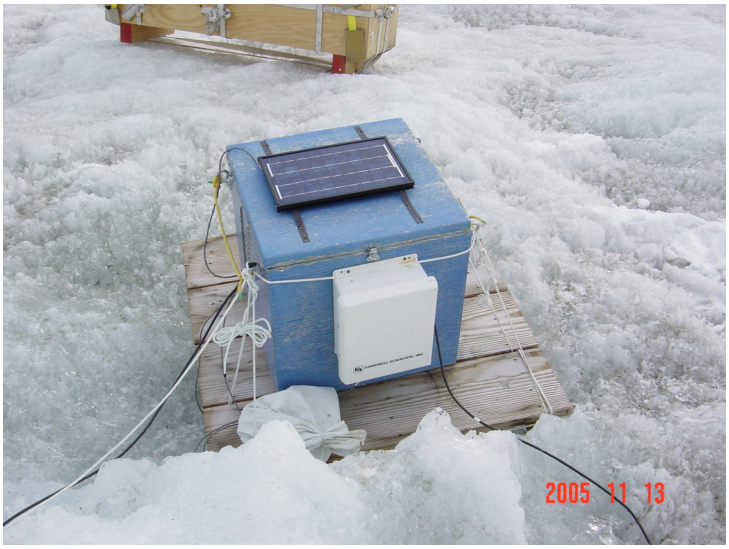
Documentation of The Taylor Valley Blue Boxes for season 2010/11



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1. Sensors

1.1 Available Sensors

Blue Box Sensor List								
SENSORS	SENSOR TYPE	Aplications	Company	Units	Deployment Date			
					Fryxell	Hoare	ELB	WLB
Surface PAR	LI190 SB Quantum	Measures incedent Photosynthetically Active Radiation	LI-COR Biosciences 4421 Superior St. Lincoln, NE 68504 Phone: 800-447-3576 Fax: 402-467-2819	micromoles of quanta per second per square meter (mmol s-1 m-2)	10/20/10	10/28/10	11/9/10	11/11/10
Underwater PAR	LI-193 Spherical Quantum Sensor	Measures PAR coming from all directions.	LI-COR Biosciences 4421 Superior St. Lincoln, NE 68504 Phone: 800-447-3576 Fax: 402-467-2819		11/16/09	10/28/10	12/3/10	11/11/10
Ablation Transducer (pressure transducer)	CS455 (at LF, LH, ELB) and Druck Pressure Transducer PDCR 1830 (at WLB)	Continuous lake ice ablation measurement	Campbell Sci. Logan, UT	m	10/21/10	10/28/10	11/9/10	11/9/09
Lake Lavel (Stage) Transducer		Continuous lake level measurements	Campbell Sci. Logan, UT	m	10/21/10	10/28/10	11/9/10	N/A
Water Temperature	CS455 (at LF, LH, ELB) and Druck Pressure Transducer PDCR (at WLB)	Continuous water temperature measurements	Campbell Sci. Logan, UT	°C	10/21/10	10/28/10	11/9/10	N/A

1.2 Sensors, Data Logger and Programming Information and Manuals at the Internet

(1) ***LI190 SB Quantum***

Sensor details:
http://www.licor.com/env/Products/Sensors/190/li190_description.jsp

Instruction Manual from Campbell Scientific:
http://www.campbellsci.com/documents/manuals/li190sb.pdf

(2) ***LI-193 Spherical Quantum Sensor***

Sensor details:
http://www.licor.com/env/Products/Sensors/193UW/li193_description.jsp
http://www.licor.com/env/PDF_Files/193SA.pdf

(3) ***Druck's Pressure Transducer*** **(WLB only)**

Sensor details:
http://www.gesensing.com/products/resources/datasheets/PDSA065june02.pdf

Instruction Manual from Campbell Scientific
http://www.campbellsci.com/documents/manuals/cs420-l.pdf

Note: Ablation Transducer (frequently called Pressure Transducer) and Lake Level Transducer (also known as Stage Transducer) are both the same type of transducers. The only difference between two is that they are differently

programmed – one for measuring the Ice ablation and the other for measuring the lake level.

