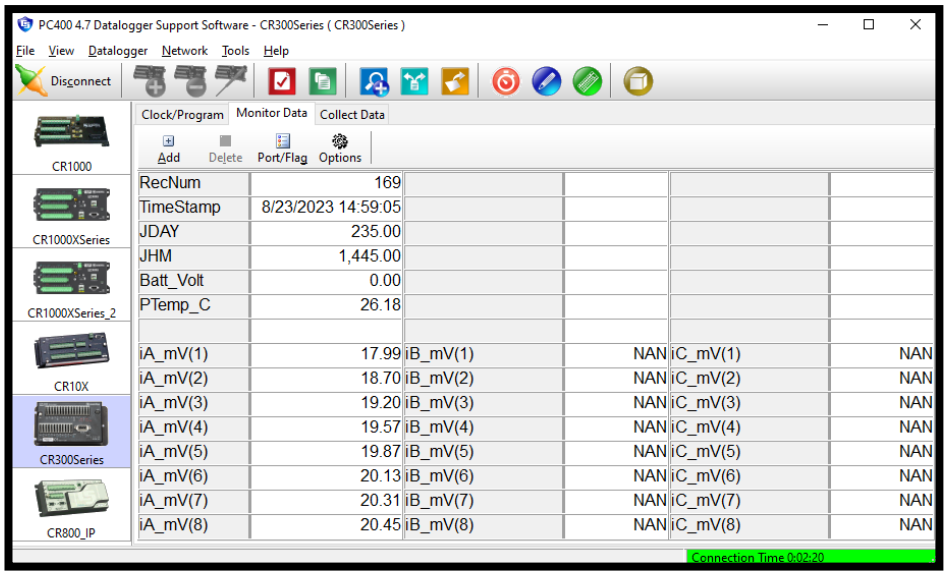
Edit Program Files

- Click ***CRBasic Editor*** (blue icon) to start the software and modify any program files in it. **DO NOT** change any of the program files name after the edit. File ended with **"FLOW10_xxxxx_ENC.CR300"** cannot be edited. Refer to page 16.



