ACRF/TWP

SURFACE MET

OWNER’S MANUAL

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INTRODUCTION AND OVERVIEW

Surface meteorological data is collected at the ARM Climate Research Facility (ACRF) Tropical Western Pacific (TWP) site at three locations, Manus, Nauru and Darwin, Australia.

The data is collected at the base of the tower using a Campbell Scientific CR23X datalogger. The datalogger is polled once a minute by Campbell Scientific LoggerNet software. The LoggerNet software runs on a Dell Optiplex GX270 small form-factor computer using Microsoft XP Professional as the operating system. The computer system is configured such that if power is interrupted it will automatically restart eliminating the need for human intervention. The LoggerNet software has been added to the start menu so that it will automatically begin to collect data from the dataloggers as soon as the system has re-booted.

The data from the datalogger is stored in a single location and the data is appended to an ever-increasing file. A PERL script has been written to search the data file once an hour to capture a single hours worth of data (00 – 59) and copy the data to another file location with a unique time and date name. The file is then deleted preventing a large, single file that continues to grow. The hourly files created by the PERL script are collected once an hour using FTP and the collected file is then deleted from the local PC.

Remote Administrator (RAdmin) software has been loaded to the computer so that remote access is available for loading new programs, troubleshooting, etc. Access is limited to the site observers, mentors, and selected operations personnel.

Temperature, relative humidity, wind speed and direction from two sensors and rain data are collected once per second. The one-second analog data is collected by the CR23X datalogger where it is accumulated to create one-minute averages and other calculated variables. Data from the barometer are collected once per minute at each location.

The data collected by the logger is requested by the LoggerNet system once per minute. The data is sent by the CR23X datalogger to the computer via a network connection. A Campbell Scientific NL-100 network interface is used to send the data via an RS-232 serial connection from the logger to the computer. The NL-100 allows each datalogger to have a unique network address. The data is passed from the NL-100 to an Allied Telesyn AT-MC13 media converter via a Cat-5 Ethernet cable. The media converter sends the data via a fiber optic cable to another media converter inside the building where it is sent through a network switch and onto the computer. See Figure 1: Network Diagram.

The data that is collected from the datalogger can be viewed locally at each sites computer. A program contained in the LoggerNet software package called Real Time Monitor and Control (RTMC) is used to plot graphs of the data and view data values, allowing observers to verify proper operation of the system and sensors. The raw one-second data can also be viewed to assist in troubleshooting.

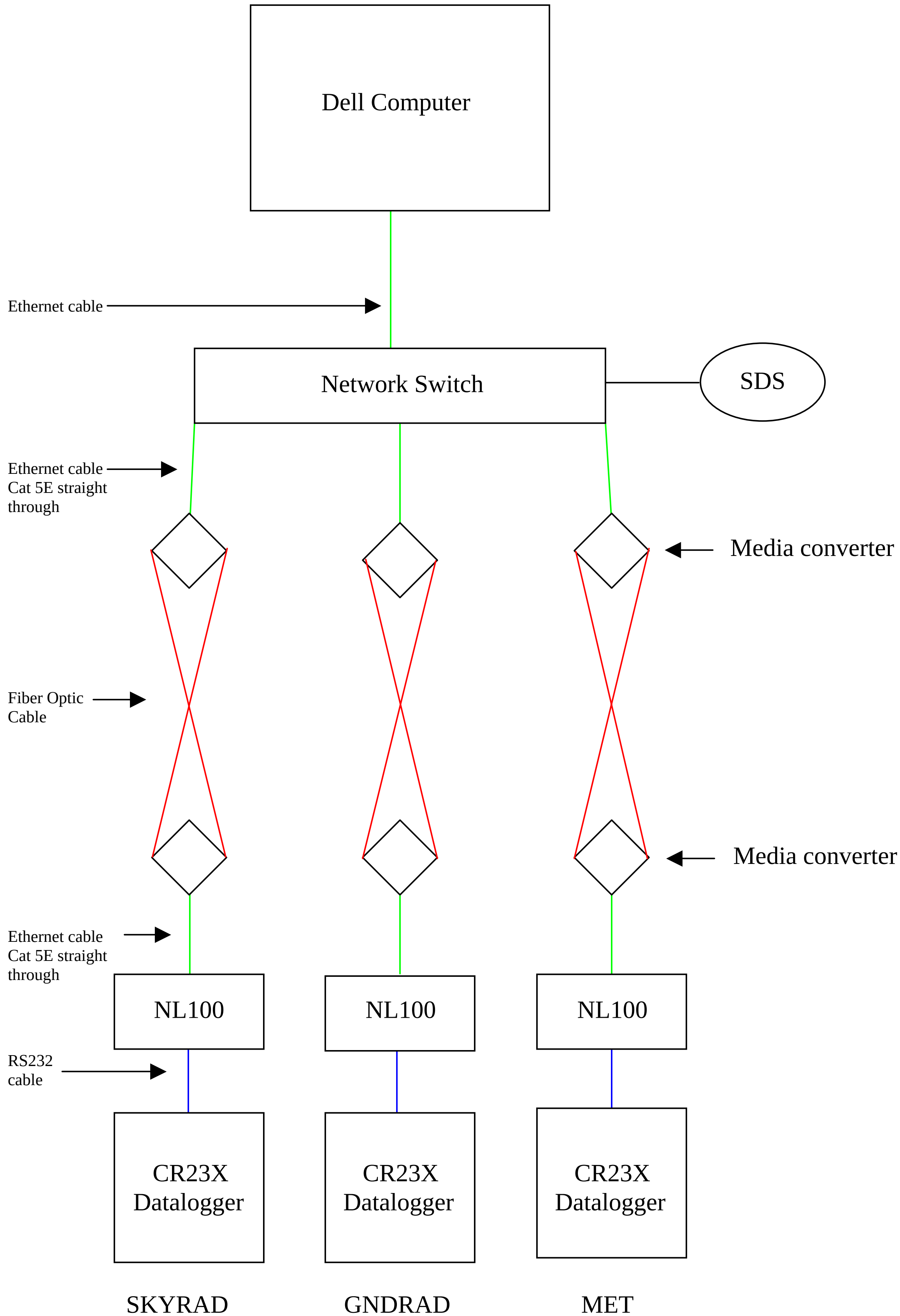


Figure 1: Network Diagram

SYSTEM COMPONENTS

METEOROLOGICAL SENSORS

Wind Monitor

The wind monitor propeller anemometers produce an AC sine wave with frequency proportional to the wind speed. The AC signal is induced in a stationary coil by a six-pole magnet mounted on the propeller shaft. Three complete sine waves are produced for each propeller revolution. Vane position is transmitted by a 10K ohm precision conductive plastic potentiometer that requires a regulated excitation voltage. With a constant voltage applied to the potentiometer, the output signal is an analog voltage directly proportional to azimuth angle.

Wind Speed:

The NIST calibration uncertainty is specified as +/-1% for wind speeds from the sensor threshold to 30 m/s. The conversion error is negligible. The schedule of routine maintenance and sensor verification is designed to eliminate any long-term stability error.

The sensor threshold is specified as 1 m/s. The following estimates of the range of underestimation caused by the threshold assume a normal distribution of wind speeds about the mean. When the true wind speed is 1.0 m/s, the winds will be below the threshold 50% of the time. This will result in an underestimate of 0.5 m/s. When the true wind speed is 1.5 m/s, assuming the standard deviation will be between 0.25 and 1.00 m/s, the winds will be below the threshold between 2 and 31% of the time. This will result in an underestimate between 0.02 and 0.23 m/s. When the true wind speed is 2.0 m/s with a range of standard deviations between 0.25 and 1.00 m/s, the winds will be below the threshold between 0 and 16% of the time. This will result in an underestimate between 0 and 0.12 m/s.

If the reported wind speed is 0.5 m/s, an underestimate of 0.5 is probable. This would bias the measurement by -0.5. If the reported wind speed is 1.0 m/s, an underestimate of 0.19 to 0.30 m/s is possible. If the reported wind speed is 1.5 m/s, an underestimate of 0.02 to 0.20 m/s is possible. If the reported wind speed is 2.0 m/s, an underestimate of 0 to 0.10 m/s is possible.

The uncertainty range with 95% confidence is approximately:

+/- 1%	for a reported wind speed from 2.5 to 30.0 m/s
-0.12 to +0.02 m/s	for a reported wind speed of 2.0 m/s
-0.22 to +0.00 m/s	for a reported wind speed of 1.5 m/s
-0.31 to -0.20 m/s	for a reported wind speed of 1.0 m/s
-0.51 to -0.49 m/s	for a reported wind speed of 0.5 m/s

Wind Direction:

The sensor accuracy is specified as +/-3 deg. The A-D conversion accuracy is equivalent to 0.7 deg over a temperature range of 0 to 40 deg C for a period of one year. I have estimated sensor alignment to true north to be accurate within +/-3 deg. The uncertainty with 95% confidence is, therefore, approximately +/-5 deg.

Two Wind Monitors are mounted on a cross-arm at a height of 10 m. One is mounted slightly above the other in order to minimize interference. The higher wind monitor is designated sensor #1 and the lower wind monitor is designated sensor #2.

Temperature and Relative Humidity Sensor

A Vaisala HMP45D temperature and relative humidity probes are used to measure air temperature and relative humidity. Each probe contains a Vaisala HUMICAP sensor and associated electronics along with a 4-wire, platinum resistance temperature detector. The relative humidity output is an analog signal, with 0 to 1V corresponding to an RH of 0 to 100%. Vaisala quotes the accuracy of the RH signal to be +/- 2% for 0 to 90 % and +/- 3% for 90 to 100%. The RH sensor has a response time of 15 seconds. The long-term stability is quoted to be better than 1% RH per year and a temperature dependence of +/- 0.05% RH/^{o}C. The measurement range of the RTD is quoted as –40 to +60 ^{o}C. Each temperature and relative humidity probe is mounted in a R.M. Young Model 43408-2 aspirated radiation shield. A brushless DC blower provides aspiration.

Optical Rain Gage

The optical precipitation gauge measures rain and snow by detecting the optical irregularities induced within a sample volume by precipitation particles falling through a beam of partially coherent infrared light. It mpunted near the tower. The environmental specifications are from –40 to +50 ^{o}C and 0 – 100% RH. The dynamic range of the ORG is 0.1 to 500 mm/hr and for accumulation is .001 to 999.999 mm. The rain accuracy is

5% of accumulation and the effective resolution is .01 mm. The following equations are used to convert the voltage signal to a rainrate.

For the ORG-815:

Rainrate (mm/hr) = $(25*(V^{1.87}) - 0.15$

For the ORG-115:

Rainrate (mm/hr) = $(20*(V^{2}) - 0.05$

<u>Barometric Pressure Sensor</u>

A Vaisala PTB201A or a PTB220 digital barometer is used to measure the station pressure (not corrected to sea level). The barometer uses a Vaisala BAROCAP silicon capacitive absolute pressure sensor. Vaisala quotes the operating temperature as –40 to +60^{o} C and the pressure measurement range as 500 to 1100 hPa. The total accuracy over the measurement range is given to be +/- 0.15 hPa. Data is sent via RS-232 to the collection system when the sensor is polled.

DATA COLLECTION SYSTEM

CR23X Datalogger

A Campbell Scientific CR23X datalogger is used to acquire and process the data collected by the SDM from the various sensors. Once per minute the datalogger prompts the SDM to request data from the PWS, CMH and barometer. The datalogger also requests the one-second data from the SDM at once-per-second intervals. The one-second data from the QLI50s are accumulated in the logger in order to calculate the one-minute data values and statistics. The one-minute data from the barometer and the PWS is stored while the CMH data is converted from Fahrenheit to Celsius and relative humidity is calculated from the Celsius temperature and dew point. Once-per-minute data is sent from the CR23X to the PC upon request. The data is sent via Ethernet through a Campbell Scientific NL-100 network interface, then to an Allied Telesyn media converter through which the data is sent to a partner media converter via fiber optic cable. Once the data reach the end of the fiber the media converter sends the data through Ethernet cable to a network switch and then on to the PC. The CR23X datalogger includes a 4 Mbyte extended memory option allowing the storage of over 2 million data points in the event of a communication outage. The datalogger has an extended temperature option giving it a valid operating temperature range of –40 to +60 C. The CR23X has been modified so that the Input/Output connectors are removable allowing for quick connect/disconnect for easy datalogger replacement.

NL-100 Network Link Interface

A Campbell Scientific NL-100 network interface is used to communicate with the Campbell Scientific CR23X datalogger. The NL100 uses an Ethernet 10 Base-T communications link between itself and the Allied Telesyn media converter. The NL100 is configured to act as a Serial Server in the TCP/IP network. The unique IP address for the system is stored within the NL100.

AT-MC13 Ethernet Media Converters

The AT-MC13 media converters are used to convert the data from the CR23X (through the NL100) to fiber optics. Converting to fiber optics and using the media converters allows for a 2Km maximum operating distance of the network. Two media converters are used; one is located at the base of the towers in the datalogger enclosure, the other is located inside the building at each location. The media converters operate at 10 Mbps and feature half- and full-duplex operation. The media converters also have a MIDI/MDI-X switch. This switch is used to configure the twisted pair port on the media converter as either MIDI or MIDI-X eliminating the need for crossover cables regardless of the type of network device that is connected to the unit. The media converters also have a Fiber Link Test switch that allows testing of the fiber optic connection without requiring the twisted pair port to be connected. See Figure 1 Network Diagram.