(4) ***CS455 Pressure Transducer (LF, LH, ELB)***

Instruction Manual from Campbell Scientific
http://s.campbellsci.com/documents/us/manuals/cs450-cs455.pdf

(5) **CR1000 DataLogger**

Measurements and Control Module Operator's Manual
http://s.campbellsci.com/documents/us/manuals/cr1000.pdf

1.3 Diagram

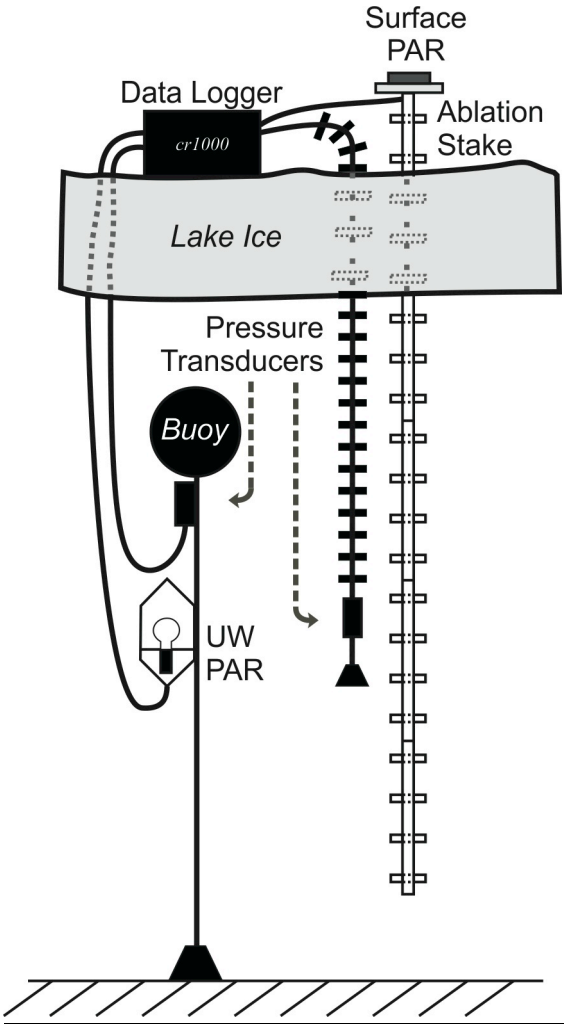

Fig.1: Lake cross-section showing buoy, data logger, position of deployed sensors and ablation stake.

UW PAR deployment depths are <u>measured from piezometric water level</u>:

Lake Fryxell: 8.06 m
Lake Hoare: 10.96 m
ELB: 10.66 m
ELB#2: 10.62 m (second sensor was not attached to the buoy. Ablation correction is necessary during data processing)
WLB: 10.65 m

Note: UW PAR is fixed to the buoy. However, due to continuous lake level change, depth corrections are necessary for UW PAR data

