Port Stanley Magnetic Observatory Installation Report 13 – 15 February 2002

Earthquake and Forensic Seismology and Geomagnetism Programme

Internal Report IR/02/14

BRITISH GEOLOGICAL SURVEY

INTERNAL REPORT IR/02/14

Port Stanley Magnetic Observatory Installation Report 13 – 15 February 2002

Christopher Turbitt and Simon Flower

Key words

Geomagnetism, observatory

Front cover

BGS observatory buildings on Sapper Hill

Bibliographical reference

TURBITT, C. W., FLOWER, S. M. . 2002. Port Stanley Magnetic Observatory Installation Report 13 – 15 February 2002. *British Geological Survey Internal Report*, IR/02/14. 51pp.

Edinburgh British Geological Survey 2002

BRITISH GEOLOGICAL SURVEY

The full range of Survey publications is available from the BGS Sales Desks at Nottingham and Edinburgh; see contact details below or shop online at www.thebgs.co.uk

The London Information Office maintains a reference collection of BGS publications including maps for consultation.

The Survey publishes an annual catalogue of its maps and other publications; this catalogue is available from any of the BGS Sales Desks.

The British Geological Survey carries out the geological survey of Great Britain and Northern Ireland (the latter as an agency service for the government of Northern Ireland), and of the surrounding continental shelf, as well as its basic research projects. It also undertakes programmes of British technical aid in geology in developing countries as arranged by the Department for International Development and other agencies.

The British Geological Survey is a component body of the Natural Environment Research Council.

Keyworth, Nottingham NG12 5GG

☎ 0115-936 3241 Fax 0115-936 3488
e-mail: sales@bgs.ac.uk
www.bgs.ac.uk
Shop online at: www.thebgs.co.uk

Murchison House, West Mains Road, Edinburgh EH9 3LA

☎ 0131-667 1000 Fax 0131-668 2683
e-mail: scotsales@bgs.ac.uk

London Information Office at the Natural History Museum (Earth Galleries), Exhibition Road, South Kensington, London SW7 2DE

☎ 020-7589 4090 Fax 020-7584 8270
☎ 020-7942 5344/45 email: bgslondon@bgs.ac.uk

Forde House, Park Five Business Centre, Harrier Way, Sowton, Exeter, Devon EX2 7HU

☎ 01392-445271 Fax 01392-445371

Geological Survey of Northern Ireland, 20 College Gardens, Belfast BT9 6BS

☎ 028-9066 6595 Fax 028-9066 2835

Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB

☎ 01491-838800 Fax 01491-692345

Parent Body

Natural Environment Research Council, Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU

☎ 01793-411500 Fax 01793-411501
www.nerc.ac.uk

Foreword

This report details the modernisation of equipment operating at the Port Stanley magnetic observatory in the Falkland Islands. Port Stanley is one of three overseas magnetic observatories maintained and operated by the British Geological Survey in addition to three in the UK. Measurements are collated in Edinburgh and are primarily used to model the main magnetic field of the Earth.

Acknowledgements

John Riddick of BGS, who installed the original Port Stanley observatory and has made many follow-up visits since, provided valuable help and advice prior to the installation. Our visit, and work carried out thereafter, would not have been possible without the considerable assistance provided by David McLeod of Cable and Wireless and the staff of the Cable and Wireless Earth Station, Port Stanley.

This report is published with the permission of the Executive Director, British Geological Survey (Natural Environment Research Council).

Contents

Tables

Figures

Summary

This report describes the modifications made to the Port Stanley Geomagnetic Observatory during a visit to the Falkland Islands in February 2002. Since the report is intended as a technical reference for observatory operation, the instruments, computing equipment, software and cabling have been described in detail. The modifications were undertaken to ensure the continued supply of high quality geomagnetic data from this observatory, and to this end, there are some further recommendations for future visits listed in the final section of the report.

1 Introduction

The magnetic observatory on Sapper Hill, near Port Stanley, Falkland Islands was installed by the British Geological Survey (BGS) in February 1994 with a proton vector magnetometer (PVM) oriented to measure variations in declination and inclination (dD/dI) as well as field magnitude. After eight years of service, much of the equipment was in need of replacement. In addition, there was a necessity to improve communications and to upgrade the observatory to INTERMAGNET V4.0 standards (INTERMAGNET, 1999). Primarily, the INTERMAGNET standard demanded a sampling rate of 0.2 Hz or higher, whereas the PVM was limited to one complete sample per minute by the lengthy sampling time of the proton precession magnetometer (PPM).