Computer

The PC is a Dell Optiplex GX270 Small Form Factor with a 15" flat panel monitor. The PC contains a Celeron 2.00 GHz, 400 Front Side Bus, and 128K Cache processor. It has 512mb of DDR non-ECC SD-RAM and an Integrated DVMT Video card. The hard drive is an 80 GB EIDE 7200 RPM drive. It also has internal Dell business audio speakers, an integrated Intel Gigabit (10/100/1000) network interface card and an 8x DVD-ROM. The operating system installed on the PC is Microsoft Windows XP Professional using NTFS. The PC was configured to conform to the ARM core PC requirements. The PC is configured to automatically restart and logon after power disruption eliminating the need for human intervention. Campbell Scientifics' LoggerNet software is loaded on the PC and is configured to initialize at start up. LoggerNet is the software application that enables communication and control of the CR23X datalogger. Radmin software is also loaded on the PC allowing remote connection to or control of the local PC. A share-ware program called InternetTime is used to verify and adjust the time of the PC clock once a day. A PERL script called "split_working_cdl.pl" is used to handle the output data file from the LoggerNet software. This script resides in C:\ARM\bin and is scheduled to run once an hour in the LoggerNet task manager. This script creates uniquely named hourly files and places the files in a folder from which the Data Collection System can access, collect and delete them. FTP software allows the Data Collection System to access the PC.

LoggerNet

LoggerNet software is an application that allows the set up, configuration, and retrieval of data from a network of Campbell Scientific dataloggers. LoggerNet also allows sharing of data over an Ethernet communications network. LoggerNet is written using advanced “client-server” architecture. The server is a software program that runs in the background, handling all of the datalogger communications. The server also takes care of storing the data and providing information to manage the datalogger network. Client software programs in LoggerNet are used to create datalogger programs, view and graph data, verify communications on the network, and run other software or tasks.

MEASURED AND CALCULATED VARIABLES

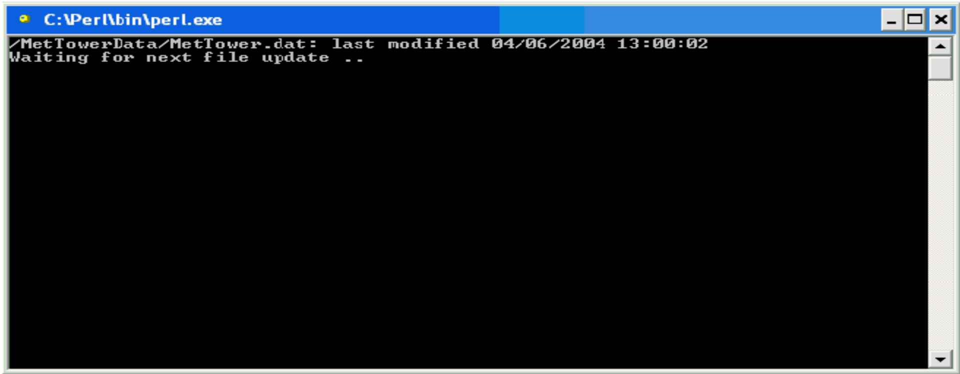
The TWP 10-meter meteorological tower consists of two levels of wind speed and direction data and one level of temperature and relative humidity data, an optical rain gage (ORG) and a barometer. The following table lists the output data from the TWP SMET system.

Table 2: TWP SMET one-minute data

Variable #	Label	Units	Common Name
1	1	N/A	Array ID
2	Year_RTM	N/A	Year
3	Day_RTM	N/A	J-day
4	Hour_Minute_RTM	N/A	Hour/minute
5	PCP_Rate_AVG	mm/hr	Arithmetic mean rain rate
6	PCP_Rate_STD	mm/hr	Standard Deviation of rain rate
7	PCP_Rate_MAX	mm/hr	Rain rate maximum
8	PCP_Rate_MIN	mm/hr	Rain rate minimum
9	Temp_AVG	Celsius	Temperature mean
10	Temp_STD	Celsius	Standard Deviation of temperature
11	RH_AVG	%	Relative Humidity mean
12	RH_STD	%	Standard Deviation of Relative Humidity
13	Vap_Press_AVG	kPa	Calculated saturation vapor pressure mean
14	Vap_Press_STD	kPa	Standard Devaition Calculated saturation vapor pressure
15	Up_WS_MS_S_WVT	m/s	Upper wind speed arithmetic mean
16	Up_WS_MS_U_WVT	m/s	Upper wind speed vector average
17	Up_WDir_DU_WVT	deg	Upper wind direction
18	Up_WDir_SDU_WVT	deg	Standard Deviation upper wind direction
19	Lo_WS_MS_S_WVT	m/s	Lower wind speed arithmetic mean
20	Lo_WS_MS_U_WVT	m/s	Lower wind speed vector average
21	Lo_WDir_DU_WVT	deg	Lower wind direction
22	Lo_WDir_SDU_WVT	deg	Standard Deviation lower wind direction
23	Up_WS_MS_STD	m/s	Standard Deviation upper wind speed
24	Up_WS_MS_MAX	m/s	Upper wind speed maximum
25	Up_WS_MS_MIN	m/s	Upper wind speed minimum
26	Lo_WS_MS_STD	m/s	Standard Deviation lower wind speed
27	Lo_WS_MS_MAX	m/s	Lower wind speed maximum
28	Lo_WS_MS_MIN	m/s	Lower wind speed minimum
29	Baro_pres	kPa	Barometric pressure
30	Batt_Volt	Volts	Datalogger Battery Voltage
31	LoggerTem	Celsius	Datalogger Panel Temperature

Once a minute data is collected from the datalogger and is appended to an ever-growing file on the collector computer. In order to collect uniquely named hourly files a PERL script was developed to remove hourly sections of data from the main file, rename and place in the outbound directory on the computer. The ARM data management facility collects the data from the outbound directory once an hour. Figure 2 is an example of the DOS window that “pops-up” when the PERL script runs.

Figure 2: PERL Script



System Maintenance and Calibration

Daily Checks

The data from the tower should be checked each day during daily maintenance rounds. Temperature and relative humidity data from the AMF Met can be compared to the Bureau of Meteorology (BoM) met stations that are co-located at each TWP site. Any discrepancies should be brought to the attention of BoM personnel or the mentor of the AMF SMET. The wind speed and direction data should be compared to one another to determine if the values appear reasonable. The barometric and optical rain gage (ORG) data should be checked to determine if what is being reported also appears reasonable. For example, if the optical rain gage is reporting 100mm/hr rainfall and it is sunny and dry out this indicates a problem with the ORG. Data from the barometer should be between 800 and 1100 hPa. An RTMC Overview screen has been built which displays 24 hours of data graphed along with text values for the current readings. The graphs will allow checks of the data to be made to determine if problems have occurred during the most recent 24 hours. Long gaps in data, long periods of or many data spikes, and flat line data (no change in values over extended periods) will be apparent and should be noted on the form.

Annual Calibration Checks

Wind Monitors

Check the calibration of the current wind monitors by using the R. M. Young Model 18810 Anemometer Drive to spin the propeller shafts for at least one minute at the different rpm's. Check the calibration of the current wind vanes by using the R. M. Young Model 18212 Vane Angle Fixture to hold the vane in place at different directions. Obtain the readings from either the RTMC Overview screen or by directly connecting to the logger and viewing the Input Location data. See Appendix E for procedures and forms.

Temperature and Relative Humidity Sensors

Check the calibration of the current temperature and relative humidity probe by comparing it to the reference probe. Ensure that there is proper flow over both the reference and the current probe and that little or no direct solar radiation influences the reading. See Appendix E for procedures and forms.

PTB201 or PTB220 Digital Barometer

Compare the reading of the digital barometer with the reference digital barometer. Replace with spare if any discrepancy noted. See Appendix E for procedures and forms.

Optical Rain Gage (ORG)

The ORG normally has an output between 0 and 85 mV. Check that the output without rainfall is within this range. The ORG lenses should be cleaned and the heaters checked for proper operation. An Optical Scientific TST-800 Test Kit is used to verify the calibration of the ORG. See Appendix E for procedures and forms.

APPENDIX A

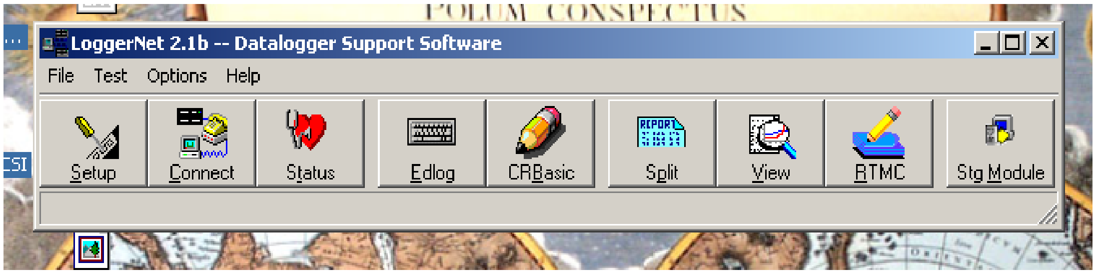
LOGGERNET SET-UP

TWP LoggerNet SET-UP FOR SMET, SKYRAD, & GNDRAD

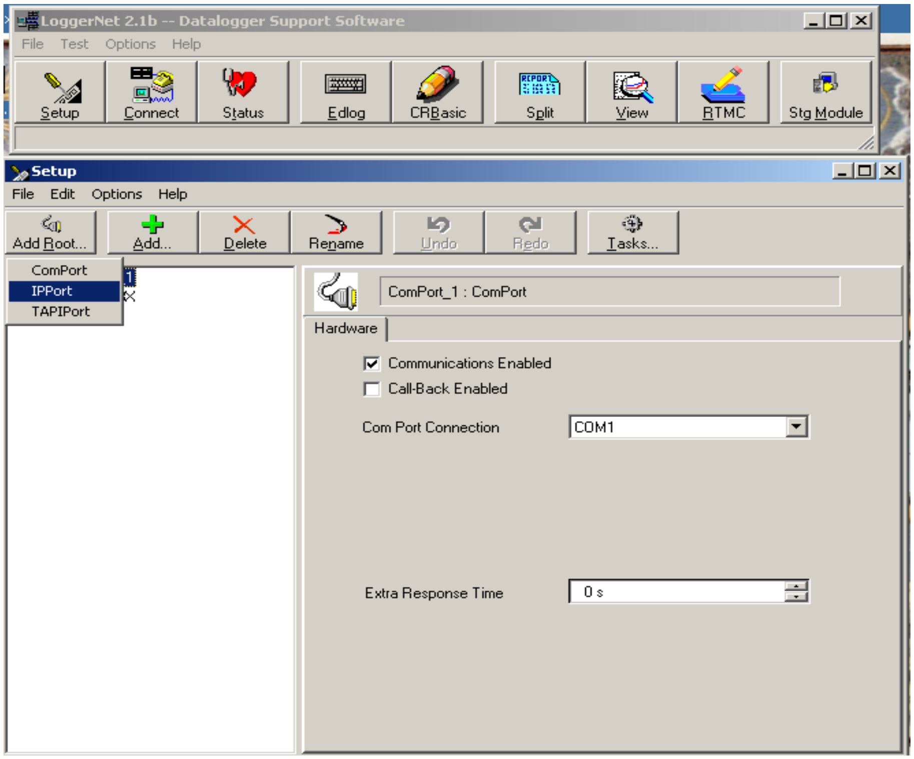
1. Setup and start PC. Ensure the PC is connected to the network and the loggers and NL-100's are connected and running.
2. Create the following directories on the PC:

    A. C:\ARM\bin
    B. C:\SendDir\SkyRadData, GndRadData, SMetData
    C. C:\SkyRadData, GndRadData, SMetData
    D. C:\SkyRadPgm, GndRadPgm, SMetPgm

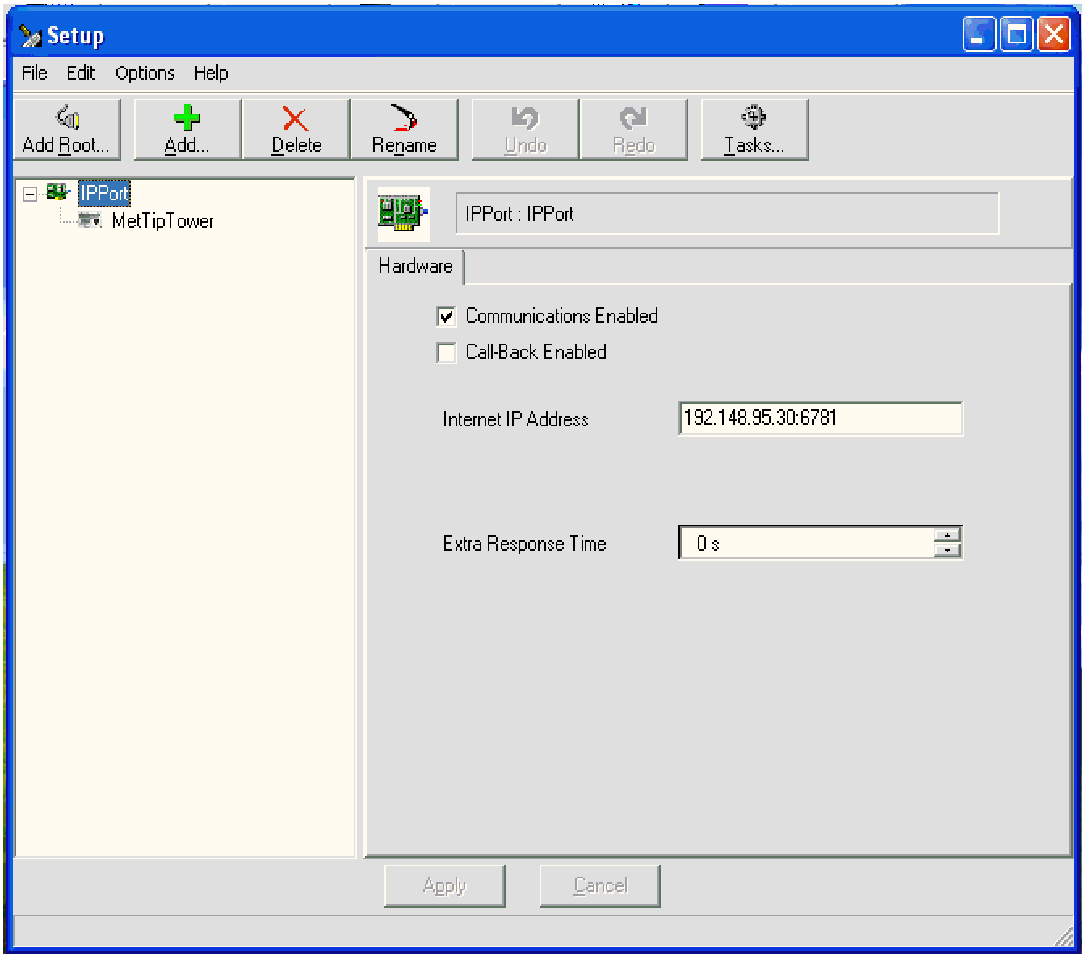
3. Start LoggerNet if it not already running (task bar will be on desk top if it is)
4. Click on the *Setup* icon