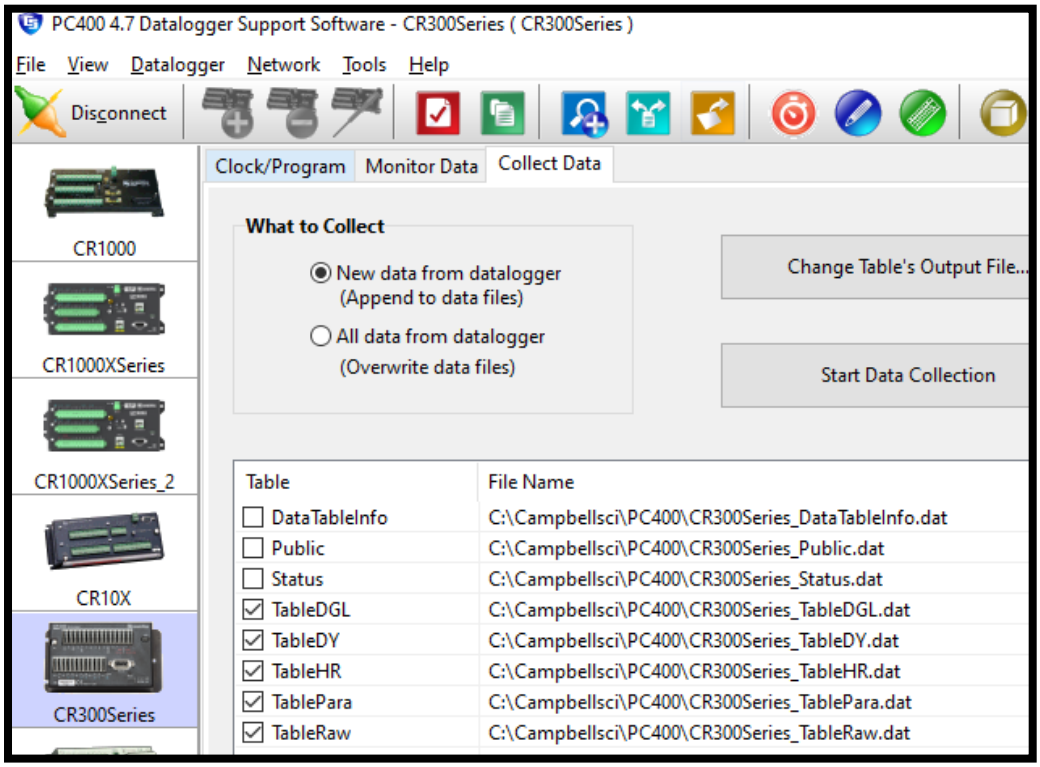
Monitor Data in Real-time

Next to the ***Clock/Program*** is ***Monitor Data*** tab. Here, you may load variables from ***Public*** table and monitor their data live at 60 seconds interval. Click ***Add*** then select ***Public*** table, select any variables you wish to monitor then paste them into the cells. Note: this is not the final result that you download from output tables, but rather an intermediate values before averaging.



Download Data

When ready to download data, click ***Collect Data*** tab, check the boxes on the data tables desired. The file location shown below is the default location of downloaded data. To change it, highlight each data table then click ***Change Table's Output File*** button. When done, choose ***New data*** or ***All data*** then click ***Start Data Collection***.