2. BlueBox Field Setup

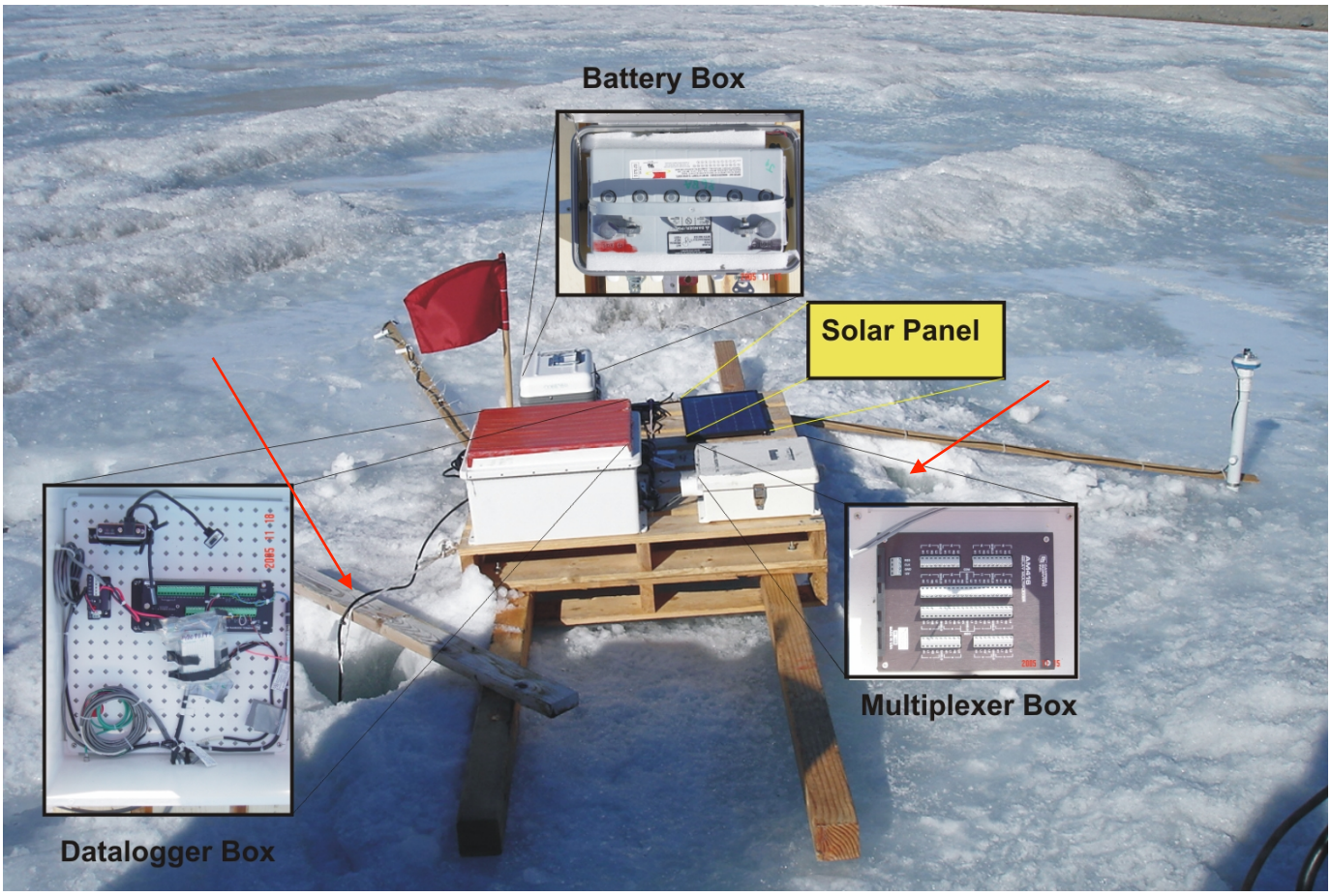

Fig. 2: Field setup and components of a Blue Box system. Outriggers are facing main wind direction and with two anchors (marked by red arrows) to prevent box from flipping.

3. Sensors/setup changes

3.1.1 Lake Fryxell

- Datalogger was upgraded to CR1000
- Surface PAR was replaced
  - Mult: 221.934201
  - Serial# Q30802
  - Date deployed: 10/20/10
- Stage pressure transducer was replaced
  - Serial# 29010007
  - Date deployed: 10/21/10
- Ablation pressure transducer was replaced
  - Serial# 29010006
  - Date deployed: 10/21/10

3.1.2 Lake Hoare

- Datalogger was upgraded to CR1000
- UW PAR was replaced
  - Mult: -206.89 (in water)
  - Tcoff: 0.0036
  - Serial# SPQA 1861
  - Deployed date: 10/28/10
- Surface PAR was replaced
  - Mult: 322.734725
  - Serial# Q23207
  - Date deployed: 10/28/10
- Stage pressure transducer was replaced
  - Serial# 29010005
  - Date deployed: 10/21/10
- Ablation pressure transducer was replaced
  - Serial# 29010002
  - Date deployed: 10/21/10

