BASIC ASSEMBLY AND USE OF THE CERRO PACHON WEATHER STATION

DOUG SIMONS
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1.0 Overview of System

This technical note is intended to explain basic assembly and operation of the Qualimetrics weather station that is to be installed at Gemini-S. It is supplemental to the Qaulimetrics manual, which has a variety of technical details about the system controller and sensors but does not contain a very useful overview of the system or straightforward assembly description for those unfamiliar with the station.

Overall, the weather station consists of 3 main electronic components, namely:

- PC - used primarily as a data logger and housed in a small building close to the weather tower
- Central controller (or StationPac) - probably located at the base of the tower, this unit interprets signals from the various sensors and transmits measurements to the PC
- Sensors - located along the tower and in the controller box, they generate typically analog (linear) voltages in response to varying atmospheric conditions.

The system is shipped in a total of ~8 boxes, the two largest of which contain the controller and most of the sensors with cables. Smaller boxes contain various hardware, including self-aspirated radiation shields (SARS), mounting equipment, and the Handar ultrasonic wind sensor and power supply. Assembly of the system (ignoring actual coupling to the tower) consists mostly of running the sensor cables into the controller box through the ports on the bottom, connecting the various color coded wires to junction blocks in the controller, connecting power lines to the controller and Handar power supply, and connecting the PC to the controller via a ~50’ RS-232 cable. The sensors are factory calibrated for the cable lengths specified, hence there should be no local calibration of the system required once it is integrated. When powered-up, the system self-configures for the sensor complement installed, and the data logging software installed on the PC begins automatically when booted. A real-time display of the sensor outputs is also provided to confirm operability of the station.

2.0 Controller Layout

Figure 1 shows the basic layout of the controller electronics, which is housed in a heavy gauge sealed plastic box. Figure 2 shows the basic layout of the system on the 24 m tower at Cerro Pachon. The controller is capable of running off of either 110 V, 60

Hz AC or 220 V, 50 Hz AC power. The controller provides power to and interprets signals from the sensors. An LCD display and keypad is available to monitor sensor readings, configure various system parameters, etc. inside the StationPac, on the controller panel. After connecting the controller to a power source, the LCD panel will indicate that the system is "initializing" and after a few seconds the temperature from one of the temperature probes will be displayed. Use the ↑ and ↓ keys to step through the various sensor outputs. In general it should not be necessary to use the keypad beyond simple scrolling of sensor output as the system is shipped pre-configured. Note that the system clock on the controller, as shipped, is set for PDT. The PC clock though acts as the system time base and the controller clock will reset to the PC clock value automatically. *The PC clock should be set to local Chilean time as part of the system setup.*

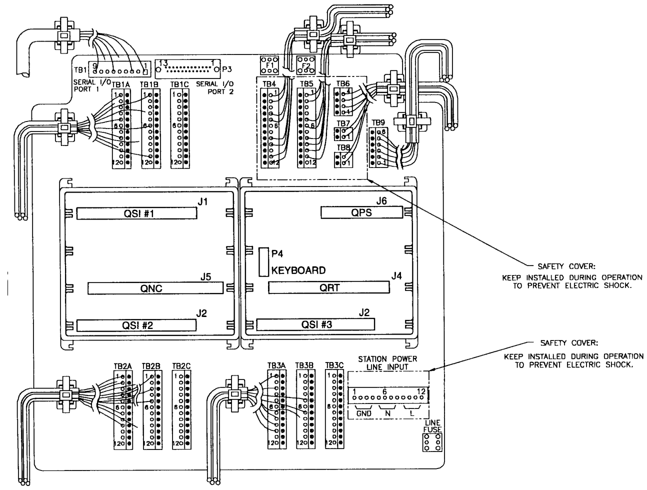

Figure 1 - The basic layout of junction blocks within the StationPac are shown. The wiring shown here is only illustrative of typical sensor configurations. Refer to Figure 3 for a detailed wiring description of the Cerro Pachon station.