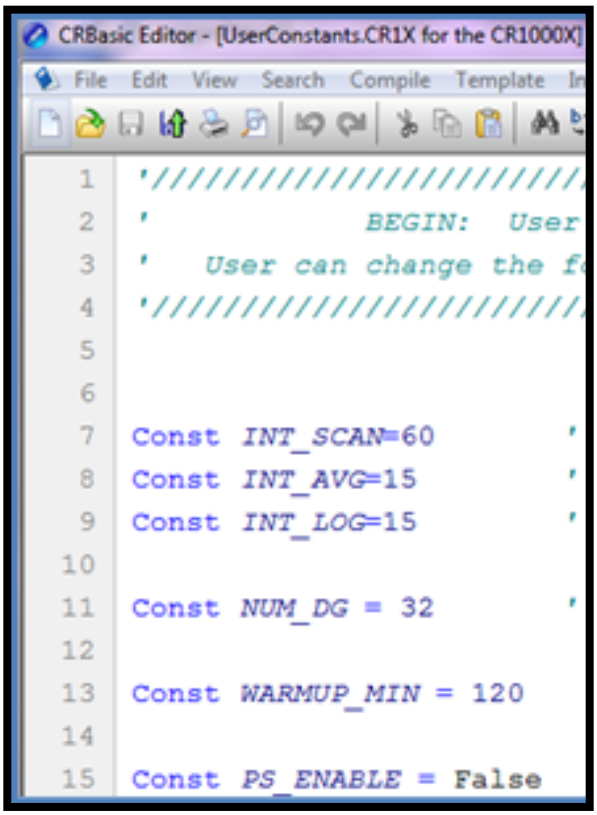
Output Table Contents

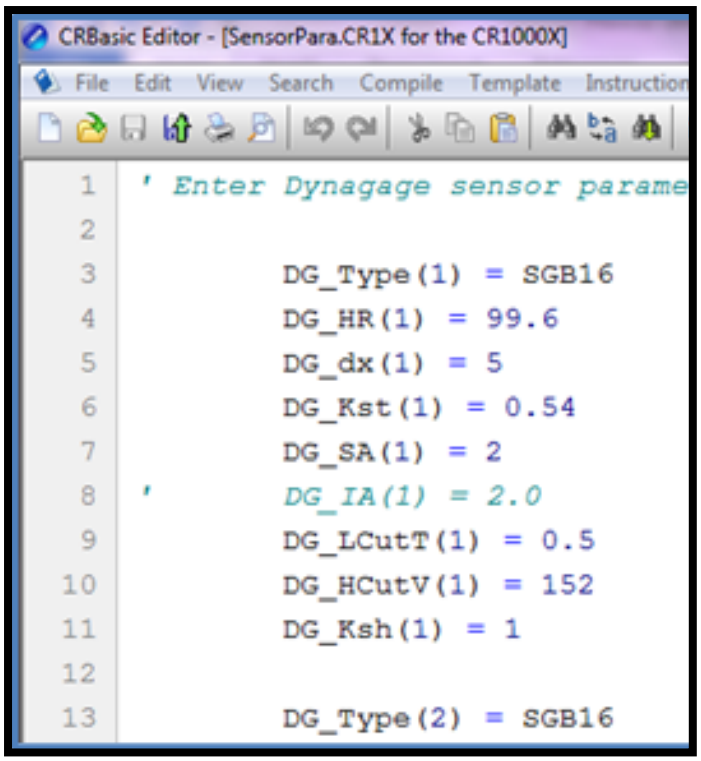
Table Name	Description	Variables
Status	Data loggers status table.	Only show the newest data
Public	Programs public table, contains all the public variables at any given time.	Only show the newest data
TableRAW	Table of thermocouple voltages and heater fvoltages. Used as a temporary table to calculate average over the averaging interval.	iA_mV(1) – iA_mV(10) iB_mV(1) – iB_mV(10) iC_mV(1) – iC_mV(10) iH_V(1) – iH_V(10)
TableDGL	Table containing calculated sap flow data and indexed sap flow data along with statuses for all the sensors and raw thermocouple voltages and intermediate calculations including energy balance variables.	JDAY JHM C_mV(1) – C_mV(10) B_mV(1) – B_mV(10) A_mV(1) – A_mV(10) H_V(1) – H_V(10) DG_Status(1) – DG_Status (10) DG_Flow(1) – DG_Flow(10) DG_DT(1) – DG_DT(10) DG_Ksh(1) – DG_Ksh(10) DG_Kshapp(1) – DG_Kshapp(10) DG_Pin(1) – DG_Pin(10) DG_Qv(1) – DG_Qv(10) DG_Qr(1) – DG_Qr(10) DG_Qf(1) – DG_Qf(10) Batt_Volt PTemp_C
TableHR	Table containing accumulated total hourly sap flow from all the sensors.	JDAY JHM Hr_Flow(1) - Hr_Flow(10)
TableDY	Table containing accumulated total daily sap flow from all the sensors, plus each sensor's parameters for analysis purpose.	JDAY DY_Flow(1) - DY_Flow(10) DG_Type(1) – DG_Type(10) DG_HR(1) – DG_HR(10) DG_SA(1) – DG_SA(10)

EDIT PROGRAMS

A standard **FLOW10_xxxxx_Enc.CR300** program is supplied with all Flow10 systems, where xxxxx is the serial number of the CR300 datalogger. This program reads 10 Dynagage sensors ever minute, average readings and calculate sap flow every hour or at specified interval on the base system. These settings can be easily modified according to the user requirements. This section explains procedure to open the standard program in CR Basic Editor and the

UserConst.CR300 and **SensorPara.CR300** program files must be modified before sending to the logger. Hence, it is not necessary to have the data logger connection established at this point. Launch PC400 software, click on **CRBasic** icon on the top right. This opens a blank editor window. In the editor window click Open icon or File>Open from the menu. In the file selection dialog box, navigate to the Flow10 software directory and open each files as shown below. **DO NOT** change file names when saving.





UserConst.CR300

This program file contains basic system settings for daily data logging and calibration. The table below is a tabular listing of the constants and values permitted for each constant. Refer to this table when modifying user constants as required. Save the file with the same name at a different directory to preserve the original.

Constant Name	Units	Value		Range	Remarks
		Default	Maintenance		
INT_SCAN	Second	60	10	10 – 60	Interval between sensor measure-
INT_AVG	Minutes	15	1	1 – 60	Average and sap flow calculation
INT_LOG	Minutes	15	1	1 - 60	Store data to memory interval
NUM_DG	Number	10	10	1 – 10	Number of Dynagage sensors
DTMIN	Deg C	0.25	0.25	0.25 – 1.5	DT below which data is ignored
WARMUP_MIN	Minutes	120	1	0 – 240	Sensor warm-up time
Const DT_HIFLOW	Deg C	0.25	0.25	0.1 – 0.5	The lowest dT allow at high flow
PS_ENABLE		False	False	0 or 1	Power-save flag (1=Enable)
PS_START	Number	1260	1260	0 – 1440	Power-save start time in minutes
PS_STOP	Number	240	240	0 – 1440	Power-save stop time in minutes
ZERO_ENABLE		1	0	0 or 1	Auto-zero flag (1=Enable)
ZERO_STARTHOUR	Hour	3	3	1 – 23	Auto zero start hour
ZERO_STOPHOUR	Hour	5	5	1 – 23	Auto zero stop hour
ZERO_DAYINT	Number	1	1	1 – 7	Interval days between auto zero

SensorPara.CR300

In addition to the above-mentioned list of parameters user must enter Dynagage (SGA/ SGB)/Exo-Skin (SGEX) sensor parameters such as Sensor type, Stem area, Initial Ksh, for each one of the Dynagage/Exo-skin sensors connected. This part of the program code can be found in **SensorPara.CR300** file.