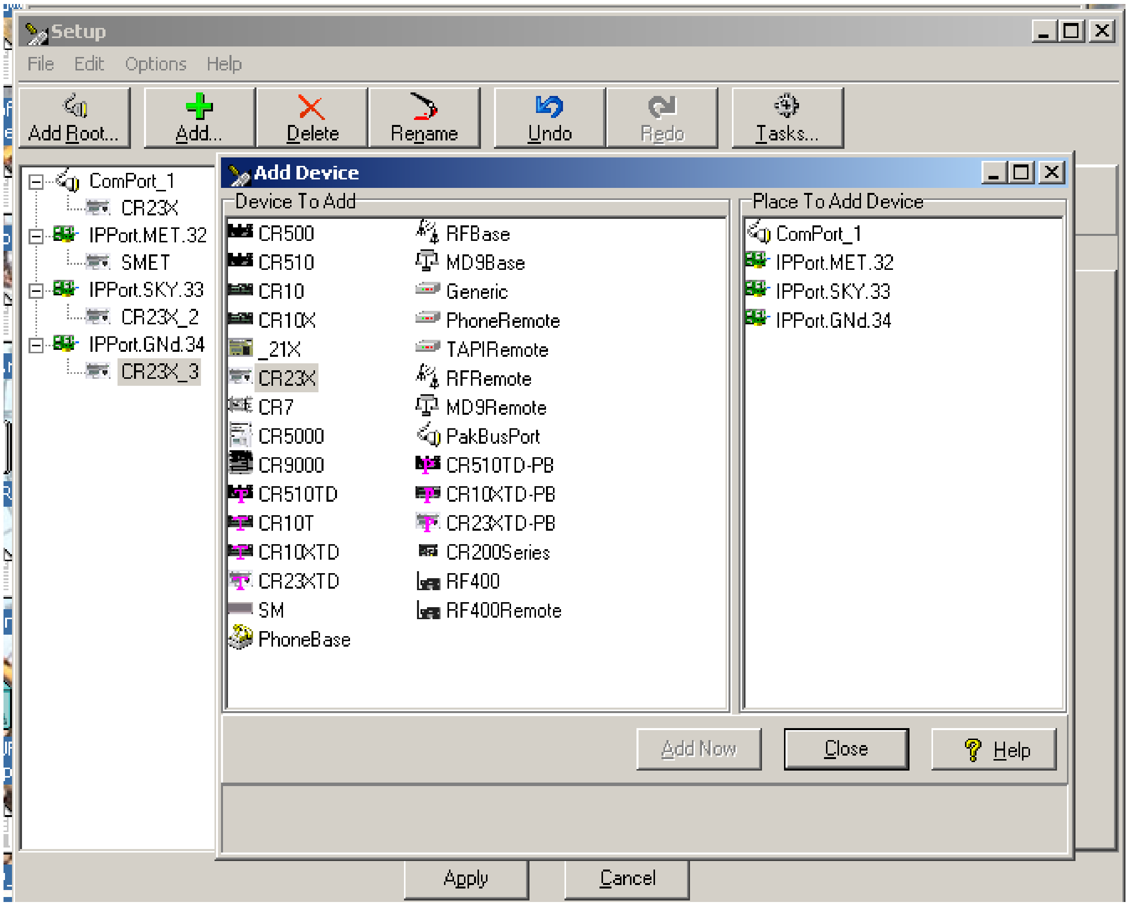
5. Once the Setup interface starts click on the *Add Root* button and choose <u>IPPort</u>.



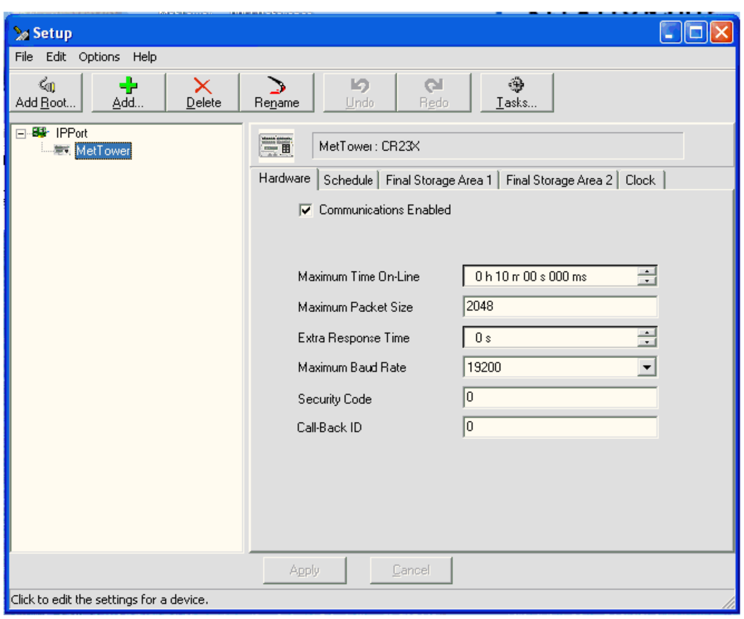
6. Once the IPPort has been added, enter the IP address supplied for each logger (SKYRAD, GNDRAD, SMET). Ensure the *Communications Enabled* box is checked. Set *Extra Response time* to 0 s if not already done. *Call-back Enabled* should not be checked.



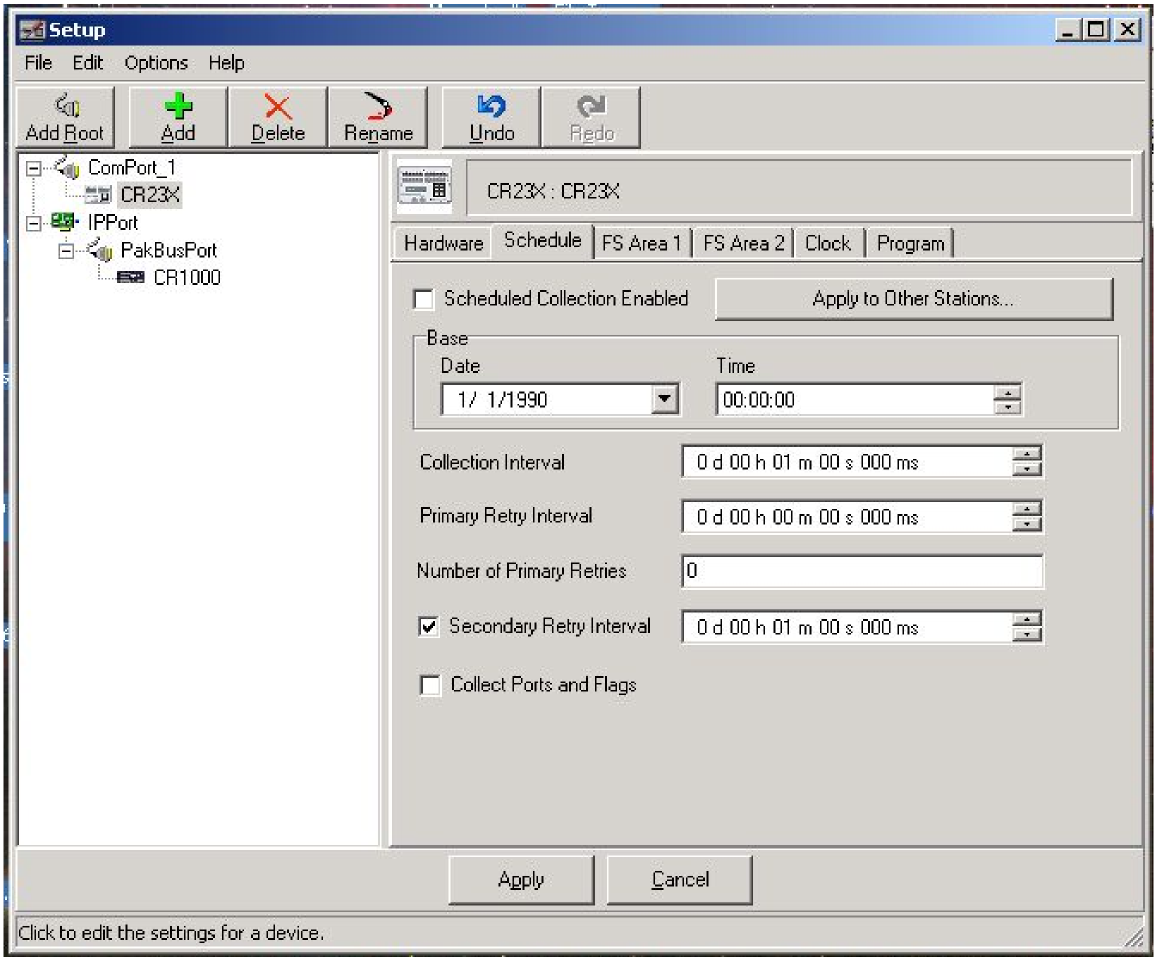
7. Once the IPPort has been added you can change the name. Suggestion would be to change the name to IPPort.Met.32. Where .Met is system (Sky, Gnd) and .32 is last digits of the IP address for each respective logger. This is not necessary but may help in identification.
8. Click on the *Add* button to add a datalogger under each IPPort. Choose CR23X. Once you highlight the logger type, click on the *Add Now* button. You must click on *Close* afterwards to shut down the Add Device window. Clicking the *Add Now* button will add multiple loggers if done more than once. If this occurs, highlight the unwanted loggers by clicking on them and then on the *Delete* button.



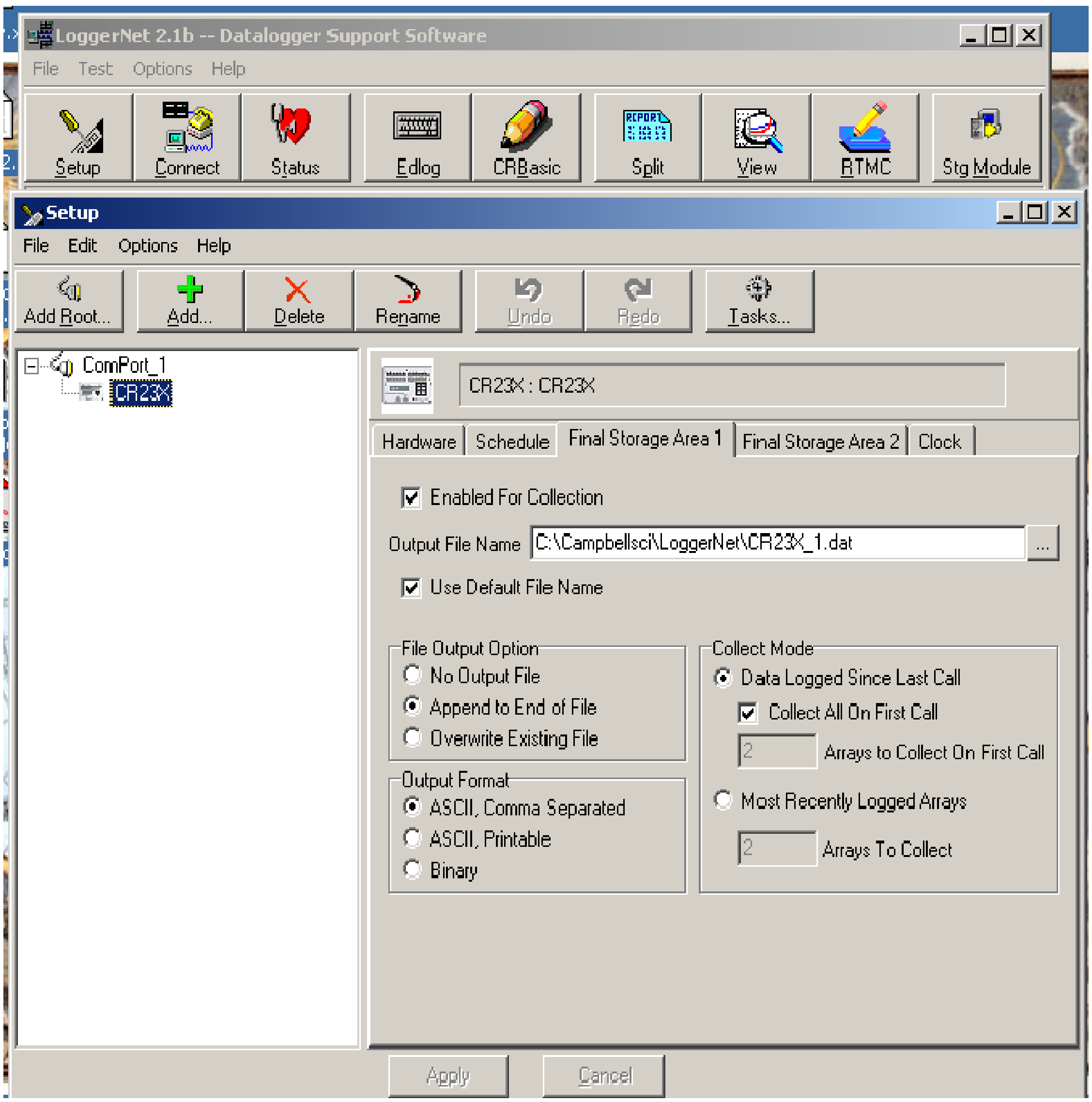
9. Once the logger has been added you should rename it either using the *Rename* button or highlighting and using right mouse button. Suggested names are: MET, SKYRAD, GNDRAD.
10. Left click on a logger to access the remaining connection information so that it can be reconfigured.