3.0 Sensor Description and Wiring

Table 1 lists the sensors included with the station. Figure 3, which is derived from the Qualimetrics documentation, summarizes the connections needed to support each sensor. All of the sensors have fairly heavy gauge (PVC) shielded cables to transmit the low voltage signals (typically <1 VDC) below to the controller. *It is important that the sensor cables not be cut or extended during installation at the tower*. Each sensor is calibrated in conjunction with cable lengths specified at the time the station was ordered and adequate lengths of cable should be available as-delivered to span mounting points along the tower. Excess cable should be spooled up at the base of the tower or in the

Sensor Type	Manufacturer Part	Performance
Wind speed and direction	Handar 425AH heated ultrasonic wind sensor	Operating: 0-144 mph, survival: 0-180 mph; accuracy: ±0.3 mph and ±2°
Temperature	Qualimetrics 4480-A temperature probe (2)	Operating: -50 - +50 °C; accuracy: ±0.2 °C
Humidity	Qualimetrics 5140	Operating: 0-100% RH; accuracy: ±2% from 0-80%, ±3% from 80-100%; 10 sec response time
Barometer	Qualimetrics 7105-A	Operating range: 600-1100 mb; accuracy ±0.88 mb
Pyranometer	Qualimetrics 3120	Sensitivity: ~70 µV/W/m^2; accuracy ±5%, output temp compensated

Table 1 - The sensors supplied with the weather station are summarized.

control room (with the PC), rather than cut.

Connecting Power - Remove the protective plate in the lower right area of the controller chassis to expose the junction block for the AC power connector and connect a power line (not included) to this block. Replace the protective plate once a power line is connected.

RS-232 PC Line - A 25-pin 50' RS-232 cable has been provided to facilitate PC↔controller communications. This cable interfaces to a serial junction block in the upper left of the controller chassis (see Figure 1).

Barometer - This unit is housed in the StationPac containing the controller and no wiring is necessary - the system was shipped with the barometer already connected to the controller. This is the only sensor that is not directly exposed to the elements on the weather tower. Air is fed through a port on the bottom of the StationPac in a plastic tube to the barometer and it is important that this plastic tube note get crimped during wiring of the system. Output is calibrated in units of millibars at both the LCD display and PC, with an accuracy of ±0.88 mb.

Temperature - A total of three temperature sensors are included in the system. Two are standalone (model 4480-A) sensors which should be mounted in SARS to allow them to sense ambient air temperature. One of these sensors should be mounted at the top of the tower, the other at the base (see Figure 2). Identical sensors were chosen since the intent is to measure temperature differences between the top and bottom of the tower as well as absolute temperatures. Note that the sensor that mounts to the top of the tower should be connected to the QSI 2 junction block in the controller, according to Figure 3. The other sensor, mounted at the base of the tower, should be mounted to the QSI 1 controller junction block. The output of both sensors is calibrated in units of degrees Centigrade. An additional temperature