The decision was made to remove the PVM and install a three-component, vector, fluxgate variometer sampling at 1Hz, and run an absolute, scalar PPM in parallel. By adding network communications, observatory data could be retrieved in near real-time, and the status of the recording system could be readily accessed. Timing for the data acquisition was to be maintained using the existing GPS (global positioning system) receiver.

This report describes the work carried out during the installation visit between 13 and 15 February 2002, with a record of the new equipment and software installed, their configuration, and also some of the measurements made during the visit.

2 Observatory Buildings

The fibreglass Cable and Wireless hut, used to house the computer and dD/dI coil switching circuits, has recently been extended and Cable and Wireless moved the BGS equipment from the shelving on the west wall to the north wall. This hut continues to give good protection for the new recording equipment, and provides a reliable power supply and network link.

The wooden sensor hut and absolute observation hut have been retained to provide shelter for the replacement instrumentation, however there are signs of deterioration in both the sensor hut, and to a greater extent, the absolute hut. The principle problem in both huts is a breakdown of the exterior plywood shell, leading to ingress of water. Both the huts will continue to provide sufficient protection over the following year, but steps will need to be taken to either re-clad, or replace the huts within the next twelve months.

The existing cables between the Cable and Wireless hut and the sensor hut remain in good condition. The power and signal cables to the proton precession magnetometer and the cable to the Garmin GPS36 have been reused unaltered, but the cable previously used to apply the biasing currents to the Helmholtz coils was instead used to provide power and communications to the fluxgate magnetometer and analogue-to-digital converter (ADC).

The cable wiring details are described in Appendix E.

3 Proton Vector Magnetometer Observatory

The $\delta D/\delta I$ PVM system was switched off at 15:55 UTC on 13 February 2002 and the Helmholtz coils, the coil switching circuits, the power supply and the GCAT-6000 data logger were removed. Prior to this, two absolute observations were made to provide a final baseline adjustments for the data, plus a final measurement of the total field site difference between the absolute observing position and the PPM sensor. The field difference (absolute site – sensor) was measured for 21 minutes commencing 15:23 on 13 February, and gave a mean of -36.8nT. The absolute observations (1 & 2) are listed in detail in Appendix A and the baselines are summarised in Table 1, along with those from previous years for comparison.

Table 1 PVM System Baseline Adjustments

δD/δI PVM Baseline Adjustments 1994-2002				
Date	Declination	Inclination	Horizontal Component	Vertical Component
Feb 1994	18.5'	-2.5'	-17.9nT	-13.1nT
Jan 1995	15.1'	-1.2'	-9.6nT	-5.8nT
Feb 1996	19.0'	2.5'	9.1nT	22.2nT
Feb 1997	16.7'	1.3'	0.4nT	17.0nT
Mar 1998	4.8'	3.7'	10.4nT	36.6nT
Feb 1999	4.7'		-10.5nT	33.4nT
Feb 2000	3.8'		-18.8nT	41.0nT
Feb 2001	5.7'		-11.3nT	37.9nT
Feb 2002	4.6'	2.7'	-6.9nT	42.8nT

The measured total field site difference was used to correct the δD/δI PPM data to the absolute observation site. The δD/δI data were converted to quasi-absolute components using estimated baselines of 270.0' for declination and –2900.0' for inclination and the baseline adjustments recorded in Table 1 show the differences between these quasi-absolute data and those observed. The differences are to be added to the quasi-absolute data to correct them to the absolute data.

On arrival, the internal clock of the GCAT-6000 PC was found to be set to an incorrect date and time. When the δD/δI logging system was moved by Cable and Wireless, it was powered down and dismantled. When reassembled, the GPS was not reconnected and the date was set to the PC's default date (1 January 1980). Immediately before the absolute observations were made, the date and time were set correctly, however the preceding data remain to be corrected. For reference, at 12:40:00 on 13 February 2002, the PC time read 12 January 1980 at 19:02:05.

The PVM power supply, the coils, the switching circuits and the data logger have been donated to the Falkland Islands Museum and National Trust, Holdfast Road, Port Stanley. The Synergetics Meteosat transmitter, with its power supply, baud rate converter and synchroniser, have been returned to Edinburgh, while the PPM and GPS receiver have been reused in the new installation.