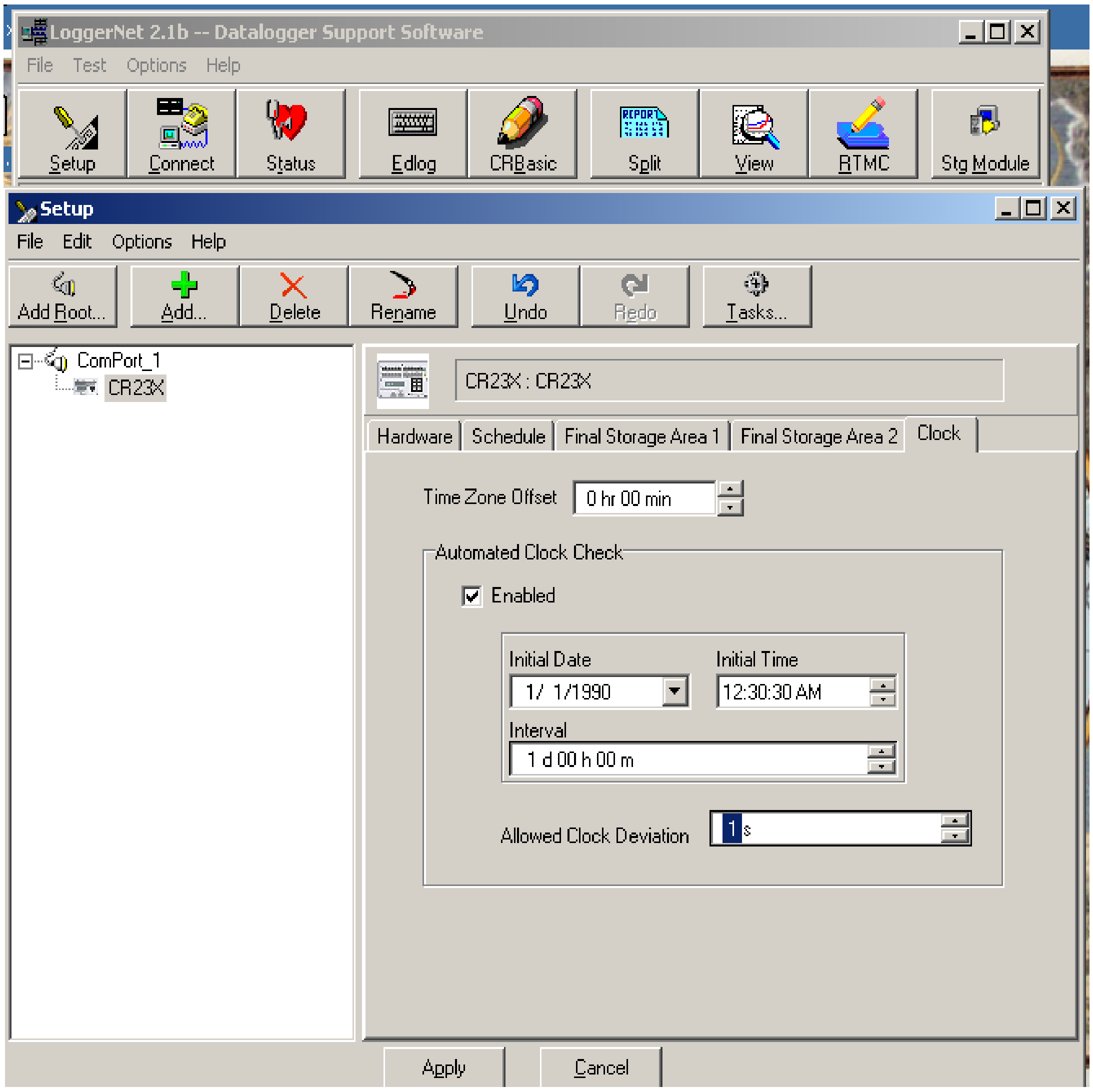
11. Ensure the *Communications Enabled* box is checked and leave all settings under *Hardware* tab as default.
12. Click on the *Schedule* tab and change the following settings: ensure *Scheduled Collection Enabled* box is checked. Change Collection Interval to 01m, rest 0's. Change *Primary Retry Interval* to all 0's and *Number of Primary Retries* to 0. Set *Secondary Retry Interval* to 01 m and rest to 0's and remove the check in *Collect Ports and Flags*. Leave everything else as defaults.



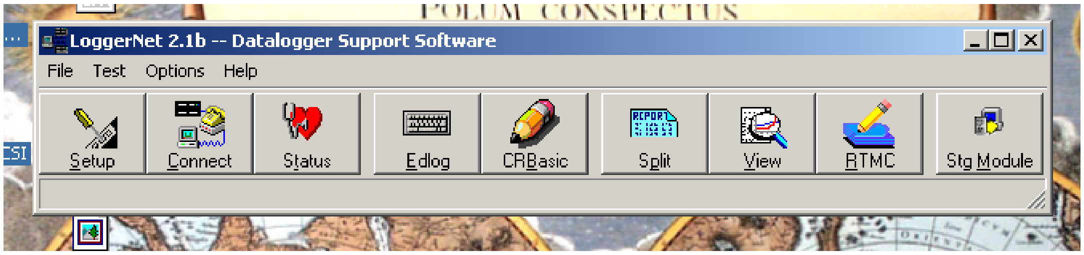
13. Click on Final Storage Area 1 tab and make the following changes to the settings: check the *Enable for Collections* box and change the destination of the data file to the directory created in step 2 (SkyRadData for SKYRAD, GndRadData for GNDRAD, etc) and change the name of the data file to the name of the system you are collecting from (example for skyrad: C:\SkyRadData\SKYRAD.dat). Uncheck the *Use Default Name* box. Under File Output Option click the *Append to End of File* radio button. Under Output Format click the *ASCII, Comma Separated* radio button. Under Collect Mode, click on *Data Logged Since Last Call* radio button and check the *Collect All on First Call* box.

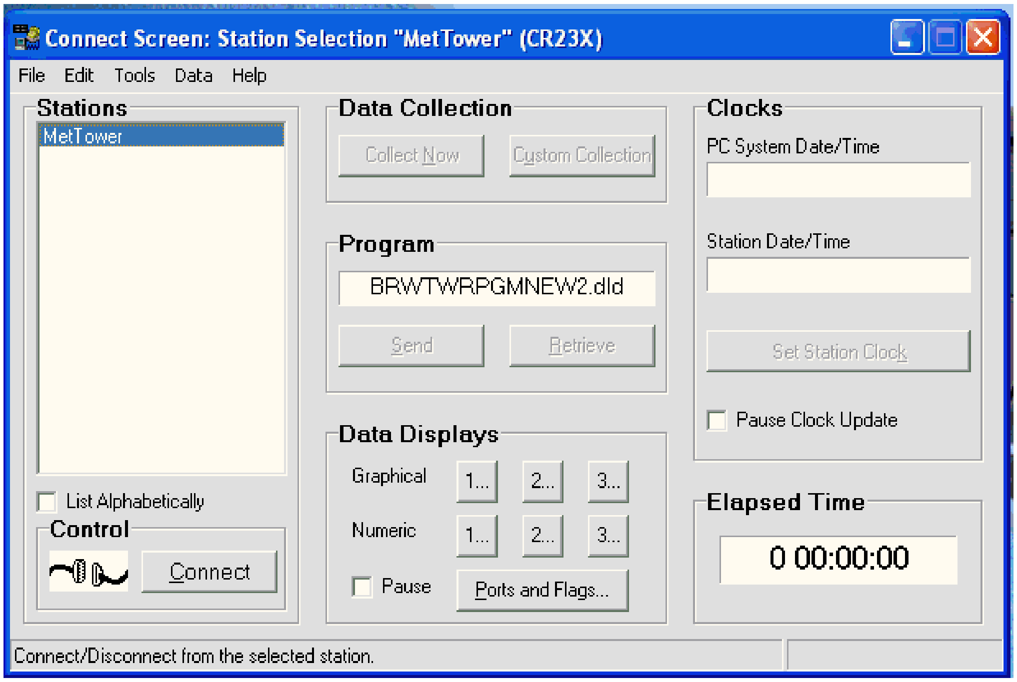


14. Click on the Clock tab to make changes to the following settings: Leave *Time Zone Offset* as 0h 00m. Under Automated Clock Check click the *Enabled* box. You can leave *Initial Date* as default, but make sure *Initial Time* is XX:XX:30 (add five seconds to subsequent systems, i.e. met XX:XX:30, sky XX:XX:35, etc) so that any clock check occurs at 30 sec past the minute with a 5 second separation between clock checks. Set *Interval* to 01 d, for once per day. Set the *Allowed Clock Deviation* to 1 sec.



15. You will not need to make any changes to the settings in the Final Storage Area 2 tab. Just ensure that the *Enabled for Collections* box is not checked.
16. Once the above steps are complete you should be able to connect to each of the loggers using the *Connect* button in the main menu.





17. The loggers you added in the above steps will be listed in the "**Stations**" menu. Highlight the logger you wish to connect to and click on the *Connect* button on the bottom. If everything is connected and correct the wires in the "**Control**" display will connect. To send a program to the logger, click on the *Send* button under the "**Program**" portion of the *Connect* screen. Navigate to the directory where the program is stored (should be C:\SkyRadPgm, GndRadPgm, MetTowerPgm) and select the appropriate program. Once the program has been selected, click on the *Send* button. A warning banner will be displayed stating that continuing will cause all data to be lost. Continue to send the program by clicking on the *Ok* button. Once the send is complete and the logger has compiled the program, another message banner will be displayed, click on *Ok* to finalize the transmission. Once connected and a program is running (assuming sensors connected) you can view the raw data and final stored data by clicking on the numbers in the "**Data Displays**" section of the *Connect* screen.

****A NOTE OF WARNING: CONNECTING TO A LOGGER USING THE CONNECT SCREEN CAN DISABLE COMMUNICATIONS TO OTHER LOGGERS ON LOGGERNET. DATA MAY NOT BE COLLECTED WHILE YOU

ARE CONNECTED THIS WAY. REGULAR COMMUNICATIONS WILL BE RESTORED WHEN THE CONNECTION IS SEVERED.

APPENDIX B

PERL SCRIPT SET-UP

PERL SCRIPT SET-UP

${DataDir} = The name of the output directory used by LoggerNet
${DataFile} = The name of the output file used by LoggerNet
For example we used the following for the MetTower at Barrow:
${DataDir} = MetData
GndRadData
SkyRadData
${DataFile} = Met.dat
GndRad.dat
SkyRad.dat

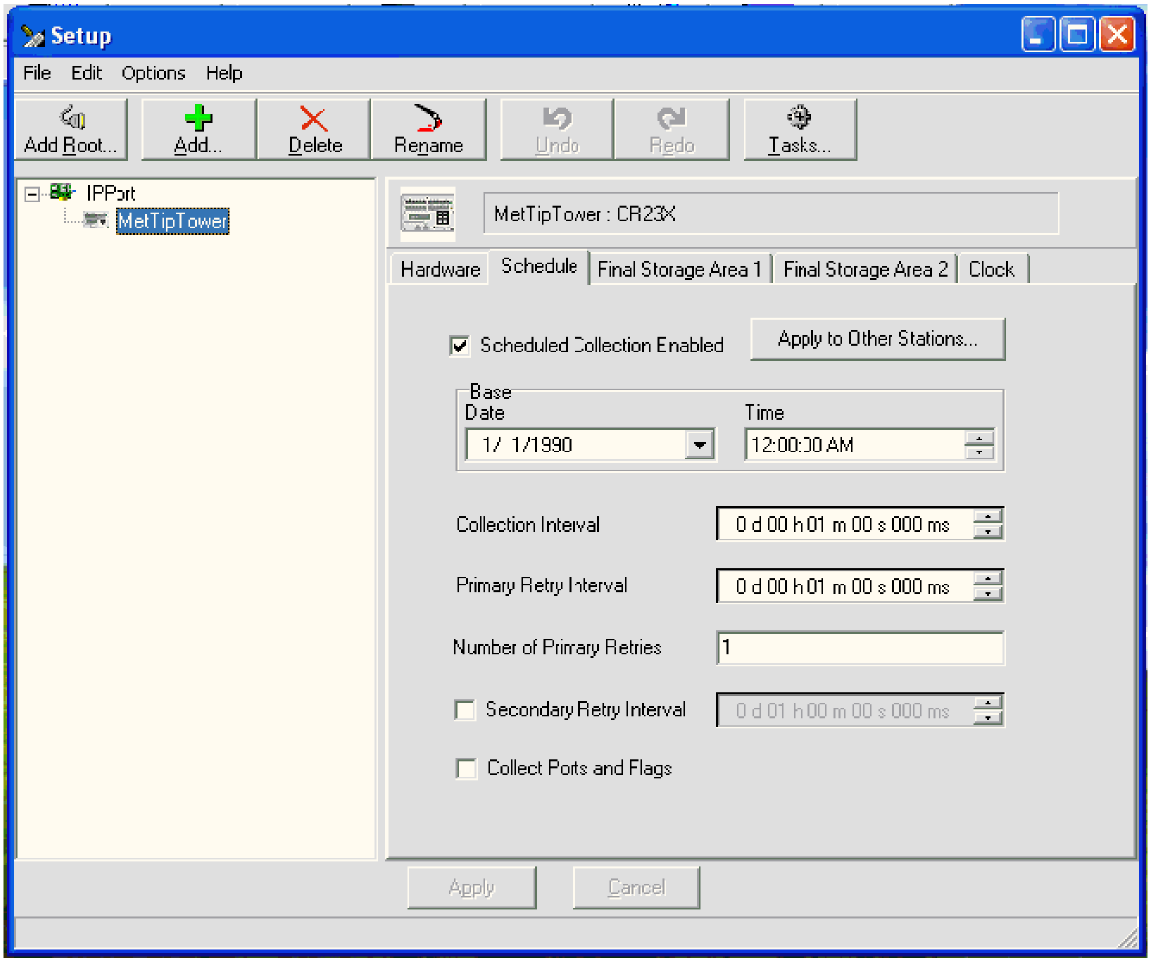
1. Create directories:
- C:\ARM\bin
- C:\SendDir\${DataDir}(for All three systems)