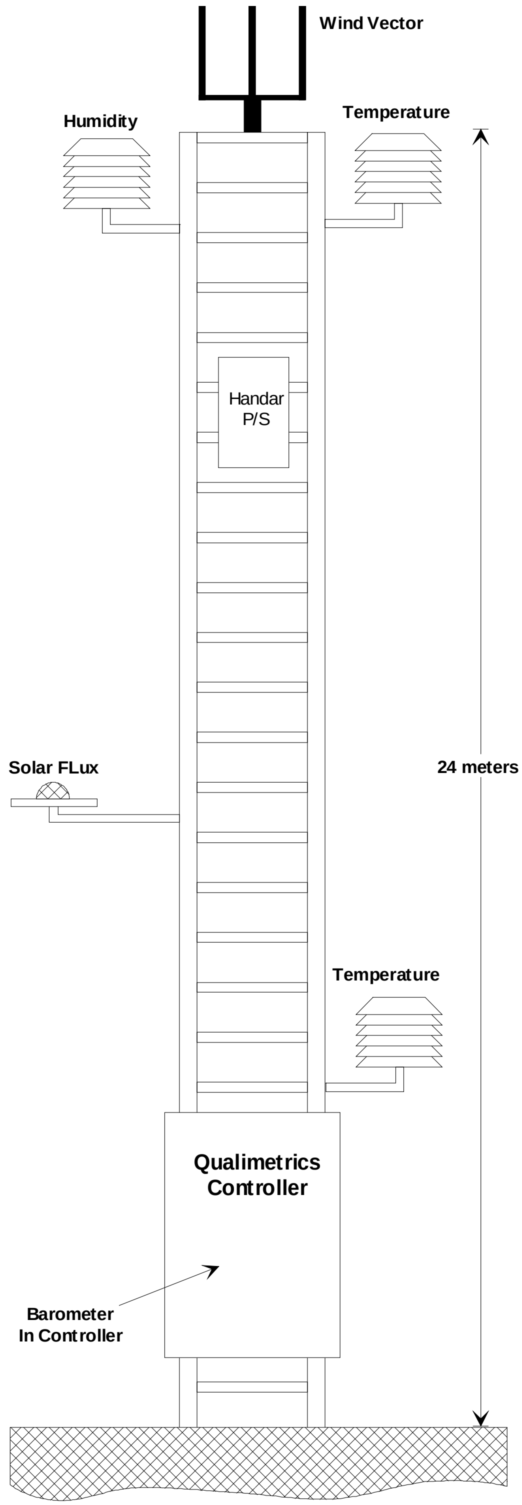

Figure 2 - The overall layout of the 6 sensors mounted on the Cerro Pachon 24 m weather tower is shown. Also shown are the Qualimetrics controller, mounted at the base of the tower, and the wind sensor power supply, mounted near the top.

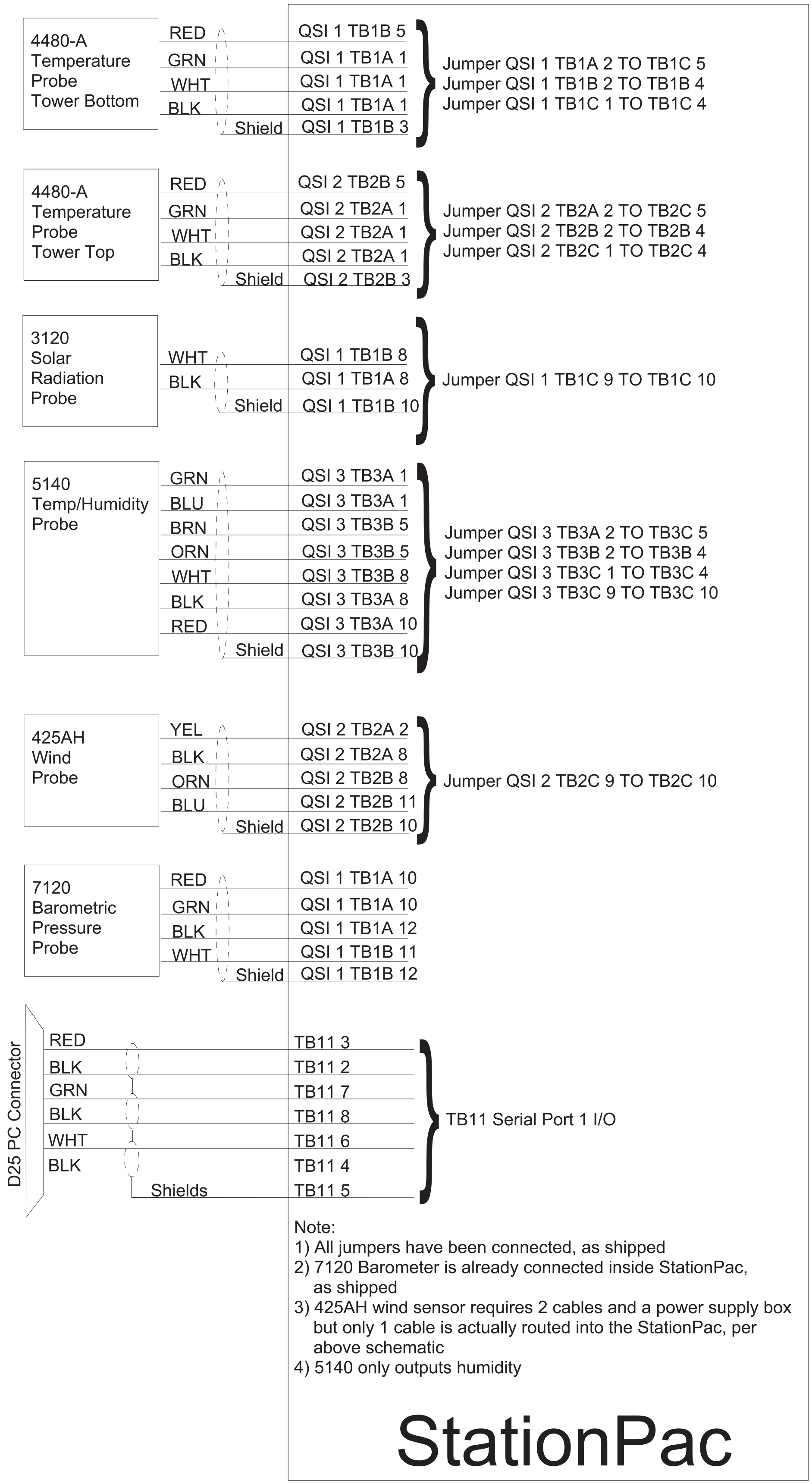

Figure 3 - Wiring details for each of the weather station sensors are shown.

probe is built into the 5140 (relative humidity) sensor but this temperature sensor has been disabled - only the humidity sensor part of the 5140 is operational.