4 Fluxgate Magnetometer Observatory

The PVM system has been replaced with a Danish Meteorological Institute (DMI) fluxgate magnetometer. GPS-timed, one-second samples are made of the fluxgate magnetometer's three magnetic channels along with one temperature channel. Once digitised, the samples are stored and filtered, using a 90-second Gaussian filter, to one-minute data points. In addition, the Geomag SM90R proton precession magnetometer is sampled every 10 seconds and also these data are reduced to one-minute values. One-minute data are both written to floppy disk and stored within the data logger to allow data to be manually sent to Edinburgh, retrieved automatically, and also provide a local backup. Remote access to the data and the operating system is possible via a network link, although it is anticipated that the usual route for the one-minute, floppy disk data to be returned to Edinburgh is by e-mail.

A block diagram of the replacement system is given in Figure 2.

4.1 FLUXGATE MAGNETOMETER AND ADC

The main observatory magnetometer is a DMI FGE fluxgate magnetometer (serial number E0244) with a suspended, triaxial sensor (S0216). The magnetometer has a range of ±4000 nT in each of its three magnetic components (approx. 400 nT/Volt) and a scale of 5 mV/K in its temperature channel. The triaxial sensor block was oriented such that one sensor was vertical (Z-sensor), one sensor was aligned along the instantaneous component of the magnetic vector in the horizontal plane (H-component) and the third sensor aligned perpendicular to both sensors in the horizontal plane (D-sensor).

The sensor rests on the concrete pillar in the wooden sensor hut with the electronics thermally insulated from the concrete floor by a wooden board. It is insulated against external temperature fluctuations by a 500 x 500 x 550 mm polystyrene cover.

The analog-to-digital (ADC) module (GMAG-FGAD.006) is located by the fluxgate electronics and contains two ADAM-4017, 16-bit converters. The first converter (address 01) has a dynamic range of ±5 Volts (±2000 nT), and a resolution of 0.1 mVolt. If the converter over-ranges, the acquisition software will automatically switch to the second converter (address 02), which has been configured with a dynamic range of ±10 Volts and resolution of 1mV.

The fluxgate magnetometer, the ADAM-4017 modules and an ADAM-4520 module are powered from the 18 Volt line of the DC power supply (GMAG-PSU.001). The ADAM-4520, mounted within the power supply, is used to convert the RS485 output of the ADAM-4017 module to RS232 level, suitable for the recording PC. The power supply is housed with the recording PC in the Cable and Wireless hut and is connected to the sensor hut via a four-core screened cable as shown in Appendix E.

The DMI fluxgate magnetometer was, by default, configured for operation at mid-latitudes in the Northern Hemisphere, where the horizontal magnetic component (H) is in the range 0 to 32000 nT and the vertical component (Z) is in the range 32000 to 64000nT. The fluxgate therefore required modification for installation at Port Stanley, where H and Z are approximately 19000 nT and –22000 nT respectively. Firstly, the fixed 32000 nT bias field on Z was disabled by removing the link between the bias generator and the bias coils (resistor R50), giving a Z bias field range of 0 to 32000 nT. Secondly, the direction of the Z bias field was reversed by swapping the two wires (blue and orange) to the Z bias coil within the magnetometer sensor. This allows a bias field between –32000 and 0 nT to be applied, but also inverts the magnetometer outputs on the Z channel. Hence the calibration value for the Z component has been entered as negative in the software configuration file (Appendix C).

4.2 PROTON PRECESSION MAGNETOMETER

Once the coils were removed and the fluxgate magnetometer sensor sited on the concrete pillar in the sensor hut, the proton precession magnetometer (PPM) sensor was fixed to the roof in the SW corner of the hut, sufficiently far from the fluxgate sensor to avoid interference.

The PPM electronics box (Geomag SM90R, S/N 61528) sits on the floor of the hut beside the PPM voltage regulator box. The regulator box has been used since the original installation to regulate the +18 Volts from the DC power supply down to +12 Volts for the PPM and its details are documented in Riddick et al., 1995. With the inclusion of the new power supply, the supply voltage to the box is a maximum of 13.8 Volts, and this regulator box no longer serves any purpose. It is recommended that the box is removed during the next service visit.

The repositioning of the PPM sensor has caused a slight change in the site difference. The new site difference between the site of the absolute observations and the repositioned PPM sensor is given in Section 8.