DG_Type(1): Number 1 in the parenthesis denotes that the parameter is for Dynagage/Exo -Skin sensors connected on sensor channel #1. Refer to **Dynagage manual**, page 11.

Enter any of the sensor types corresponding to the sensor connected on channel #1. Sensor type entered can be any of the following. **DO NOT change DG_Type to SGEX if using Exo-Skin sensors**. Using old sensor name with SGEX sensors will **NOT** affect the normal operation of the program.

SGA2
SGA3
SGA5
SGA9 (or SGEX9)
SGA10 (or SGEX10)
SGA13 (or SGEX13)
SGB16 (or SGEX16)
SGB19 (or SGEX19)
SGB25 (or SGEX25)
SGB35
SGB50
SGA70
SGA100
SGA150

```
' Enter Dynagage sensor parameters here.

    DG_Type(1) = SGB16          ' sensor type/ model
    DG_HR(1) = 99.6             ' heater resistance (Ohms)
    DG_dx(1) = 5                ' thermocouple gap (mm)
    DG_Kst(1) = 0.54            ' stem constant
    DG_SA(1) = 2.0              ' stem area (cm2)

    DG_LCutT(1) = 0.5           ' Low flow cut off temp. (C)
    DG_HCutV(1) = 152           ' High flow cut off velocity (cm/s)
    DG_Ksh(1) = 0.8             ' initial sheath constant
```

DG_HR(1): Resistance of the heater for the sensor connected on channel #1. Heater resistance in Ohms. Found on sensor cable label.

DG_dX(1): Thermocouple gap. Obtain this number from Dynagage specifications. Refer to **Dynagage manual**, page 11.

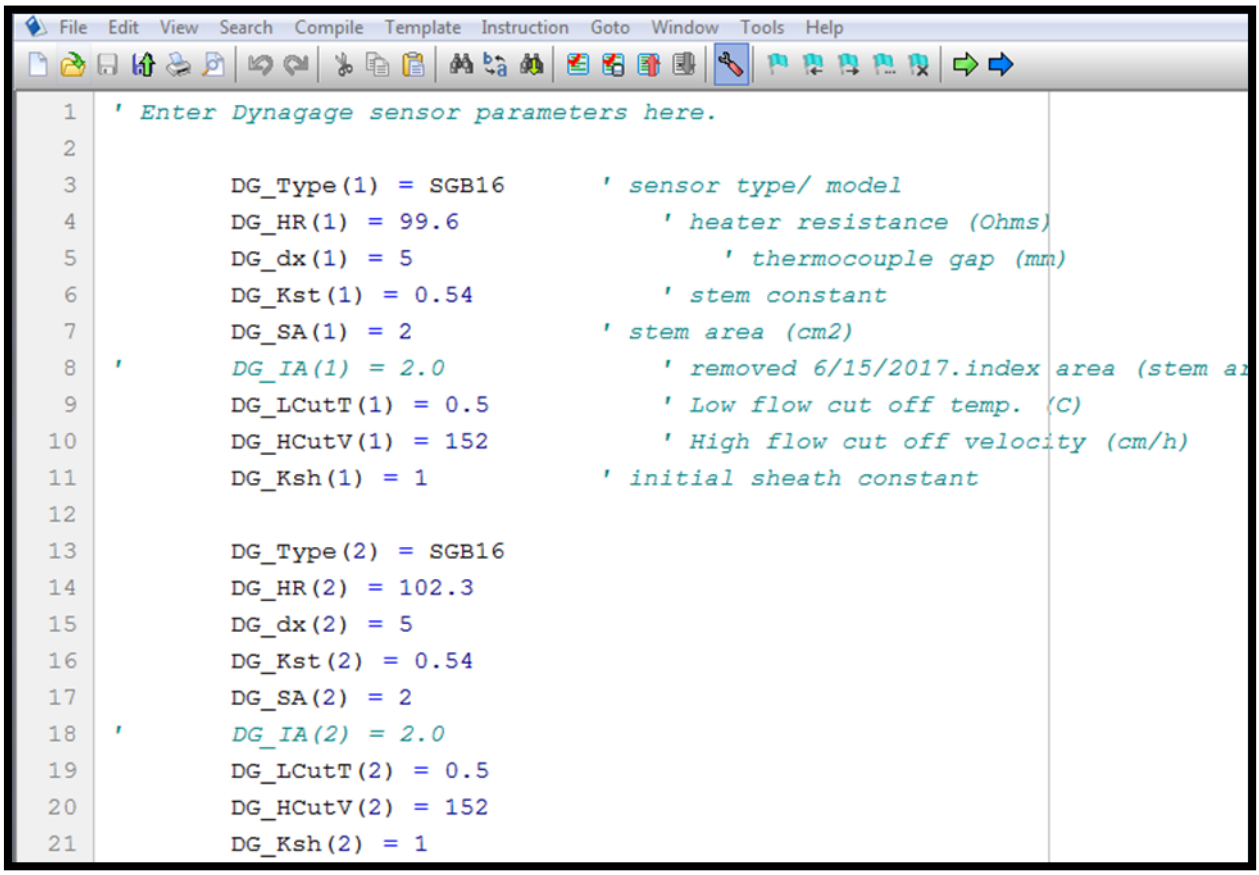
DG_Kst(1): Stem constant of the plant or tree on which sensors are installed. Stem constant depends on whether the stem is woody, herbaceous or hollow. Refer to **Dynagage manual**, page 19.