Humidity - Relative humidity is sensed through the 5140 probe. Like the temperature sensors, the 5140 should be mounted in a SARS. It should be mounted at the top of the tower to sample (approximately) the humidity of the air at the base of the dome slit. Output is calibrated in units of percent. Attach the 5140 wires to the QSI 3 junction block in the controller, again, as illustrated in Figure 3.

Dew Point - No dewpoint sensor is provided with this system but the PC software has been configured to derive a dewpoint temperature based upon the temperature (4480-A) and relative humidity (5140) sensors at the top of the tower. Output is in the form of degrees Centigrade. This calculation is done in the PC, not the controller, hence a dewpoint is not displayed when scrolling through sensor outputs at the controller keypad.

Pyranometer - A calibrated silicon photovoltaic cell is provided mounted on a small metal stage with integral bubble level. The cell is hermetically sealed behind a plastic dome hence should remain impervious to weather. The purpose for this sensor is to (crudely) sense daily cloud cover over the site by measuring the solar flux near the ground. Since it is an optical sensor it should be mounted somewhere along the tower where it is not covered by shadows from the tower, other sensors, support building, etc. Ideally this would be a spot along the north side of the tower, near enough to the base to facilitate installation and servicing (occasional cleaning of the plastic dome). Connect the 3 wires in the sensor's cable to junction QSI 1 of the controller. The output is calibrated in units of Watts/m^2.

Wind Vector - Wind data is provided by the only non-Qualimetrics sensor in the package, namely the Handar ultrasonic wind sensor. This sensor consists of two main components, the triad of ultrasonic transmitter/receivers on a metal stage with integral electronics package, and a separate 220 V 50 Hz AC power supply*. Note that this unit is not compatible with 110 VAC power*. The sensor should be mounted at the top of the tower, following the alignment procedure described in the Handar manual. A set of bird spikes is shipped with the sensor. These should be threaded into the top of each acoustic transducer to (hopefully) keep creatures from landing on it. The obvious advantage to this sensor over conventional wind vanes and propeller driven anemometers is the lack of moving parts, which gives at a fairly long (26 yr) MTBF rating. The Handar power supply also trips a heater within the sensor package if freezing conditions exist to prevent ice build-up on the unit. Due to length limitations on the power supply cables, the Handar power supply will have to be mounted somewhere on the tower, above the base (see Figure 2). This necessitates running a 220 VAC line up to the Handar supply and a cable up from the Handar supply box up to the sensor at the top of the tower. A separate cable labeled "analog" should be routed down from the power supply to the Qualimetrics controller and wired according to Figure 3, into junction QSI 2 of the controller. The PC software has been configured to compute the wind vector and take into account the discontinuity in average values for winds crossing the 0-360 (north) direction. Output is calibrated in units of 0-360 degrees for wind direction and mph for speed. Upon applying power to the Handar supply you should hear a faint chirp from the sensor at a ~1 Hz rate, indicating the transducers are functioning.

4.0 Mechanical Interfaces

In general, where Qualimetrics or Handar offered mounting hardware (braces, posts, etc.) in their catalog to mount their sensors, they were ordered and shipped with the system. This includes mounting hardware for all of the sensors (mounted in SARS) and the controller. That said, having never seen the tower, it was impossible to confirm if the mounting hardware is compatible with the tower design and some level on "ingenuity" may be needed to physically attach everything to the tower.

5.0 PC Interface

The system was shipped with a pair of PCs, both of which are configured with identical software to run the weather station. The intent is that one PC should act as a hot spare should the primary fail. Note that one PC has been labeled "primary" as it was found to be reliable even under the harsh temperature conditions (>40 °C) in Tucson during testing while the other PC (not labeled) was found to have problems booting under such high temperatures (but worked fine under more reasonable conditions). Due to cable length constraints with the RS-232 line drivers, the PC must be within ~50 feet of the controller at the base of the tower, which of course dictates the location of the enclosure for the PC relative to the tower. If this turns out to be a problem, there are fallback modes available to increase the distance between the controller and PC (see below), albeit with reduced bandwidth and possibly increased error rates. Alternatively, the StationPac may be mounted on the outside of the PC enclosure (shack) and cables run from the tower base to the controller.