3.1.3 East Lobe Bonney

- Datalogger was upgraded to CR1000
- UW PAR was replaced
  - Mult: -236.84 (in water)
  - Tcoff: 0.0036
  - Serial# SPQA 1316
  - Deployed date: 11/11/10
- Second UW PAR was installed
  - Mult: -183.53 (in water)

    - Tcoff: 0.0036
    - Serial# SPQA 4417
    - Deployed date: 12/3/10
- Surface PAR was replaced
    - Mult: 234.176682
    - Serial# Q29766
    - Date deployed: 11/9/10
- Stage pressure transducer was replaced
    - Serial# 29010004
    - Date deployed: 11/9/10
- Ablation pressure transducer was replaced
    - Serial# 29010003
    - Date deployed: 11/9/10
- UW Altimeter was removed

3.1.4 West Lobe Bonney

- Datalogger was upgraded to CR1000
- UW PAR was replaced
    - Mult: -215.99 (in water)
    - Tcoff: 0.0036
    - Serial# SPQA 1860
    - Deployed date: 11/11/10
- Surface PAR was replaced
    - Mult: 237.5364618
    - Serial# Q28265
    - Date deployed: 11/11/10

3.2.1 Software Changes

LF, LH, ELB, and WLB were uploaded with program for CR1000 datalogger. LF, LH, and ELB stage pressure transducers were programmed to measure temperature of the water. WLB ablation transducer is still Druck.

3.2.2 Note on Multipliers

In the program running at Blue Boxes, we always have multiplier value of:

- 100 for UW PAR (or “–100” - depending on how we wired the sensor).
- 200 for Surface PAR

4. Programs and CR1000 Datalogger Wiring

4.1.1 Lake Fryxell wiring

Stage transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C5
Clear	G

Ablation transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C7
Clear	G

Underwater PAR (diff channel)

Green	2H
Blue	2L
Jump	2L - G

Surface PAR (diff channel)

Black	1L
Red	1H
Jump	1L - G

4.1.2 Lake Fryxell program

```
'CR1000  Datalogger
'Lake Fryxell
'Sensors installed: Stage, Ablation, UW PAR, and surface PAR
'Control port (sw12V) for: Electronically Actuated Valve switch
'Program written on: Oct 20 2010
'by Maciej Obryk

'Declare Public Variables
Public PTemp
Public batt_volt As Float
Public CS455(2) As Float
Public ablation As Float
Public UW_PAR As Float
Public surface_PAR As Float
```

```
Public PortOn

'Declares array for Julian time and decimal time
Public rTime (9)
Alias rTime(1) = Year
Alias rTime(9) = Day_of_Year
Alias rtime(4) = Hour
Alias rtime(5) = Minutes
Public Dec_Time As Float
Public MilitaryTime As Float
Alias CS455(1) = stage
Alias CS455(2)= W_Temp
'declares MilitaryTime/100 for decimal time conversion
'Dim A 'military time/100
'Dim B 'integer of A

'Declare Units
Units ablation = psi
Units stage = psi
Units W_temp = degC
Units UW_PAR = ╡ mol/s/m▒
Units surface_PAR = ╡ mol/s/m▒
Units batt_volt = volts
Units PTemp = degC


'Define Data Tables - what is being stored
DataTable (LF,true,-1)
  'store data points every 20min, averages where indicated below
  DataInterval (0,20,Min,10)
  'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  'Sample (1,Hour,IEEE4)
  'Sample (1,Minutes,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  'Sample (1,Dec_Time,IEEE4) - working on it (displaying decimal time
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False)
  Average (1,UW_PAR,FP2,False)
  Average (1,surface_PAR,IEEE4,False)
  Average (1,batt_volt,FP2,False)
  Sample (1,PTemp,FP2)
```

```
EndTable

'Main Program
BeginProg
  'measurments every 60 seconds
  Scan (60,Sec,1,0)
    RealTime rTime()
    MilitaryTime = (Hour*100)+Minutes
    'pressure transducer - ablation
    SDI12Recorder (ablation,7,0,"M!",1.0,0)
    'pressure transducer - stage
    SDI12Recorder (CS455,5,0,"M!",1.0,0)
    'surface PAR - Licor 190
    VoltDiff (surface_PAR,1,mV25,1,True ,0,250,200,0)
    'underwater PAR - Licor 193
    VoltDiff (UW_PAR,1,mV7_5,2,True ,0,250,-100,0)
    'datalogger's temp
    PanelTemp (PTemp,_60Hz)
    'battry voltage
    Battery (Batt_volt)
    CallTable LF
  NextScan

  'control port for UW PAR cleaning system - valve
  'scan every min; every 2 min days look for one min interval; if if one min set port
1 to high, keep it open for 1sec and close it

  'SlowSequence 'allows for concurent sequence scanning

  'Scan (7200,Sec,1,0)
    ' If (Day_of_Year >= 335) AND (Day_of_Year <= 60) Then
     '  If IfTime (0,7,day) Then
         'power is constantly supplied to the pump
      '   PortSet (9,1) 'activates 12V switch port to open SPDT switch
       '  Delay (0,2,Sec)
        ' PortSet (9,0) 'closes SPDT switch
'      EndIf
 '   EndIf
    'EndIf
  'NextScan

EndProg
```