The calibration carried out on the PPM during the installation is listed in Appendix B, along with that carried out on the auxiliary Gem Systems GSM-19 PPM, used for the site difference measurement.

4.3 GPS TIMING

The existing Garmin GPS36 antenna/receiver has been re-used to provide a time reference against which the time and date on the acquisition system are synchronised to within 0.2 second of UTC. From its position inside the sensor hut, the antenna has a sufficiently unobstructed view of the sky to provide a time solution for most of the time, and is distant enough from any Cable and Wireless transmission equipment to avoid interference.

The antenna cable has been routed via the lightning-suppression box to the DC power supply. The power supply provides the 12 Volts necessary for the antenna and also a 9-way D-type connector from which the RS232 NMEA signal from the receiver is routed to COM1 on the logging PC.

4.4 POWER SUPPLY

The fluxgate magnetometer, the ADC, the PPM and the GPS are powered via a mains-to-DC converting power supply (GMAG-PSU.001), which produces a +15 Volt and a +13.8 Volt (nominally 12 Volt) output and provides breakout for the GPS signal and also conversion from RS485 to RS232 for the ADC signal. The circuit diagrams for the power supply are given in Figure 4 and Figure 5.

A single 12 V, 24 Ah battery is connected to the +13.8 V output of the supply to provide up to 10 hours of standby power in the event that mains power is lost to the observatory.

All of the connections from the power supply to the batteries, magnetometers, GPS and ADC are detailed in Appendix E.

4.5 LIGHTNING SUPRESSION

The power and signal lines for the PPM, the fluxgate magnetometer and the GPS have been routed through one of two lightning suppression boxes to provide protection from externally induced current surges in any of the cables. One box is mounted on the wall of the Cable and Wireless hut, while the other has been placed on the top shelf, above the logging equipment.

The wiring diagram of the lightning suppression box is given in Figure 9. The boxes contain Furse 30E and 15D suppression modules, which are connected to earth using a grounding spike external to the Cable and Wireless hut.

4.6 DATA RECORDING PC AND CONFIGURATION

The data logger installed at Port Stanley observatory is a DSP Design TP400 embedded PC (GMAG-QPC.01-016) with 64 Mb memory, floppy disk drive and a 2.5 inch, 30 Gbyte hard disk drive. The processor card provides a parallel port, and four serial ports, 10/100 base-T Ethernet, mouse and keyboard ports and VGA output and has been set to operate at 200 MHz.

An additional printed circuit board (PCB) has been included to convert the TTL level of COM4 to RS232. Note that COM4 has only a three-wire connection – Rx, Tx and GND. The four serial ports and their connections are listed in Table 2. The parallel port on the motherboard is not used.

Table 2 Serial Port Settings

Port	QNX Port Name	Type	Address	Interrupt	Device
COM1	/dev/ser1	9-way male	0x3F8	IRQ4	GPS
COM2	/dev/ser2	9-way male	0x2F8	IRQ3	ADAM-4520
COM3	/dev/ser3	9-way male	0x3E8	IRQ5	PPM
COM4	/dev/ser4	9-way male	0x2E8	IRQ9	Not connected

The PC is powered from the 12 Volt output of the DC power supply. This is converted internally to 5 Volts using a NFC10-12S05 10 Watt DC-DC converter. In this installation, the 12 Volts supply has been rewired to bypass the switch on the front panel to avoid the power being accidentally switched off as has commonly occurred during floppy-disk changes.

4.7 REMOTE COMMUNICATIONS

Prior to the visit, Cable and Wireless installed an Ethernet link and router, giving a single IP port in the equipment hut. This provides a means of access from Edinburgh to the operating system of the Port Stanley logger and also enables files to be received or transmitted, allowing the logger to be remotely monitored, changes or upgrades implemented and data retrieved.

The Ethernet link is defined by the following addresses:

IP Address: 195.248.193.234

Router Address: 195.248.193.233

Subnet Mask: 255.255.255.252

The hostname is, as yet undefined, but may be configured by Cable and Wireless in the future. The router configuration has been listed in Appendix D.