6.0 Qualimetrics Software

Windows 95 is the operating system installed on the PCs. All of the Qualimetrics software can be found under the c:\qsoft directory. The software is basically broken up into a set of 5 programs with supporting configuration files, libraries, etc. The modules necessary to run the controller and log data are configured under the Win95 startup icon, therefore once power is applied to the Qualimetrics

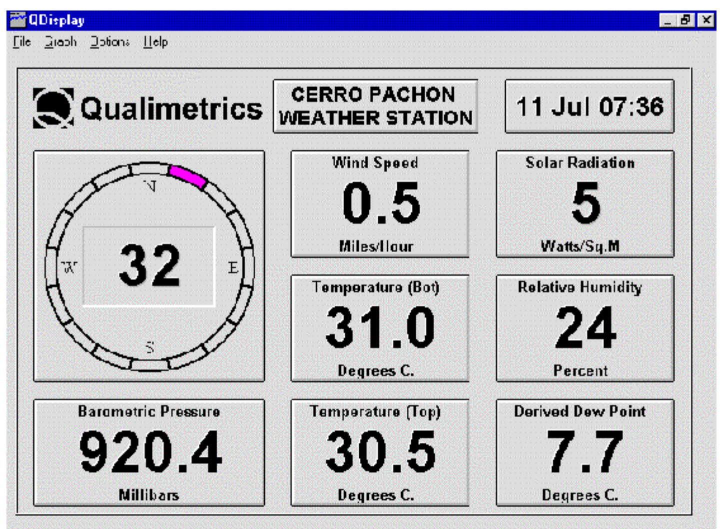

Figure 4 - Representative output from the main display screen generated by qdisplay.exe is shown. Readings from the sensors are updated every 15 seconds on this PC display.

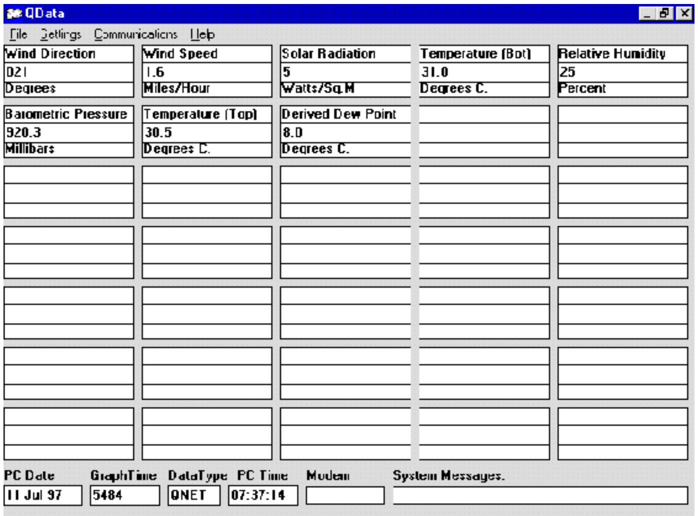

Figure 5 - The program qdata.exe, which establishes communications between the controller and PC, generates the above screen display. The sensor values generated by qdata.exe are identical to those shown graphically by qdisplay.exe.

controller and Handar power supply, the PC will automatically detect and initialize the station's sensors at boot-time. This configuration should make the package fairly impervious to power failures, i.e., it should come back on-line automatically in the event of a power failure at the station.