2. Copy split_working_cdl.pl script to C:\ARM\bin

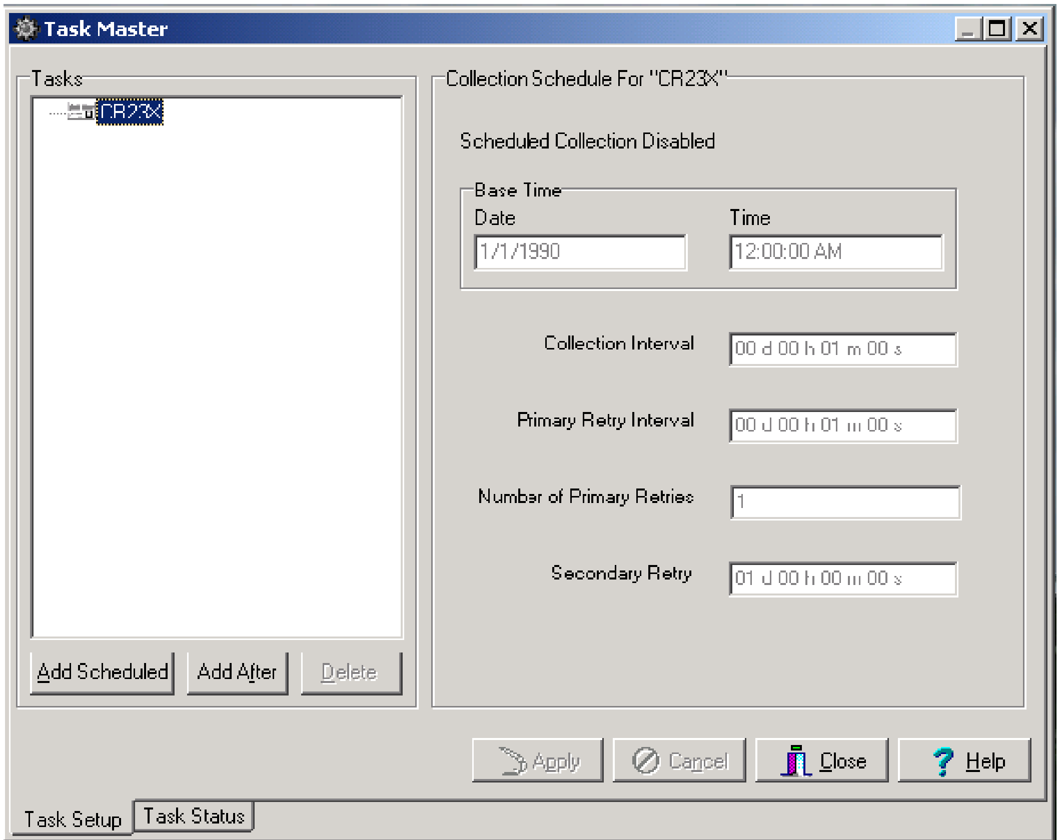
3. Install ActivePerl-5.8.0.806-MSWin32-x86.msi
- Choose default options

4. Install susetup.exe (Serv-U FTP Server)
- Choose default options
- Remove any anonymous users and accounts
- Add Domain: ftp.arm.gov
- Create User: sds
- Password: pa55word
- Home Directory: C:\SendDir
(don't worry about subs--inherit subdirectories)
- DirAccess:
Files:
x Read
x Write
x Append
x Delete
Execute
Directories:
x List
x Create
x Remove
Sub-directories:
x Inherit

5. Schedule split_working_cdl.pl script in LoggerNet Tasks:
   (three times at same time)
6. Click on *Setup* button on main LoggerNet task bar.
7. Click on the *Task* button.



8. Click on *Add Scheduled* button on lower left hand side of window. This will be done once for each scheduled split.



9. Rename the task in the window by right clicking on the highlighted task and rename each as: SplitMetData, SplitGndRadData, SplitSkyRadData

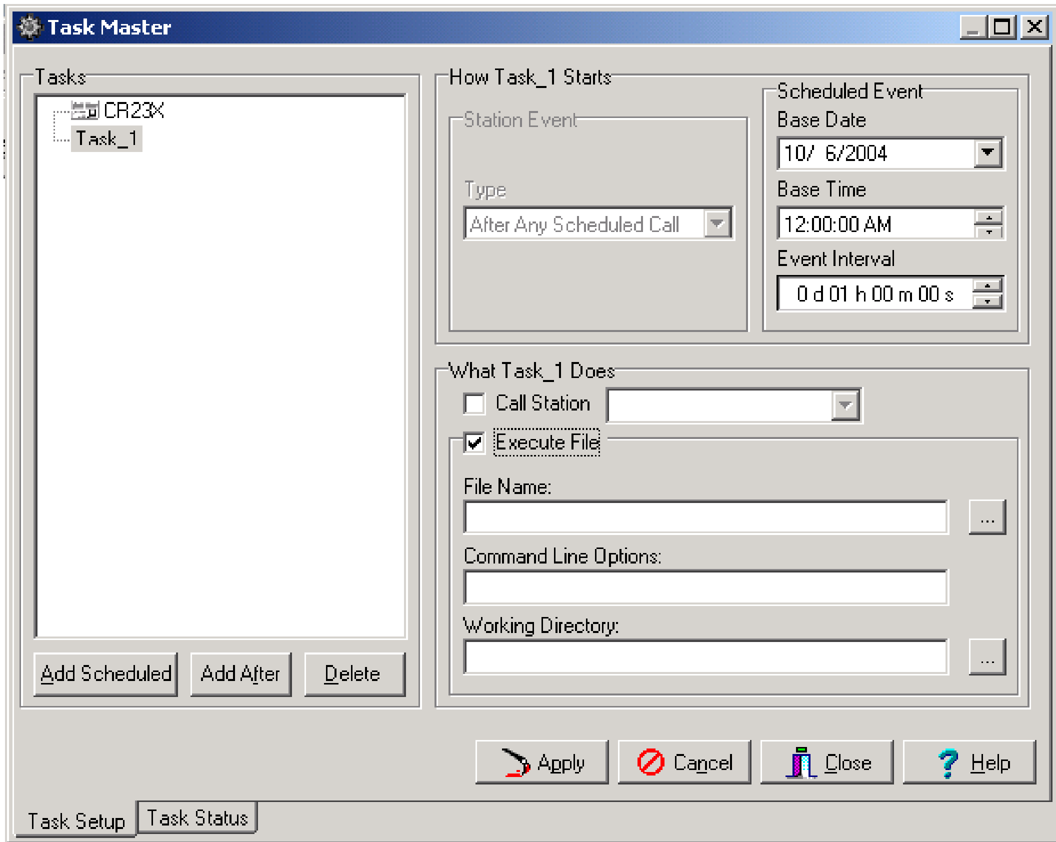
10. Change the following in the "**Scheduled Event**" section

Base Date: any previous date (i.e. 5/7/2004)
Base Time: 12:00:50 AM
Event Interval: 0 d 01 h 00m 00 s

11. In the "**What Task Does**" section do the following for each task.

Check box for *Execute File*:
File Name: C:\ARM\bin\split_working_cdl.pl
Command Line Options:
-f GndRad.dat –i /GndRadData –o /SendDir/GndRadData
-f SkyRad.dat –i /SkyRadData –o /SendDir/SkyRadData
-f MetTower.dat –i /$MetTowerData –o /SendDir/$MetTowerData

The generic format is:
-f ${DataFile} –i /${DataDir} –o /SendDir/${DataDir}



Working Directory:
C:\MetTowerData
C:\SkyRadData
C:\GndRadData
The generic format is:
C:\${DataDir}

When finished, click on the *Apply* button.

APPENDIX C

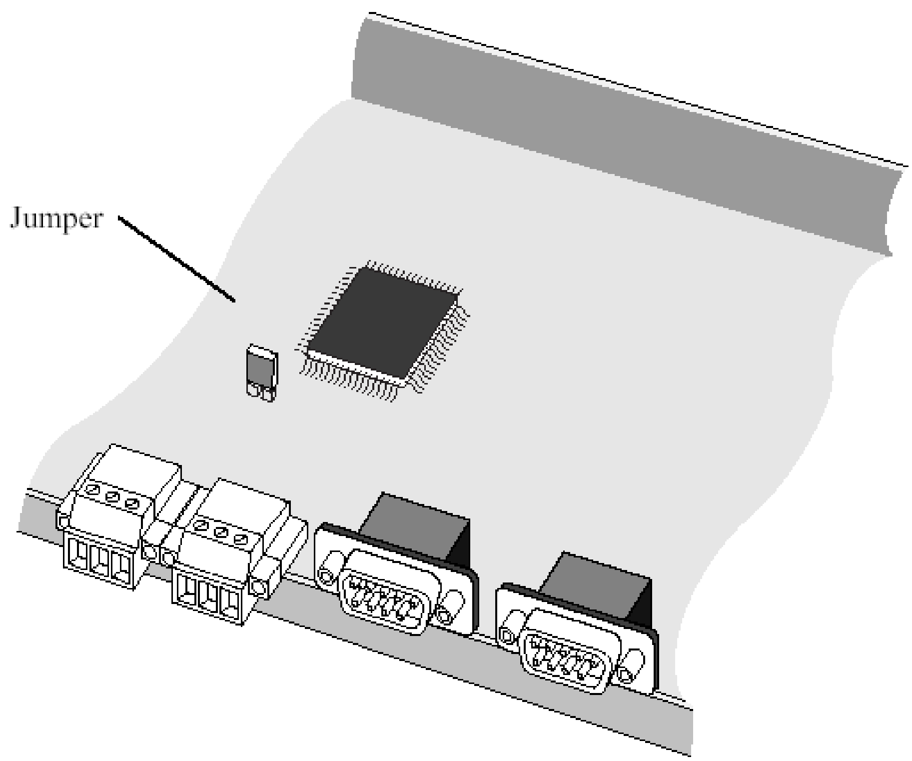
NL-100 SET-UP

NL-100 SET-UP

In order to communicate with the NL-100 you need a Null-modem cable and a PC or Laptop with a terminal communication package. It is assumed for the rest of this document that HyperTerminal is used. You will also need 12VDC to power the NL-100.

Connect the null modem cable to the PC and the NL-100. You will need a cable with female connections at both ends. Use gender adaptors if necessary. If this is the first time communicating with the NL-100 after receipt from factory go to step 1b.

1a. Open NL-100 by removing four screws. Connect boot jumper across both terminals.



1b. Connect power to NL-100 and connect Null Modem cable.

1c. Open hyperterminal and use following settings:
baud: 115200
databits: 8
parity: none
stop bits: one
flow control: none

2. Strike the Enter button a few times to get the attention of the NL-100 once the following is returned you may continue:

NL100/105 (ver, show, edit, defaults, reset, help, bye):

3. Type E to Edit and make sure the following is set:
Tlink config [dis]
RS485 [dis]
CS I/O [dis]
RS232 Config [TCPServ]
RS232 bps [19K]
RS232 Serial Server Port [6781]
Ethernet 10-baseT [enabled]
10-baseT port IP# [192.148.95.30] **this value is logger IP address
mask [255.255.255.0]**whatever mask is used
default gateway [no]
Pakbus node [678]
Clock neighbor node ID [0]
PakTcp Server config [dis]
PakTcp client config [dis]
Modbus/Tcp gateway config [dis]
Config monitor telnet port [23]
Telnet Session password [nl100]
Serial Server Watchdog [2]

Save

You can progress through the menu by pressing <ENTER>. If you make a mistake after entering a setting, the up arrow can be used to move backwards. If you need help for a particular setting, press the F1 key or the ? key. You can also choose to select <cancel> at the end instead of save if you want to start over.

**If the jumper was used it must be disconnected before returning the NL-100 to use. If this is not done, the NL-100 will always be at the boot prompt and will be inaccessible for remote communications.

APPENDIX D

BAROMETER SET-UP

VAISALA PTB-201 SET-UP
FOR ALL CAMPBELL LOGGERS

The Barometers are serial devices and to connect to them you will need:

A computer
A 9-pin straight through serial cable
A 12-volt supply for power to the Barometer (logger)
A serial communication program such as HyperTerminal
A special built connector so 12V and ground can remain on the logger and TX/RX/GND can be connected to the communications port of laptop.

1. Apply Power to the Barometer and start HyperTerminal. If this is the first time setting up communications to the Barometer to change settings, the following HyperTerminal settings should be used:

    a. Baud Rate: 1200
    b. Data Bits: 7
    c. Parity: Even
    d. Stop Bits: 1
    e. Flow control: None

    If system already in use, the following settings should be used:

	SGP/TWP	NSA
f. Baud Rate:	1200	1200
g. Data Bits:	8	7
h. Parity:	None	Even
i. Stop Bits:	1	1
j. Flow control:	None	None

2. The following commands will change the settings in the Barometer to match what the Campbell Dataloggers need: DO NOT TYPE QUOTATIONS

    a. Type “OPEN”
    b. Type “ECHO ON”

c. Type “FORM <CR>”

    The unit will return the following:
    “\PPPP.PP\ \uuuu\\r\n”
    ?
    Or “\PPPP.P\ \uuuu\\r\n
    ?
    The cursor will be after the question mark
    Type “\PPPP.P\ \uuuu\\r\n<CR>”
    There is a space between the 2nd and 3rd backslash. You MUST type the format after the question mark regardless of the current form. Typing FORM <CR> puts barometer into the “change format mode”

d. Type “UNIT hPa” (probably not needed—but good to check)
e. Type “SERI 1200 N 8 1”
f. Type “ECHO OFF”
g. Type “?” and make sure the following are all the same:

Software version	PTB 200 / 2.03
Baud Parity Data Stop	1200 N 8 1
Output format	\PPPP.P\\uuuu\\r\n
Pressure unit	hPa
Temperature unit	'C
Sending mode	STOP
Address	0
Sleep mode	OFF
Measurement time	64 x 25 milliseconds
Filter	OFF / FAST
Output interval	0 s
Calibration day code	92261
Offset drift comp.	ON
Offset drift correction	-0.056
Multipoint correction	ON

h. If any of the 2nd – 11th settings are not the same as above, see manual to set as above. The last four settings may differ between barometers.
i. Type “RESET” to save all settings.
j. Type “CLOSE”.