DG_SA(1): Stem area of under the sensor, at the midpoint. Measure diameter or circumference of the stem and calculate area of the circular stem from this data. Units in sq.cm

DG_LCutT(1): Low flow cut-off temperature. Minimum temperature below which the sensor data is said to be invalid or suggests a problem with the sensor. Units in deg C

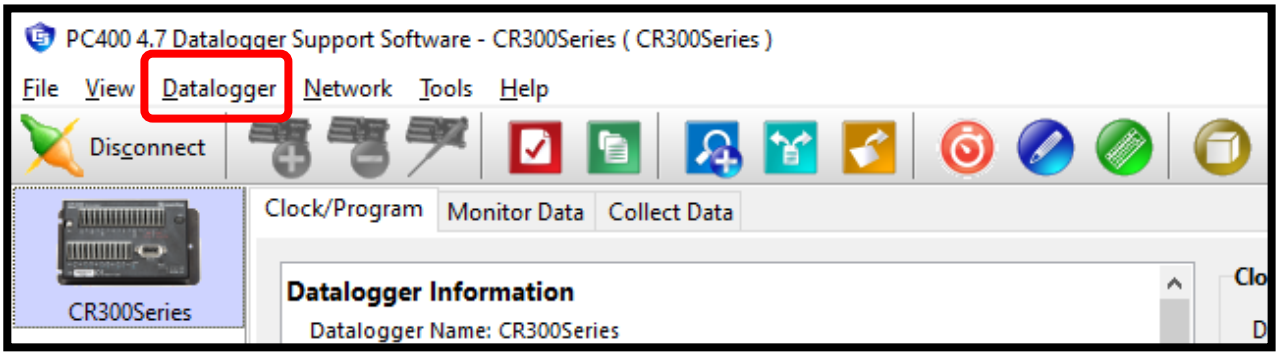
DG_HCutV(1): High flow cut-off velocity, maximum velocity above which the senor is maxed out or the data form sensor is not reliable. Units in cm/s.

DG_Ksh(1): Initial default Ksh for the sensor on channel #1.