5 Replacement Observatory Software

The introduction of a real-time, multi-tasking operating system in the form of QNX 4.25j has enabled a more versatile data acquisition system to be developed and has allowed features, such as a graphical display and multiple data output, to be added. The Port Stanley observatory is running a beta version of the BGS SDAS v0.2 data acquisition software (Date: 24 January 2002), which simultaneously takes samples from the ADC and proton precession magnetometer synchronised to the GPS receiver time (UTC). Raw data are stored in an internal ring buffer in both unfiltered and one-minute filtered form. Additionally, Flare *Plus* format data are written to the internal hard disk and, optionally, to an external DOS-formatted floppy disk. QNX also allows remote access to the operating system, the acquisition system (SDAS) and data via the network link.

5.1 SOFTWARE CONFIGURATION

In the system configuration file /etc/config/sysinit.1, the acquisition software has been configured to launch automatically once the operating system starts. This file also defines the operating system drivers for the serial ports and disks.

Although some of the SDAS acquisition utilities require ‘root’ privilege, all are launched from the ‘sdas’ user ID. The account for this ID resides under the directory /home/sdas and contains all of the acquisition software, the acquisition configuration files and the locally recorded data. The significant directories for the acquisition are:

/home/sdas/bin	- Contains all of the acquisition executables and the main scripts
/home/sdas/config	- Files containing the configurable parameters for the acquisition
/home/sdas/data/wave	- Ring buffer directory. Each individual data channel is written to a separate directory; chan_00, chan_01, etc.
/home/data/archive	- Location of extracted one-minute filtered data in Flare *Plus* format
/home/data/log	- Location of log files containing errors, warnings and status messages created by the acquisition software
/dos/a	- The DOS format floppy disk, to which a copy of the contents of /home/data/extract are written

The files in the configuration directory (/home/sdas/config) have been created to reflect the type of ADC, PPM and GPS used at the Port Stanley observatory, as well as the ADC and fluxgate magnetometer calibration parameters so that the output data are correctly scaled to nanoTesla. The significant files in this directory are:

/home/sdas/config/general.cfg	- Sets the parameters required by the acquisition clock, lists utilities to be started before and after the acquisition software and also sets some of the necessary directory paths for output files.
/home/sdas/config/acquire.cfg	- Instructs the acquisition software as to which drivers are to be started in order to collect data. Any parameters required by the drivers are set here, as are the serial port settings.

/home/sdas/config/channels.cfg - This file is used to set the characteristics of each individual channel. The parameters here are linked to those in acquire.cfg, but this is the file where the channel names and calibrated conversion factors are set.

/home/sdas/config/schedule.cfg - Configuration file for the SDAS schedule program. The schedule program executes utilities defined in this file at the allocated times. Utilities include extracting data from the ring buffer and deleting data and log files.

/home/sdas/config/archive.ext - Configuration file for the extract utility, describing the Flare*Plus* format and the location of output files on the hard drive.

/home/sdas/config/flare.ext - Identical to 'archive.ext', except that the location of the output file is set to the floppy disk rather than the hard drive.

The contents of these configuration files have been recorded in Appendix C, along with the contents of the system configuration file /etc/config/sysinit.1. In this configuration, the channel numbers with which the data are recorded are listed in Table 3.

Table 3 Input Data Channel Numbers

Channel Number	Channel Name	Recording Interval	Channel Unit
0	H-component	1 second	µVolts
1	D-component	1 second	µVolts
2	Z-component	1 second	µVolts
3	Temperature	1 second	µVolts
4	PPM F value	10 seconds	0.01 nTesla
5	Filtered H-component	1 minute	0.1 nTesla
6	Filtered D-component	1 minute	0.1 nTesla
7	Filtered Z-component	1 minute	0.1 nTesla
8	Filtered Temperature	1 minute	0.1 °C
9	Filtered PPM F value	1 minute	0.1 nTesla

5.2 DATA FILES

To allow the of use existing processing software with the minimum of modification, the extracted one-minute filtered data from the fluxgate and proton magnetometers are written in Flare *Plus* format. The data are stored on the hard-disk in 36000-byte day files with the name *yyyymmdd*.fkqa; where *yyyy* is the four-digit year, *mm* is the two-digit month and *dd* is the two-digit day. Each one-minute record is a 25-byte C structure, with Intel byte order, of the form:

```
struct FILE_DATA{
     char mon,day;
```

```
        char hr,min;
        long vh,vd,vz,vt,pf;
        char proton_sn;
    };
```

Where:

mon	is the month
day	is the day of the month
hr	is the hour
min	is the minute
vh	is the fluxgate variometer horizontal component (0.1 nT)
vd	is the fluxgate variometer declination component (0.1 nT)
vh	is the fluxgate variometer vertical component (0.1 nT)
vt	is the fluxgate sensor temperature (0.1 °C)
pf	is the PPM field magntitude (0.1 nT)
proton_sn	is the PPM signal to noise indicator. Since this is not recorded here, it is always set to ‘x’.