VAISALA PTB-220 SET-UP
FOR ALL CAMPBELL LOGGERS

The Barometers are serial devices and to connect to them you will need:

A computer
A 9-pin straight through serial cable
A 12-volt supply for power to the Barometer (logger)
A serial communication program such as HyperTerminal
A special built connector so 12V and ground can remain on the logger and TX/RX/GND can be connected to the communications port of laptop.

3. Apply Power to the Barometer and start HyperTerminal. If this is the first time setting up communications to the Barometer to change settings, the following HyperTerminal settings should be used:

    a. Baud Rate: 9600
    b. Data Bits: 7
    c. Parity: Even
    d. Stop Bits: 1
    e. Flow control: None

    If system already in use, the following settings should be used:

	SGP/TWP	NSA
f. Baud Rate:	1200	1200
g. Data Bits:	8	7
h. Parity:	None	Even
i. Stop Bits:	1	1
j. Flow control:	None	None

4. The following commands will change the settings in the Barometer to match what the Campbell Dataloggers need: DO NOT TYPE QUOTATIONS

    a. Type “OPEN”
    b. Type “ECHO ON”

c. Type “FORM <CR>”

    The unit will return the following:
    4.2 P “ “ UUUU #r #n
    ?
    Or 4.1 P “ “ UUUU #r #n
    ?
    The cursor will be after the question mark
    Type “4.1 P “ “ UUUU #r #n<CR>”
    There is a space between the 2nd and 3rd quotations (must type these). You MUST type the format after the question mark regardless of the current form. Typing FORM <CR> puts barometer into the “change format mode”

d. Type “UNIT hPa” (probably not needed—but good to check)
e. Type “SERI 1200 N 8 1”
f. Type “ECHO OFF”
g. Type “?” and make sure the following are all the same:

Software version	PTB 220 / 3.05
Serial	XXXXXXXXX
Configuration	1
Linear adjustments	OFF
Mulitpoint adjustments	ON
Calibration Date	XXXX-XX-XX
Baud Parity Data Stop	1200 N 8 1
Echo	OFF
Sending Mode	STOP
Measurement Mode	NORMAL
Pulse Mode	OFF SLOW LOW 0.0
Address	0
Output Interval	0
Output format	4.1 P “ “ UUUU #r #n
Error Output Format	
SCOM Format	
Pressure unit	hPa
Temperature unit	'C
Averaging Time	0.5s

h. If any of the 7th – 15th settings are not the same as above, see manual to set as above. The Software Version, Serial and Cal Date settings may/should differ between barometers.
i. Type “RESET” to save all settings.
j. Type “CLOSE”.

APPENDIX E

ANNUAL CALIBRATION

CHECKS

SMET
YEARLY CALIBRATION PROCEDURES

Facility: **TWP**
Frequency: **Once a year**
Mentor: **Michael Ritsche**

NOTE: Prior to all testing and verification, the variables need to set in the connect screen to be monitored. In LoggerNet, open the Connect screen, Click on SMET and then on the Connect button. Click on Numeric 1 and add the following from the InLocs: UP_WS_MS, UP_WS_HZ, UP_WDIR, LO_WS_MS, LO_WS_HZ, LO_WDIR, TEMP, RH, PCP_RATE, PCP_MV. Ensure the update rate is set to 1 second.

1. 05106 RM Young Wind Monitor

A. *Wind speed*

To check that the wind speed sensor is measuring properly, the following equipment is needed.

1. 9/16" wrench
2. #18810 Anemometer drive
3. Two people

Tilt the tower down to access the wind monitor. Refer to the Tower lowering documentation for the procedure. Remove the propeller from the propeller shaft and install the torque nut provided. The anemometer drive connects to the wind monitor body and the motor connects to the torque nut. Next, select one of the following RPM levels on the anemometer drive and start the unit. Wait for the RPM level to stabilize.

RPM/HZ/Speed	HZ	Speed
200/10 Hz/1 m/s		
800/40 Hz/4 m/s		
1600/80 Hz/8 m/s		

Compare the reading from the anemometer drive and the sensor output as read from the computer

B. *Wind Direction*

Using the angle fixture and the computer to check that the sensor output matches the direction settings determined by the angle fixture #18212. The angle fixture is inserted between the orientation ring and the wind monitor. Once the angle fixture is installed, make sure that the notches of the orientation ring, angle fixture and wind monitor all match up. Use the positioning arm to hold the tail of the wind monitor in the correct position. Rotate the wind monitor through the positions listed below and compare them to directions measured by the data logger.

Direction	Measured
10	
45	
90	
180	
270	
355	

The accuracy of this measurement is +/- 5.0 degrees, with a resolution of 1.0 degree.

NOTE: The absolute accuracy of this measurement depends on the exactness of the orientation of the sensor with respect to true north.

2. HMP-45D Temperature & Relative Humidity

To verify the accuracy and installation of the HMP-45D sensor the following tools will be needed.

1. HMI41/HMP31 Temperature and Relative Humidity Meter, recently calibrated.
2. Computer.
3. Portable Aspiration Unit.

Remove the sensor from the radiation shield and inspect, clean or replace the humidity cap. Verify that the sensor is working properly using the following procedures.

The verification of the temperature sensor is done with the Vaisala HMI41/HMP31 T/RH meter. Mount the portable aspiration unit on the SMET tower approximately chest high. Place the HMP-45D T/RH sensor and the HMI41/HMP31 T/RH Meter in the holders of the portable aspiration unit. Turn on the HMI41/HMP31 meter.
Allow the sensors to stabilize such that the temperature and RH readings are changing by less that +/- 0.2 Deg C or +/- 1% RH, then wait another 5 minutes before taking readings.
Compare the data logger measurement to the read-out of the HMI41/HMP31. The temperature readings should match within +/- 0.5 C. The RH readings should match within +/- 2 % RH from 0 - 90 % RH or +/- 3 % RH from 90 - 100 % RH.

NOTE: If the probe or the T/RH Meter has been exposed to a temperature significantly different from the ambient air temperature and RH, it may take an appreciable time for the sensor to stabilize.

Measurement	HMP-45D	HMI41/HMP31
Temperature		
Relative Humidity		

3. Optical Rain Gage (ORG-115 or 815)

To verify proper functioning of the ORG, the following tools will be needed.

1. TST-800 Series Test Kit.
2. Computer.
3. Calculator (may use Computer).

Clean the lenses of the ORG using established procedures. Check and note the voltage of the ORG after cleaning. Check and note the rainrate value. Then turn off power to the ORG. Connect the Test Kit. Turn on power to the ORG and wait at least 10 minutes. Check and note the voltage value. Check and note the rainrate value. Use the following equations to hand check the rainrate value when the Test Kit is attached:

815: $25*(V^{1.87}) – 0.5$
115: $20*(V^{2.0}) – 0.05$

	mV	**Rainrate**	**Computed**
Without Test Kit			N/A
With Test Kit			

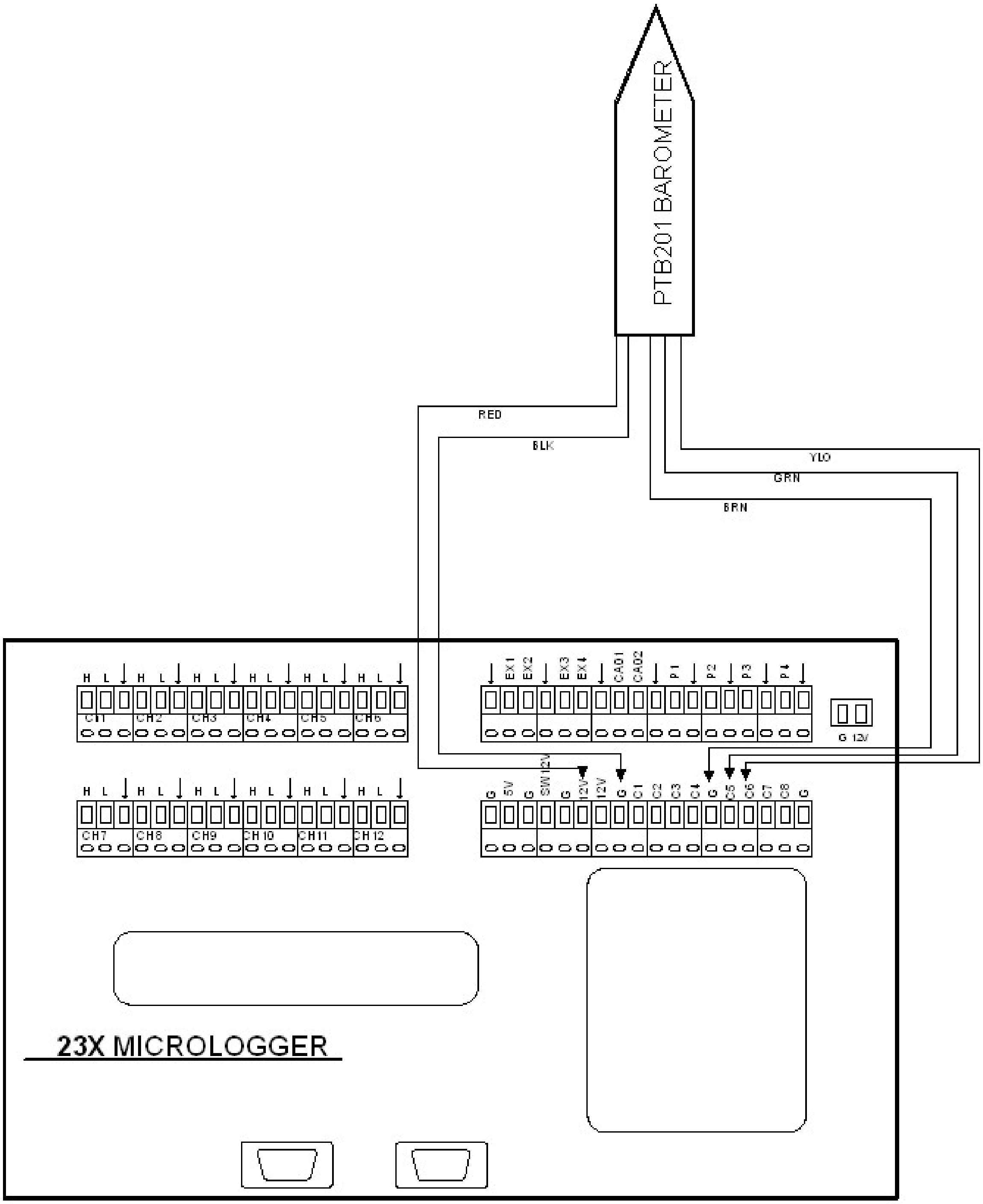
4. PTB-220 Barometric Pressure

The PTB-220 barometer is located inside of the enclosure. The computer is used to monitor the location where the barometric pressure is being displayed. Use the PA-11 Precision Digital Barometric pressure transducer to read the current barometric pressure in millibars and compare the two values. The two values should be with in +/- 0.5 millibars of each other.

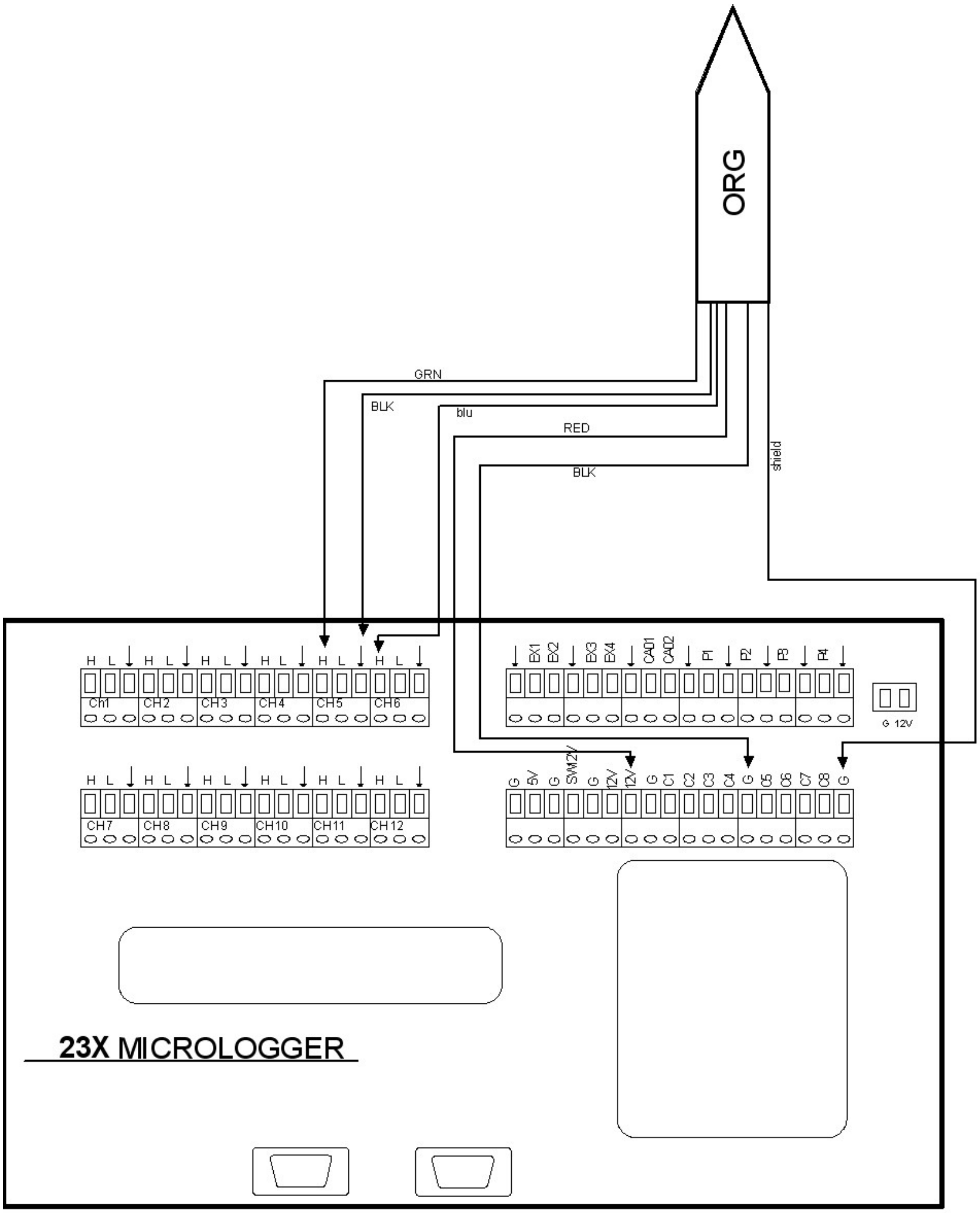
Sensor	**Pressure**
PTB220	
Precision PA-11	