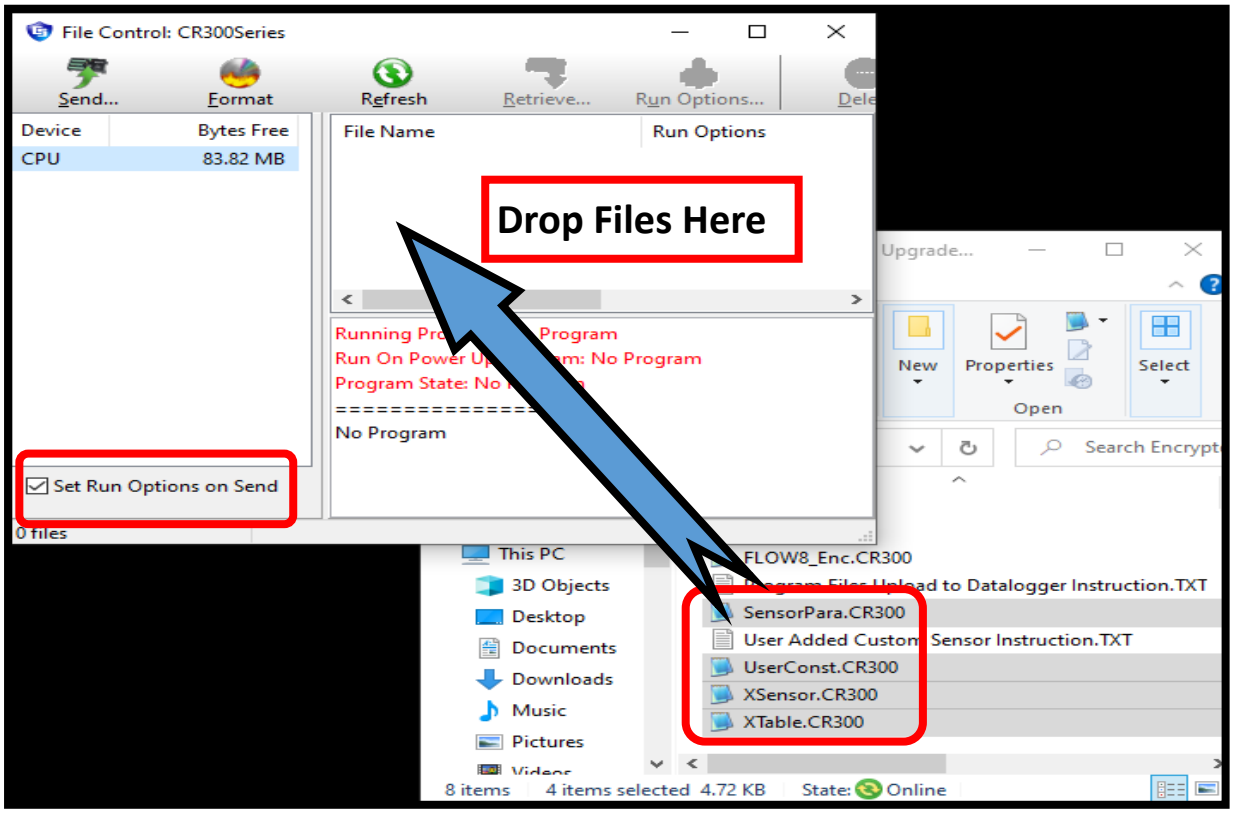


PROGRAM UPLOAD

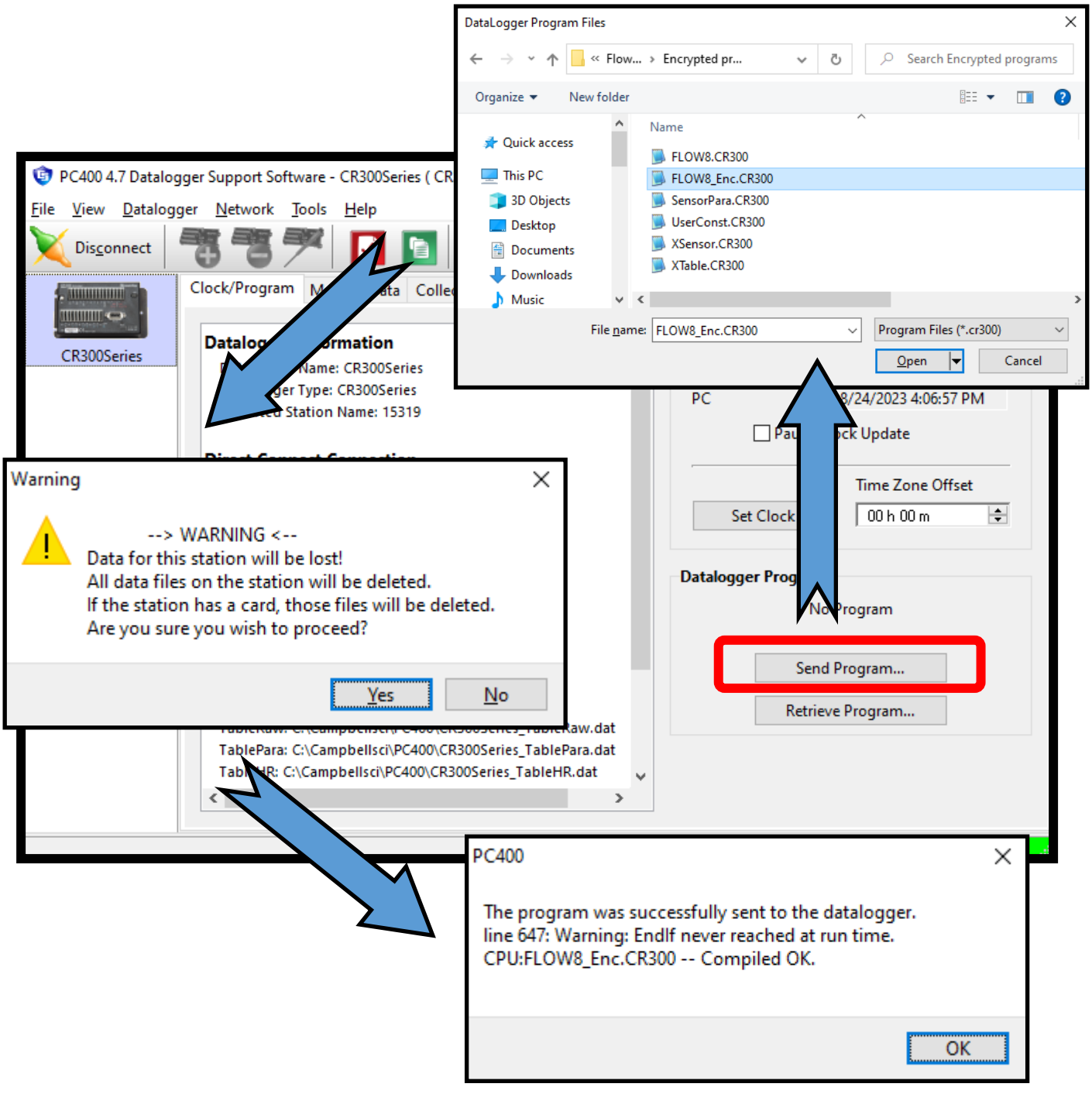
- Connect to FLOW10 system through PC400 (or LoggerNET)
- At the main screen, click ***Datalogger*** then select ***File Control***.



- Uncheck the box ***Set Run Options on Send*** at bottom left corn of the new window.
- From saved program files folder, drag and drop each of the following files (***SensorPara.CR300***, ***UserConst.CR300***, ***Xsensor.CR300***, ***XTable.CR300***) to the new window, shown below.
- Once completed, re-check ***Set Run Options on Send*** box then close the window.



- Back to the main window, click ***Send Program*** button.
- At popup window, navigate to program files folder.
- Select ***FLOW10_xxxxx_Enc.CR300*** file and click ***Open***.
- A warning window pops up and click ***Yes***. WARNING: If you have previously collected data stored on the system, click No and download the data first before proceeding to upload new programs.
- If upload is successful, a Compiled OK confirmation window pops up.