The amount of data stored in the hard disk archive and the floppy disk is dictated by the size of the respective disks. A 1.44 Mbyte floppy disk has a capacity of 40 days, and should therefore be changed once per month. The hard disk has such a large capacity that it should hold many years of archived data. The amount of ring buffer data, however, is regulated and older files are deleted by the ‘hourly_proc’ script. The size of the ring buffer is set in ‘general.cfg’ to 40000 hours (over 1600 days), while the size of the error log is set to 30 days.

6 Absolute Observations and Variometer Baselines

Once the installation was complete, preliminary baselines for the fluxgate magnetometer were derived from five absolute observations (3 to 7). The memorial cross on the top of Tumbledown Mountain (Riddick, 1994) was used as a true north reference. The observations were made using the observatory fluxgate theodolite and are listed in detail in Appendix A. The baselines are summarised in Table 4.

Table 4 Fluxgate Magnetometer Baselines

Observation	Declination	Horizontal Component	Vertical Component
3	3° 56' 25"	19208.6 nT	-22002.1 nT
4	3° 56' 55"	19207.0 nT	-22003.4 nT
5	3° 56' 29"	19205.6 nT	-22004.6 nT
6	3° 56' 00"	19206.7 nT	-22004.2 nT
7	3° 56' 08"	19205.7 nT	-22005.1 nT
Mean	**3° 56' 23''**	**19206.7 nT**	**-22003.9 nT**

There may be an error introduced to the absolute observations by some of the various radio transmitters sited on Sapper Hill and operated by Cable and Wireless, amongst others. With the fluxgate theodolite on the tripod in the absolute observing hut, and the fluxgate electronics outside of the hut so that the joining cable was laid in a straight line between the two, it was possible to induce changes in the fluxgate reading of over 10 nT by lifting the cable a few inches off the ground, i.e. changing the location of the cable within the electromagnetic field generated by the transmitters. This effect was difficult to quantify, but appeared to diminish closer to the sensor hut, although not to zero. The sensor hut is not within the main lobe of transmitted power defined by the antennas mounted on the Cable and Wireless mast, whereas the absolute hut is. It is likely that the fluxgate and proton magnetometers are not measurably affected by the transmission, but the recorded data and subsequent baselines should be analysed with this possibility in mind.

As can be seen from the repeatability, this effect has not significantly affected the quality of the baselines derived from absolute measurements conducted during the installation.

7 Fixed Mark Bearing

The bearing from the absolute observation position to the fixed reference mark has previously been measured to be 281° 31' 01" with respect to True North (Riddick, 1999). This fixed mark, the memorial cross on Tumbledown Mountain, was used to derive declination from the absolute observations. Although the Tumbledown bearing was not re-determined, the bearing from the observation mark to an auxiliary fixed mark was measured against it. The auxiliary mark is the left-hand edge of the visible metal peg protruding from the concrete base of a former gun emplacement. The gun emplacement is located on top of the rocky outcrop overlooking the absolute observing position on Sapper Hill.

Hence, the bearing of the auxiliary fixed mark with respect to True North was measured as 1° 43' 57" (Appendix A).

8 Total Field Site Differences

Once the PPM sensor had been moved to its new position in the sensor hut as described in Section 4.2, the difference in the total field intensity was measured between the new location and the absolute observation site by running a second PPM at the over the absolute mark, at the same height as the theodolite. The second magnetometer was a Gem Systems GSM19 (S/N 701595).

A total of 48 one-minute samples were taken from both proton magnetometers, beginning at 15:22 UTC on 14 February. The mean difference between them (Absolute site – observatory PPM site) was -28.2 nT. This compares to a site difference of -36.7 nT measured at the original location.

9 Instrument Calibrations

Appendix B lists the on-site calibrations of the ADC, the fluxgate and proton precession magnetometers, as well as calibrations carried out prior to shipment for comparison. The calibrations performed during the installation concur with those carried out at Eskdalemuir observatory and verify the correct operation of the magnetometers. In addition, the alignment angles between the elements of the fluxgate magnetometer sensor were measured to be within the manufacturer's specification of 2 mrad, ensuring that no damage had been sustained during transportation.