APPENDIX F

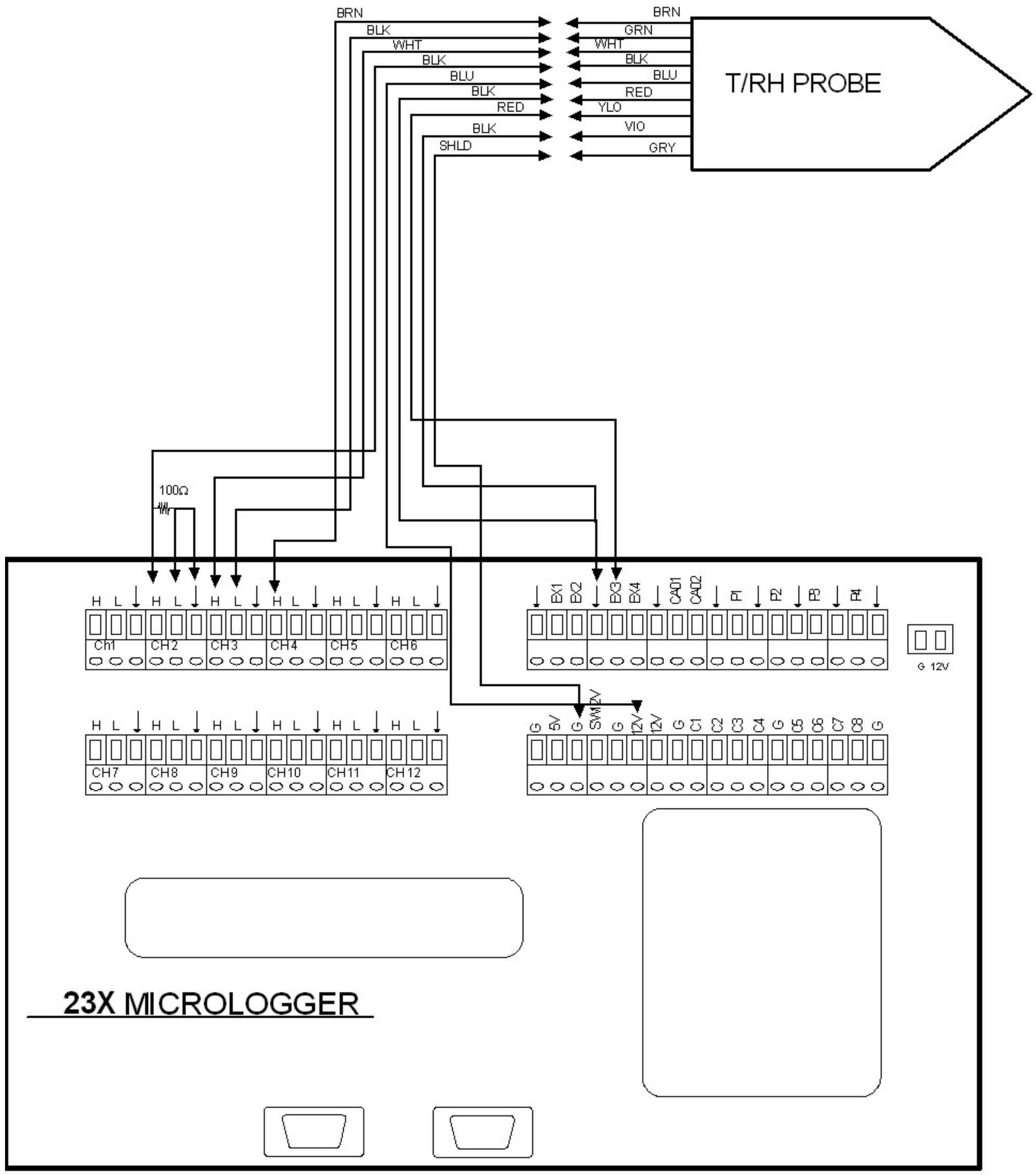
WIRING DIAGRAMS



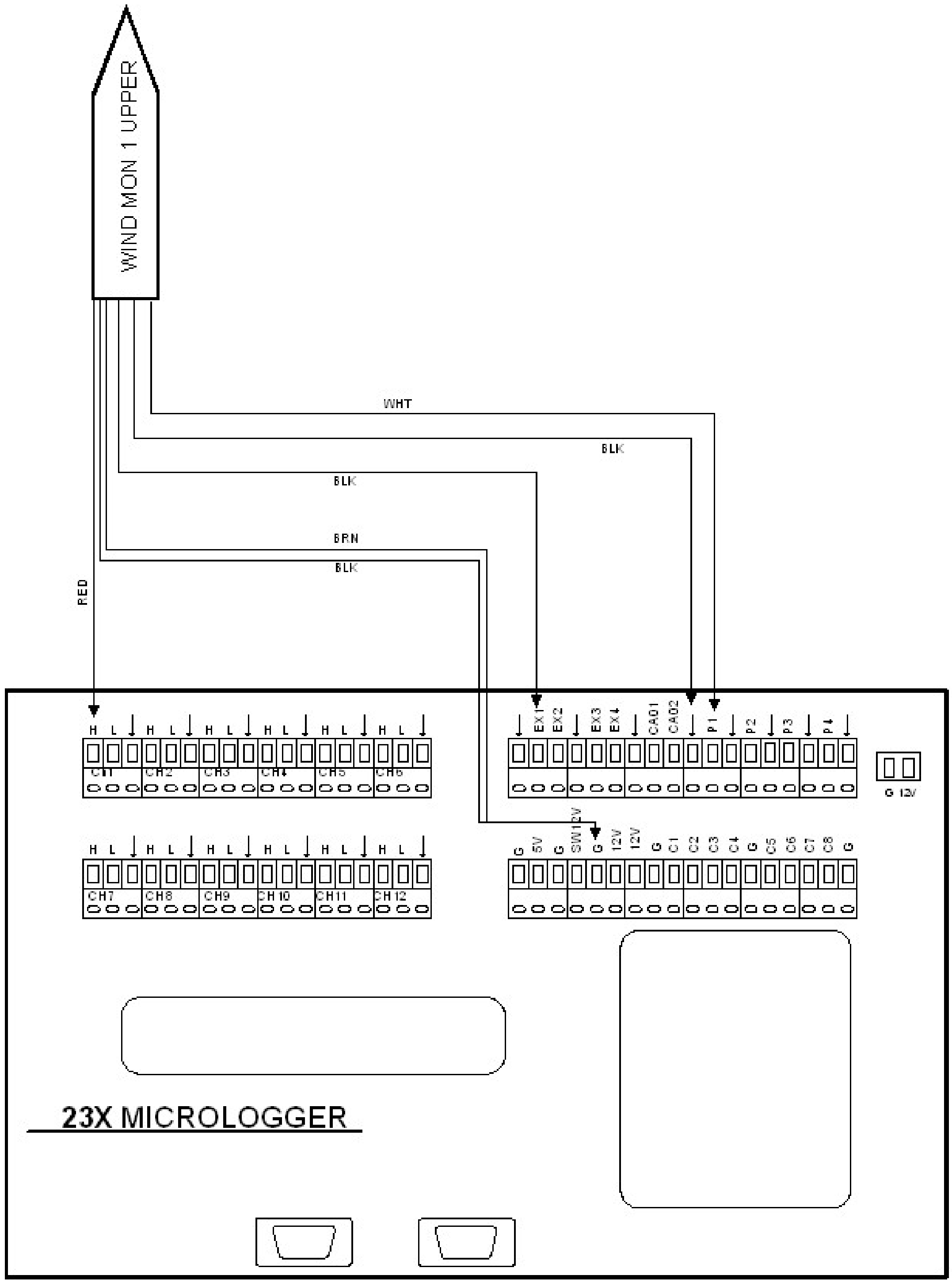
	XXXXXX Data Logger Wiring			
5/25/04	SIZE: NS	FSCM NO	DWG NO	REV
Mike Ritsche	SCALE: NS		SHEET	1 OF X



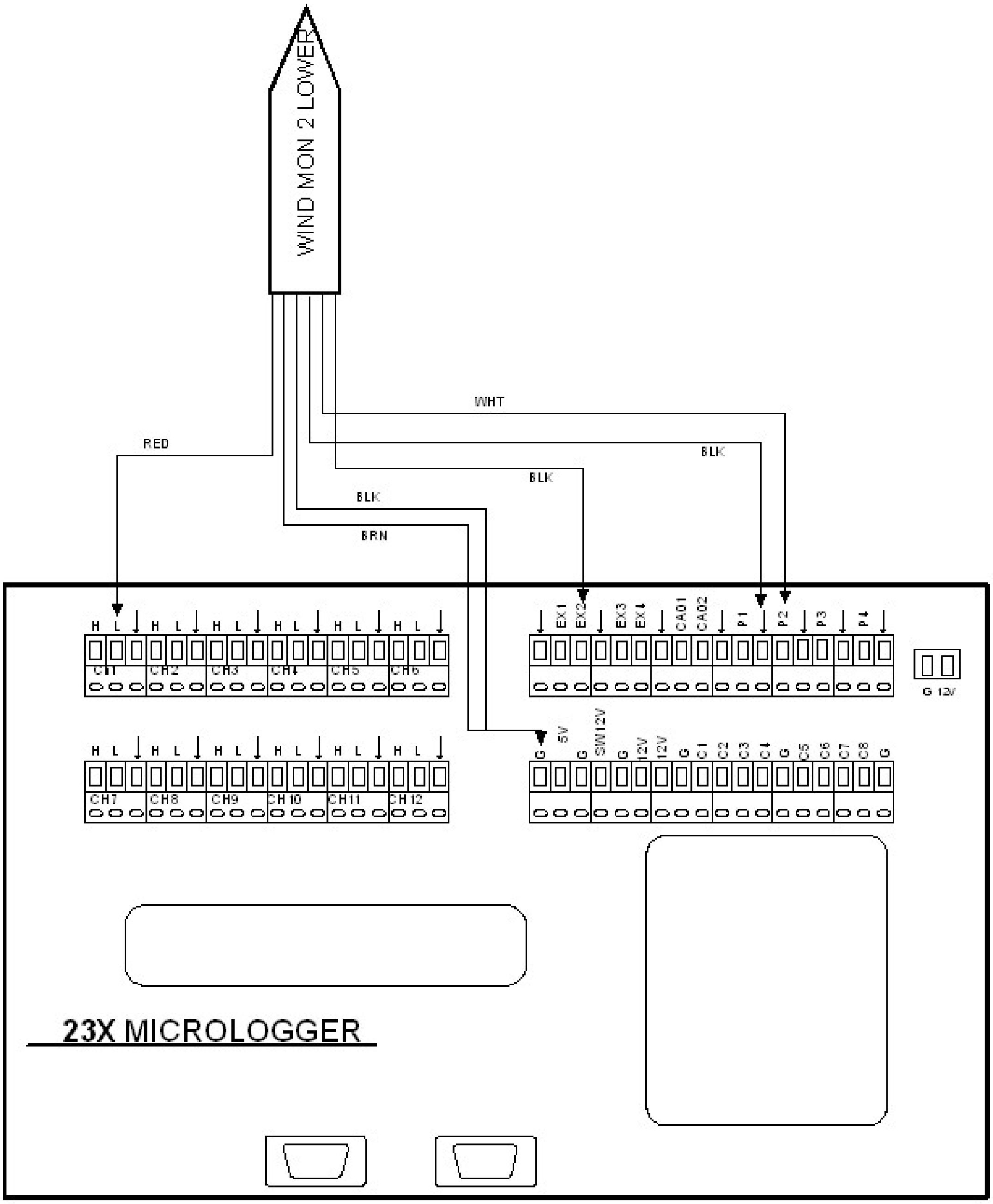
	ORG to Data Logger Wiring				
02/18/2005	SIZE NS	FSCM NO	DWG NO		REV
Mike Ritsche	SCALE	NS		SHEET	1 OF 1



	T/RH Probe To Data Logger Wiring				
5/26/04	SIZE: NS	FSCM NO	DWG NO		REV: 1
Mike Ritsche	SCALE	NS		SHEET	1 OF 1



	Wind Monitor 1 (Upper) to Data Logger Wiring			
5/26/04	SIZE: NS	FSCM NO	DWG NO	REV: 1
Mike Ritsche	SCALE: NS		SHEET	1 OF 1



	Wind Monitor 2 (Lower) to Data Logger Wiring					
5/26/04	SIZE NS	FSCM NO	DWG NO			REV 1
Mike Ritsche	SCALE	NS		SHEET	1 OF 1	