4.2.1 Lake Hoare wiring

Stage transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C5
Clear	G

Ablation transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C7
Clear	G

Underwater PAR (diff channel)

Green	2H
Blue	2L
Jump	2L - G

Surface PAR (diff channel)

Black	1L
Red	1H
Jump	1L - G

4.2.2 Lake Hoare program

```
'CR1000  Datalogger
'Lake Hoare
'Sensors installed: Stage, Ablation, UW PAR, and surface PAR
'Control port (sw12V) for: Electronically Actuated Valve switch
'Program written on: Oct 28 2010
'by Maciej Obryk

'Declare Public Variables
Public PTemp
Public batt_volt As Float
Public CS455(2) As Float
Public ablation As Float
Public UW_PAR As Float
Public surface_PAR As Float
'Public PortOn
```

```
'Declares array for Julian time and decimal time
Public rTime (9)
Alias rTime(1) = Year
Alias rTime(9) = Day_of_Year
Alias rtime(4) = Hour
Alias rtime(5) = Minutes
Public Dec_Time As Float
Public MilitaryTime As Float
Alias CS455(1) = stage
Alias CS455(2)= W_Temp
'declares MilitaryTime/100 for decimal time conversion
'Dim A 'military time/100
'Dim B 'integer of A

'Declare Units
Units ablation = m
Units stage = m
Units W_temp = degC
Units UW_PAR = ╡ mol/s/m▓
Units surface_PAR = ╡ mol/s/m▓
Units batt_volt = volts
Units PTemp = degC


'Define Data Tables - what is being stored
DataTable (LH,true,-1)
  'store data points every 20min, averages where indicated below
  DataInterval (0,20,Min,10)
  'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  'Sample (1,Hour,IEEE4)
  'Sample (1,Minutes,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  'Sample (1,Dec_Time,IEEE4) - working on it (displaying decimal time
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False)
  Average (1,UW_PAR,FP2,False)
  Average (1,surface_PAR,IEEE4,False)
  Average (1,batt_volt,FP2,False)
  Sample (1,PTemp,FP2)

EndTable
```

```
'Main Program
BeginProg
  'measurments every 60 seconds
  Scan (60,Sec,1,0)
    RealTime rTime()
    MilitaryTime = (Hour*100)+Minutes
    'pressure transducer - ablation
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (ablation,7,0,"M!",0.704088,0)
    'pressure transducer - stage
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (CS455,5,0,"M!",0.704088,0)
    'surface PAR - Licor 190
    VoltDiff (surface_PAR,1,mV25,1,True ,0,250,200,0)
    'underwater PAR - Licor 193
    VoltDiff (UW_PAR,1,mV7_5,2,True ,0,250,-100,0)
    'datalogger's temp
    PanelTemp (PTemp,_60Hz)
    'battry voltage
    Battery (Batt_volt)
    CallTable LH
  NextScan

  'control port for UW PAR cleaning system - valve
  'scan every min; every 2 min days look for one min interval; if one min set port 1
to high, keep it open for 1sec and close it

  'SlowSequence 'allows for concurent sequence scanning

  'Scan (7200,Sec,1,0)
   ' If (Day_of_Year >= 300) AND (Day_of_Year <= 60) Then
    '  If IfTime (0,7,day) Then
        'power is constantly supplied to the pump
     '   PortSet (9,1) 'activates 12V switch port to open SPDT switch
      '  Delay (0,2,Sec)
       ' PortSet (9,0) 'closes SPDT switch
      'EndIf
    'EndIf
    'EndIf
  'NextScan

EndProg
```