10 Temperature Records

During the previous visit, a Tinytalk temperature logger (S/N 26851) was left in the sensor hut to take two-hourly samples of the ambient temperature of the instruments. These data were recovered and the logger re-launched on 14 February. The recovered data have been plotted in Figure 1.

11 H.M.S Endurance Magnetometer

BGS have loaned an Elsec 820 proton precession magnetometer (S/N 147) to the crew of the Royal Navy survey ship, H.M.S Endurance for use during their annual survey mission in the South Atlantic. During their mission, the magnetometer was reported to have developed a fault whereby it had been giving spurious values, occasionally jumping hundreds of nanoTesla between samples. Since this magnetometer had been left with Cable and Wireless, Port Stanley for repair, it was tested during the visit, as was another Elsec 820 (S/N GM109/A3), previously used as the observatory auxiliary magnetometer. Both magnetometers tested and calibrated satisfactorily so both were left with Cable and Wireless for collection by the crew of H.M.S Endurance, along with some suggestions to improve the quality of the magnetometer readings.

Details of the calibrations for both of the Elsec 820 magnetometers are given in Appendix B.

12 Conclusions and Recommendations for Future Visits

Port Stanley observatory was successfully upgraded from a proton vector magnetometer observatory, sampling at one-minute intervals, to a 1Hz fluxgate magnetometer observatory with GPS timing and remote network access. Where possible, existing equipment and cabling were re-used, but a new sensor, power supply and data recorder were installed. At the point of completion, all of the replacement observatory equipment was operating satisfactorily and despite the observed interference in the absolute observations, the magnetometer baselines were consistent.

Should successive absolute observations show that the level of external radio interference is sufficiently high to adversely affect the quality of observatory baselines, it will be necessary to implement measures to reduce the effect. Some such measures include: reducing the length of the cable between the fluxgate magnetometer sensor on the theodolite and the electronics; improving the shielding of the magnetometer electronics; shielding the inside of the hut using a Faraday cage, possibly by cladding the inside of the hut with aluminium sheet or foil; or, ultimately, moving the absolute observing position.

The network communications provided by Cable and Wireless allow data to be readily transferred to Edinburgh, and also give remote access to the operating system. The status of the observatory can now be regularly monitored from Edinburgh, and should a problem arise it can be investigated remotely and, if necessary, software upgrades implemented.

The wiring through the lightning suppression box, as described in Figure 9, should not affect the voltages or signals passing through, however, the GPS signal Rx and Tx lines have been wired through the same '15D' module, which could potentially cause loss of GPS data. These data lines should be wired through separate modules, with the GPS ground line as the common reference. During a future visit, this will entail moving the GPS Tx line (blue wire) to the free '15D' module adjacent to the current module, and also linking the GPS ground connection (green wire) from the '30D' module across to the two '15D' modules with the GPS signals. The current configuration, however, is not causing any loss of GPS data.

As described in Section 4.2, the PPM regulator box is superfluous and should be removed during a future visit.

Of immediate concern is the state of the sensor and absolute huts as described in Section 2. The observed deterioration of the huts is already leading to water leaking into the huts and the huts are estimated to have a further useful life of twelve months. Efforts are currently under way to replace the huts with non-magnetic, fibre glass shelters, which should last for at least a further ten years.

Glossary

PPM Proton Precession Magnetometer – a scalar, full-field instrument, capable of giving a quasi-absolute measurement of the magnetic field.

SDAS Simple Data Acquisition Software – a BGS-developed set of programs which operate under the QNX operating system.

UTC Coordinated Universal Time – a global time reference, used to relate observations between observatories.

ADC Analog-to-digital converter – Used to convert the analog output of an instrument to a digital record for recording and transmission.

QNX A UNIX-like, real-time, multitasking operating system for personal computers.

Fluxgate Abbreviation of fluxgate magnetometer – a vector magnetometer, here composed of three orthogonally-mounted elements.

PSU Power Supply Unit – A device for providing electrical power to another device or instrument, usually by conditioning another electrical power source.

Variometer An instrument which only measures variations of a natural element with respect to a fixed offset value, rather than measuring the true (absolute) value.