APPENDIX G

CR23X PROGRAM EXAMPLE

```
;{CR23X}
;
;
;TWP SMET ARCSC3 SMET Program
;Mentor: Michael T. Ritsche, ANL
;
;ARCSC#SMET.csi
;
;Installed: XX/XX/XXXX
;
;Version 01132006.1

*Table 1 Program
          01: 1.00  Execution Interval (seconds)


;
;
;*********************CALIBRATION DATA**************************
;
;
;


;User entered wind speed calibration slope for upper wind monitor.
;This stores value for daily calibration output.

1:  Z=F x 10^n (P30)
 1: .09656   F
 2: 0        n, Exponent of 10
 3: 25       Z Loc [ UP_WS_SLP ]

;User entered wind speed calibration offset for upper wind monitor.
;this stores value for daily clibration ouput.

2:  Z=F x 10^n (P30)
 1: .35      F
 2: 0        n, Exponent of 10
 3: 26       Z Loc [ UP_WS_OFF ]


;User entered wind speed calibration slope for lower wind monitor.
;This stores value for daily calibration output.


3:  Z=F x 10^n (P30)
 1: .09656   F
 2: 0        n, Exponent of 10
 3: 27       Z Loc [ LO_WS_SLP ]
```

;User entered wind speed calibration offset for lower wind monitor.
;this stores value for daily clibration ouput.

```
4:  Z=F x 10^n (P30)
 1: .42      F
 2: 0        n, Exponent of 10
 3: 28       Z Loc [ LO_WS_OFF ]
```

;
;
;********************END CALIBRATION DATA*************************

;Measure frequency output by RM Young Model 05106 upper wind monitor.

```
5:  Pulse (P3)
 1: 1        Reps
 2: 1        Pulse Channel 1
 3: 21       Low Level AC, Output Hz
 4: 1        Loc [ Up_Ws_Hz  ]
 5: 1.0      Mult
 6: 0.0      Offset
```

;Convert the upper wind monitor wind speed frequency to m/s using
;calibration data.

```
6:  Z=X*Y (P36)
 1: 1        X Loc [ Up_Ws_Hz  ]
 2: 25       Y Loc [ UP_WS_SLP ]
 3: 2        Z Loc [ Up_WS_MS  ]
```

```
7:  Z=X+Y (P33)
 1: 2        X Loc [ Up_WS_MS  ]
 2: 26       Y Loc [ UP_WS_OFF ]
 3: 2        Z Loc [ Up_WS_MS  ]
```

;Measure wind direction for Upper Wind Monitor

```
8:  Excite-Delay (SE) (P4)
 1: 1        Reps
 2: 15       5000 mV, Fast Range
 3: 1        SE Channel
 4: 1        Excite all reps w/Exchan 1
 5: 2        Delay (0.01 sec units)
 6: 2500     mV Excitation
 7: 3        Loc [ Up_WDir   ]
 8: .142     Mult
 9: 0.0      Offset
```

```
;Measure frequency output by RM Young Model 05106 lower wind monitor.

9:  Pulse (P3)
 1: 1        Reps
 2: 2        Pulse Channel 2
 3: 21       Low Level AC, Output Hz
 4: 4        Loc [ Lo_WS_Hz  ]
 5: 1.0      Mult
 6: 0.0      Offset



;Convert the lower wind monitor wind speed frequency to m/s using
;calibration data.


10:  Z=X*Y (P36)
 1: 4        X Loc [ Lo_WS_Hz  ]
 2: 27       Y Loc [ LO_WS_SLP ]
 3: 5        Z Loc [ Lo_WS_MS  ]


11:  Z=X+Y (P33)
 1: 5        X Loc [ Lo_WS_MS  ]
 2: 28       Y Loc [ LO_WS_OFF ]
 3: 5        Z Loc [ Lo_WS_MS  ]

;Measure wind direction for Lower Wind Monitor

12:  Excite-Delay (SE) (P4)
 1: 1        Reps
 2: 15       5000 mV, Fast Range
 3: 2        SE Channel
 4: 2        Excite all reps w/Exchan 2
 5: 2        Delay (0.01 sec units)
 6: 2500     mV Excitation
 7: 6        Loc [ Lo_WDir   ]
 8: .142     Mult
 9: 0.0      Offset

;Measure the resistance ratio for temperature

13:  Full Bridge w/mv Excit (P9)
 1: 1        Reps
 2: 22       50 mV, 60 Hz Reject, Slow, Ex Range
 3: 22       50 mV, 60 Hz Reject, Slow, Br Range
 4: 2        DIFF Channel
 5: 3        Excite all reps w/Exchan 3
 6: 90       mV Excitation
 7: 7        Loc [ RsRo      ]
```

8: 1.0   Mult
9: 0.0   Offset

;Convert resistance ratio to temperature in deg C

14: Temperature RTD (P16)
1: 1   Reps
2: 7   R/R0 Loc [RsRo   ]
3: 8   Loc [Temp   ]
4: 1.0   Mult
5: 0.0   Offset

;Measure RH%

15: Volt (SE) (P1)
1: 1   Reps
2: 15   5000 mV, Fast Range
3: 7   SE Channel
4: 9   Loc [RH   ]
5: 0.1   Mult
6: 0.0   Offset

;Calculate saturation vapor pressure

16: Saturation Vapor Pressure (P56)
1: 8   Temperature Loc [Temp   ]
2: 18   Loc [SatVap   ]

;Calculate vapor pressure from RH% and saturation vapor pressure

Vap_Press = (RH*SatVap)/100

;Obtain voltage reading from Optical Rain Gage (ORG)

17: Volt (SE) (P1)
1: 1   Reps
2: 15   5000 mV, Fast Range
3: 9   SE Channel
4: 10   Loc [PCP_mV   ]
5: 1.0   Mult
6: 0.0   Offset

;Obtain the ORG carrier signal for diagnostic purposes

18: Volt (SE) (P1)
1: 1   Reps
2: 15   5000 mV, Fast Range
3: 11   SE Channel
4: 33   Loc [ORG_car   ]

```
 5: 1.0      Multiplier
 6: 0.0      Offset


;Condtional statement to apply rainrate equation to values that are
;only at or above the threshold of 85mV.  Any value below 85mV and
;the PCP Rate is set to 0mm/hr.


19:  If (X<=>F) (P89)
 1: 10       X Loc [ PCP_mV    ]
 2: 4        <
 3: 85       F
 4: 30       Then Do



    20:  Z=F x 10^n (P30)
     1: 0.0      F
     2: 00       n, Exponent of 10
     3: 11       Z Loc [ PCP_Rate  ]



21:  Else (P94)

    PCP_Rate = (25*((PCP_mV/1000)^1.87)) - 0.15



22:  End (P95)

;Read barometer and sample internal battery voltage at top of every
;minute.

23:  If time is (P92)
 1: 0        Minutes (Seconds --) into a
 2: 1        Interval (same units as above)
 3: 30       Then Do


    24:  Batt Voltage (P10)
     1: 21       Loc [ Batt_Volt ]


    25:  Do (P86)
     1: 1        Call Subroutine 1


26:  End (P95)
```

```
27:  Excite-Delay (SE) (P4)
 1: 1        Reps
 2: 10       Auto, Fast Range (OS>1.06)
 3: 12       SE Channel
 4: 1        Excite all reps w/Exchan 1
 5: 10       Delay (0.01 sec units)
 6: 0000     mV Excitation
 7: 31       Loc [ Dummy     ]
 8: 1.0      Mult
 9: 0.0      Offset

;Check value returned by barometer.  If value is too low (bad read)
;Try one more time.

     28:  If (X<=>F) (P89)
      1: 30       X Loc [ Baro_pres ]
      2: 4        <
      3: 80       F
      4: 30       Then Do


          29:  Do (P86)
           1: 1        Call Subroutine 1

     30:  End (P95)


;Begin 1-minute output.


     31:  If time is (P92)
      1: 0        Minutes (Seconds --) into a
      2: 1        Interval (same units as above)
      3: 10       Set Output Flag High (Flag 0)


     32:  Set Active Storage Area (P80)^13221
      1: 1        Final Storage Area 1
      2: 1        Array ID


     33:  Real Time (P77)^5301
      1: 1220     Year,Day,Hour/Minute (midnight = 2400)


     34:  Average (P71)^4540
      1: 1        Reps
      2: 11       Loc [ PCP_Rate  ]
```

35: Standard Deviation (P82)^18507
1: 1 Reps
2: 11 Sample Loc [PCP_Rate]

36: Maximum (P73)^22695
1: 1 Reps
2: 0 Value Only
3: 11 Loc [PCP_Rate]

37: Minimum (P74)^32517
1: 1 Reps
2: 0 Value Only
3: 11 Loc [PCP_Rate]

38: Average (P71)^14056
1: 1 Reps
2: 8 Loc [Temp]

39: Standard Deviation (P82)^23815
1: 1 Reps
2: 8 Sample Loc [Temp]

40: Average (P71)^5402
1: 1 Reps
2: 9 Loc [RH]

41: Standard Deviation (P82)^7406
1: 1 Reps
2: 9 Sample Loc [RH]

42: Average (P71)^25147
1: 1 Reps
2: 19 Loc [Vap_Press]

43: Standard Deviation (P82)^10107
1: 1 Reps
2: 19 Sample Loc [Vap_Press]

44: Wind Vector (P69)^23261
1: 1 Reps
2: 0 Samples per Sub-Interval
3: 02 S, U, theta(u), sigma(theta(u)) with polar sensor

4: 2 Wind Speed/East Loc [Up_WS_MS]
5: 3 Wind Direction/North Loc [Up_WDir]

45: Standard Deviation (P82)^2848
1: 1 Reps
2: 2 Sample Loc [Up_WS_MS]

46: Maximum (P73)^16743
1: 1 Reps
2: 0 Value Only
3: 2 Loc [Up_WS_MS]

47: Minimum (P74)^821
1: 1 Reps
2: 0 Value Only
3: 2 Loc [Up_WS_MS]

48: Wind Vector (P69)^10029
1: 1 Reps
2: 0 Samples per Sub-Interval
3: 02 S, U, theta(u), sigma(theta(u)) with polar sensor
4: 5 Wind Speed/East Loc [Lo_WS_MS]
5: 6 Wind Direction/North Loc [Lo_WDir]

49: Standard Deviation (P82)^7443
1: 1 Reps
2: 5 Sample Loc [Lo_WS_MS]

50: Maximum (P73)^15483
1: 1 Reps
2: 0 Value Only
3: 5 Loc [Lo_WS_MS]

51: Minimum (P74)^14872
1: 1 Reps
2: 0 Value Only
3: 5 Loc [Lo_WS_MS]

52: Resolution (P78)
1: 1 High Resolution

53: Sample (P70)^4992

1: 1   Reps
2: 30   Loc [Baro_pres]

54: Resolution (P78)
1: 0   Low Resolution

55: Sample (P70)^31219
1: 1   Reps
2: 21   Loc [Batt_Volt]

56: Panel Temperature (P17)
1: 32   Loc [LoggerTem]

57: Sample (P70)^11748
1: 1   Reps
2: 32   Loc [LoggerTem]

;Daily output of wind monitor calibration values. Done at 00Z.

58: If time is (P92)
1: 0   Minutes (Seconds --) into a
2: 1440   Interval (same units as above)
3: 10   Set Output Flag High (Flag 0)

59: Set Active Storage Area (P80)^27116
1: 1   Final Storage Area 1
2: 20   Array ID

60: Real Time (P77)^24367
1: 1220   Year,Day,Hour/Minute (midnight = 2400)

61: Resolution (P78)
1: 1   High Resolution

62: Sample (P70)^23754
1: 1   Reps
2: 25   Loc [UP_WS_SLP]

63: Sample (P70)^20589
1: 1   Reps
2: 26   Loc [UP_WS_OFF]

64: Sample (P70)^5017

```
 1: 1       Reps
 2: 27       Loc [ LO_WS_SLP ]


65:  Sample (P70)^5855
 1: 1       Reps
 2: 28       Loc [ LO_WS_OFF ]


66:  Resolution (P78)
 1: 0       Low Resolution
```

*Table 2 Program
    01: 0.00 Execution Interval (seconds)

*Table 3 Subroutines

;Serial I/O for collecting data from the barometer.
;The ascii command "SEND(carriage return)" is sent to
;the barometer.

```
1:  Beginning of Subroutine (P85)
 1: 1       Subroutine 1


 2:  Z=F x 10^n (P30)
  1: 83       F
  2: 0       n, Exponent of 10
  3: 12       Z Loc [ S        ]


 3:  Z=F x 10^n (P30)
  1: 69       F
  2: 0       n, Exponent of 10
  3: 13       Z Loc [ E        ]


 4:  Z=F x 10^n (P30)
  1: 78       F
  2: 0       n, Exponent of 10
  3: 14       Z Loc [ N        ]


 5:  Z=F x 10^n (P30)
  1: 68       F
```

```
 2: 0        n, Exponent of 10
 3: 15       Z Loc [ D        ]


6:  Z=F x 10^n (P30)
 1: 13       F
 2: 0        n, Exponent of 10
 3: 16       Z Loc [ CR       ]


7:  Z=F x 10^n (P30)
 1: 10       F
 2: 0        n, Exponent of 10
 3: 17       Z Loc [ LF       ]


8:  Port Serial I/O (P15)
 1: 1        Reps
 2: 01       RS-232 ASCII, 1200 Baud
 3: 5        Delay (0.01 sec units) before TX
 4: 15       C1 RTS/DTR, C5 TXD/RXD
 5: 12       Start Loc for TX [ S        ]
 6: 6        Number of Locs to TX
 7: 104      Termination Character for RX
 8: 15       RX Buffer Size or Max Chars to RX if Par 2 indexed (--)
 9: 10       Time Out for CTS (TX) and/or RX (0.01 sec units)
10: 30       Start Loc for RX [ Baro_pres ]
11: 1.0      Mult for RX
12: 0.0      Offset for RX



9:  End (P95)

End Program
```