4.3.1 East Lobe Bonney wiring

Stage transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C5
Clear	G

Ablation transducer (instrument with desiccant-filled vent tube)

Red	12V
Black	G
Yellow	G
Blue	G
White	C7
Clear	G

Underwater PAR (diff channel)

Green	2H
Blue	2L
Jump	2L - G

Surface PAR (diff channel)

Black	1L
Red	1H
Jump	1L - G

4.3.2 East Lobe Bonney program

```
'CR1000  Datalogger
'Lake Bonney East
'Sensors installed: Stage, Ablation, UW PAR, and surface PAR
'Control port (sw12V) for: Electronically Actuated Valve switch
'Program written on: May 4 2010
'updated on: Dec 3 2010
'by Maciej Obryk

'Declare Public Variables
Public PTemp
Public batt_volt As Float
Public CS455(2) As Float
Public ablation As Float
Public UW_PAR As Float
Public UW_PAR_backup As Float
```

```
Public surface_PAR As Float
'Public PortOn

'Declares array for Julian time and decimal time
Public rTime (9)
Alias rTime(1) = Year
Alias rTime(9) = Day_of_Year
Alias rtime(4) = Hour
Alias rtime(5) = Minutes
Public Dec_Time As Float
Public MilitaryTime As Float
Alias CS455(1) = stage
Alias CS455(2)= W_Temp
'declares MilitaryTime/100 for decimal time conversion
'Dim A 'military time/100
'Dim B 'integer of A

'Declare Units
Units ablation = m
Units stage = m
Units UW_PAR = ╡ mol/s/m▒
Units UW_PAR_backup = ╡ mol/s/m▒
Units surface_PAR = ╡ mol/s/m▒
Units batt_volt = volts
Units PTemp = degC

'Define Data Tables - what is being stored
DataTable (ELB,true,-1)
  'store data points every 20min, averages where indicated below
  DataInterval (0,20,Min,10)
  'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  'Sample (1,Hour,IEEE4)
  'Sample (1,Minutes,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  'Sample (1,Dec_Time,IEEE4) - working on it (displaying decimal time
  Average (1,ablation,IEEE4,False)
  Average (1,stage,IEEE4,False)
  Average (1,W_Temp,FP2,False
  Average (1,UW_PAR,FP2,False)
  Average (1,UW_PAR_backup,FP2,False)
  Average (1,surface_PAR,IEEE4,False)
  Average (1,batt_volt,FP2,False)
  Sample (1,PTemp,FP2)
```

```
EndTable

'Main Program
BeginProg
  'measurments every 60 seconds
  Scan (60,Sec,1,0)
    RealTime rTime()
    MilitaryTime = (Hour*100)+Minutes
    'pressure transducer - ablation
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (ablation,7,0,"M!",0.704088,0)
    'pressure transducer - stage
    'multiplier of "0.704088" is used to covert psi to m, i.e
    'psi to feet = 2.31; feet to m = 0.3048; hence 2.31*0.3048 = 0.704088
    SDI12Recorder (CS455,5,0,"M!",0.704088,0)
    'surface PAR - Licor 190
    VoltDiff (surface_PAR,1,mV25,1,True ,0,250,200,0)
    'underwater PAR - Licor 193
    VoltDiff (UW_PAR,1,mV7_5,2,True ,0,250,-100,0)
    'underwater PAR - Licor 193 - backup from Chicago
    VoltDiff (UW_PAR_backup,1,mV7_5,3,True ,0,250,-100,0)
    'datalogger's temp
    PanelTemp (PTemp,_60Hz)
    'battry voltage
    Battery (Batt_volt)
    CallTable ELB
  NextScan

  'control port for UW PAR cleaning system - valve
  'scan every min; every 2 min days look for one min interval; if if one min set port
1 to high, keep it open for 1sec and close it

  'SlowSequence 'allows for concurent sequence scanning
'Scan (7200,Sec,1,0)
  ' If (Day_of_Year >= 300) AND (Day_of_Year <= 60) Then
  '  If IfTime (0,7,day) Then
  'power is constantly supplied to the pump
  '   PortSet (9,1) 'activates 12V switch port to open SPDT switch
  '  Delay (0,2,Sec)
  ' PortSet (9,0) 'closes SPDT switch
  'EndIf
  'EndIf
  'EndIf
  'NextScan
```

```
EndProg
```