Refer to the Qsoft manual that was shipped with the system for a detailed description of all the software. For the purposes of this short tech-note, after applying power to the StationPac controller, Handar power supply, then to the PC the system should come on-line automatically and a thorough understanding of the software is not needed to run the station. The software that links the PC to the controller is called qdata.exe. It can be started directly under Win95 or started by running qdisplay.exe, a program that provides a graphical interface (see Figure 4) to the text data displayed by qdata.exe. Running either qdata.exe or qdisplay.exe will also start qrecord.exe, which is the data logging program that basically manages and formats the data read-in from the controller by qdata.exe and sends it periodically to a *.met file in the qsoft directory. The system was configured to update all displayed sensor data at 15 sec intervals. Note that this displayed data is actually an average of many readings taken during each 15 sec period by the controller (the controller handles averaging at faster rates internally). The data logger has been configured to compute the average of these 15 sec updates every 10 minutes and write those 6 lines of averages into a file every hour on the hour. The net result is a file named mmddyynn.met containing 6×24=144 lines of data in the qsoft directory each 24 hour day, i.e., the file generated on August 4, 1997 will be named 08049701.met (nn always equals 01 in the file nomenclature). These files contain ~15 KB of data, hence a huge number of them can be stored onto the PC's disk before it needs to be purged and ~100 of these files can be stored on a single 1.44 MB disk. Shown below is an excerpt from a log file generated when the station was in Tucson for initial integration and debugging.

```
'                  Tmp (Bot) Tmp (Top)   Wnd Spd   Wnd Dir        SR        BP        RH        DP
'                        Avg       Avg       Avg       Avg       Avg       Avg       Avg       Avg
'                          C         C       MPH  Deg(360)     W/m^2        mb         %         C
'
07Jul97 16:10:00        39.6      39.6       2.1       152     606.9     917.6      16.4       9.3
07Jul97 16:20:00        39.6      39.6       1.0       110       7.5     917.7      16.2       9.2
07Jul97 16:30:00        39.6      39.6       1.0       116       7.1     917.6      15.6       8.6
07Jul97 16:40:00        39.7      39.7       1.2       125       6.8     917.6      15.0       8.2
07Jul97 16:50:00        39.7      39.7       0.9       119       6.4     917.6      14.6       7.8
07Jul97 17:00:00        39.7      39.7       1.0       114       6.1     917.5      14.3       7.4
07Jul97 17:10:00        39.6      39.6       1.1       129       5.7     917.4      14.7       7.7
07Jul97 17:20:00        39.4      39.4       1.0       119       5.4     917.4      14.6       7.6
07Jul97 17:30:00        39.4      39.4       1.0       125       4.9     917.3      13.9       6.7
```

Since the weather station is acting like a remote and standalone data logger, we have no way of checking that it is running properly without someone actually looking at the PC screen and confirming that sensor values are reasonable and log files are being generated. It is therefore worthwhile that someone check the system say once a week to make sure it is running properly. If the system is checked-out only on a basis of every ~100 days (the number of daily log files that fit onto a single floppy) a significant amount of weather data may be lost should a catastrophic failure happen to the PC, controller, etc.

6.1 Long RS-232 Cable Support

The system, as shipped, is configured to transmit data in a "continuous" mode across the RS-232 link. This is essentially an open-loop mode without error checking but at the 1200 baud rate used in the RS-232 line, this should work fine for the recommended (and supplied) 50’ cable. Other modes are supported, including a "polling" mode in which the controller stores data internally until polled by the PC. This approach has the disadvantage of requiring slower transmission rates but does support error checking, hence is recommended if a PC-controller cable longer than 50’ is necessary. It is possible to switch over to a polling mode under the "settings" menu in the qdata.exe top-level menu. Other modes including the use of a controller memory card (not purchased with this system) are available. Refer to the Qsoft manual for a more detailed description of these and other modes that the system can run under.

7.0 Help and Long Term Support

If you encounter problems with the installation of the weather station components, e.g., you cannot get a reading from a sensor or the PC doesn’t display data properly, please contact me (520-318-8433) before contacting Qualimetrics. Having fully integrated the controller, sensors, and PC (and debugged some wiring errors in the original Qualimetrics documentation!), I have a reasonably good idea of how the system should behave and can act as your first line of support if problems emerge. If I cannot resolve a problem, we can contact the technical staff at Qualimetrics directly for help.

The data recorded by this station will be permanently archived by the central Gemini Project office. That archive will be openly available to anyone interested in acquiring it, e.g., CTIO or SOAR. Given the size of the log files generated, it will be possible to store well over a year’s worth of data on the PC’s hard disk, hence the PC can certainly be used as a temporary archive until data transmitted to the central Project office has been confirmed as "received and OK". I suggest checking that the weather station is working properly about once a week by looking at the PC display (are the values reasonable?) and checking that *.met files are being generated. Log files should be copied to floppies (compress them first to improve efficiency if you like) between once a week and once a month, depending on your schedule and work load. I hesitate to recommend shipping log files to the Project office less frequently than once a month since there is a chance that we may loose all data on the PC’s disk if it catastrophically fails, and a month of data is as much as I care to lose!