SPECIFICATION

Datalogger	CR300 logger with built-in sap flow calculator Optional: 4G/LTE Cellular Modem
Base Inputs	3 Differential Channels - Analog, SDI-12, Pulse
Channel Expansion	AM16/32B Relay Multiplexer
Expanded Inputs	32 Differential Channels - Analog
Sensor Capacity	(10) Dynagages/Exo-Skin sensors
Range	-100 to 2500 mV
Resolution	0.23 to 1.6 uV
Voltage Regulation	AVRD Dual Voltages, 1.5 - 10 V DC, 5 A each output channel
Base Memory	30 MB - Data serial flash storage Sap flow calculation - up to 24 months with 10 sap flow sensors
SIM slot & Antenna Port	Available with Cellular option
Communications	USB for laptop connectivity Ethernet Port: RJ45/ jack, 10/100 Base Mbps RS232
CHG120 - Battery & Charger	Optional: 7 Ahr / 12 V Sealed Lead Acid battery and 120 - 230 V AC charger
Solar Option	12 V connections supplied for solar panel/marine battery
Sensor Cables	10 x 7.6 m (25 ft) with Weather-proof Connectors
Enclosure	White fiberglass, NEMA 4X, with pole mounts, lockable, 17 x 14 x 6.5” (43 x 35 x 16 cm)
System Weight	10 kg