4.4.1 West Lobe Bonney wiring

Ablation transducer (instrument with desiccant-filled vent tube)

Red	EX1
Black	3L
Yellow	4H
Blue	4L
White	G
Orange	3H
Clear	G

Underwater PAR (diff channel)

Green	2H
Blue	2L
Jump	2L - G

Surface PAR (diff channel)

Black	1L
Red	1H
Jump	1L - G

4.4.2 West Lobe Bonney program

```
'CR1000  Datalogger
'Lake Bonney West
'Sensors installed:  Ablation, UW PAR, and surface PAR
'Program written on: Nov 11 2010
'by Maciej Obryk

'Declare Variables and Units
Public batt_volt As Float
Public ablation As Float
Public UW_PAR As Float
Public surface_PAR As Float

'Declares array for Julian time and decimal time
Public rTime (9)
Alias rTime(1) = Year
Alias rTime(9) = Day_of_Year
Alias rtime(4) = Hour
Alias rtime(5) = Minutes
Public Dec_Time As Float
Public MilitaryTime As Float

'Declare Units
```

```
Units batt_volt=volts
Units UW_PAR = ╡ mol/s/m▓
Units surface_PAR = ╡ mol/s/m▓
Units ablation = cm

'Define Data Tables
DataTable(WLB,True,-1)
  'store data points every 20min
  DataInterval(0,20,Min,10)
  'data to storage module; CFM100
  CardOut (0 ,-1)
  Sample (1,Year,IEEE4)
  Sample (1,Day_of_Year,IEEE4)
  Sample (1,MilitaryTime,IEEE4)
  Average(1,ablation,IEEE4,False)
  Average(1,UW_PAR,IEEE4,False)
  Average(1,surface_PAR,IEEE4,False)
  Average(1,batt_volt,FP2,False)
EndTable

'Main Program
BeginProg
  Scan(60,Sec,1,0)
    RealTime rTime()
    MilitaryTime = (Hour*100)+Minutes
    'surface PAR - Licor 190
    VoltDiff(surface_PAR,1,mV25,1,True,0,250,200,0)
    'underwater PAR - Licor 193
    VoltDiff (UW_PAR,1,mV7_5,2,True ,0,250,-100,0)
    'CS420/CS425 Druck PDCR 1830/1230 Pressure Tansducer (6-wire)
measurement Lvl_m:
    BrFull6W(ablation,1,mV2500,mV25,3,1,1,2500,True,True,0,_60Hz,101.53,0)
    'Call Data Tables and Store Data
    Battery (batt_volt)
    CallTable WLB
  NextScan
EndProg
```