GPS Global Positioning System – A system consisting of an array of 24 satellites, base stations and remote receivers which has been designed to give accurate position and time.

PC Personal Computer – a term used to describe a computer capable of operating independently of other computers, typically based on the Intel 8086 chipset.

References

Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

INTERMAGNET TECHNICAL REFERENCE MANUAL, 1999, *US Geological Survey*, Box 25046 MS968, Denver, CO 80225-0046, USA.

RIDDICK, J. C. AND HARRIS, T. J., 1994, Falkland Islands Magnetic Observatory Installation Report, *BGS Technical Report* WM/94/18

RIDDICK, J. C., TURBITT, C. W., MCDONALD, J., 1995, The BGS Proton Magnetometer (dD/dI) Observatory Mark II System, Installation Guide and Technical Manual, *BGS Technical Report* WM/95/32

RIDDICK, J. C., Report on Falkland Islands Magnetic Observatory Service Visit, 7 13 February 2001

Appendix A Absolute Observations

The following entries list the manual measurements made at the Port Stanley observatory absolute observing site using a fluxgate theodolite magnetometer. These null-method measurements are used to determine a precise vector measurement of the magnetic field to estimate the offsets, or baselines, of the vector variometer instrument. The variometer in question for measurements 1 and 2 was the dD/dI proton vector magnetometer, while the other measurements were determined for the fluxgate magnetometer.

ABSOLUTE MEASUREMENT 1

```
Absolute Observation                       Observatory:  Port Stanley
Date: 13 2 2002    Observer:     CWT   Theodolite:   Bartington


True North Circle -

Fixed Mark Circle Right:          242 24 47
Fixed Mark Circle Left:           062 24 47
Fixed Mark Circle Mean:           062 24 47

Fixed Mark True North Bearing:    281 31 01
True North Circle:                140 53 46

Declination -
   Time Circle              δD/δI Declination Values

WU 1305 054 46 29                     003 51 23
EU 1307 234 56 16                     003 51 33
WD 1308 234 54 18                     003 51 39
ED 1310 054 42 15                     003 51 44
Mean:   144 49 50           Mean:     003 51 35

Dec :   003 56 04           Dec-δD:   000 04 29

Inclination -
   Time Circle                          δD/δI    H         Z         F
NU 1321 131 11 13    048 48 47                 19246.8  -22086.1   29295.7
SD 1322 311 11 56    048 48 04                 19246.6  -22086.4   29295.8
SU 1326 048 57 51    048 57 51                 19246.0  -22085.4   29294.7
ND 1325 228 58 40    048 58 40                 19245.5  -22086.1   29294.8
             Inc:    048 53 20        Mean:    19246.2  -22086.0   29295.2

Site Difference:    -36.8          Absolute       δD/δI        Difference
Corrected F:      29258.5    H:     19238.0      19246.2           -8.2
                             Z:    -22044.4     -22086.0           41.6
                             Inc: -048 53 20   -048 55 49      000 02 29
```

ABSOLUTE MEASUREMENT 2

```
Absolute Observation                  Observatory:  Port Stanley
Date: 13 2 2002    Observer:     CWT   Theodolite:   Bartington


True North Circle -

Fixed Mark Circle Right:          242 24 38
Fixed Mark Circle Left:           062 24 38
Fixed Mark Circle Mean:           062 24 38

Fixed Mark True North Bearing:    281 31 01
True North Circle:                140 53 37

Declination -
   Time Circle                 δD/δI Declination Values
WU 1355 054 48 41                        003 53 53
EU 1357 234 59 38                        003 54 20
WD 1359 234 57 34                        003 54 23
ED 1400 054 44 14                        003 54 29
Mean:   144 52 32              Mean:     003 54 16
Dec :   003 58 55              Dec-δD:   000 04 39

Inclination -
   Time Circle                            δD/δI    H         Z          F
NU 1409 131 12 32    048 47 28                  19238.9  -22086.3   29290.6
SD 1411 311 10 56    048 49 04                  19238.4  -22086.7   29290.5
SU 1416 048 58 36    048 58 36                  19239.4  -22085.8   29290.5
ND 1414 228 59 14    048 59 14                  19239.1  -22086.2   29290.7
             Inc:    048 53 36         Mean:    19239.0  -22086.2   29290.6

Site Difference:    -36.8           Absolute       δD/δI        Difference
Corrected F:      29253.8    H:      19233.3      19239.0           -5.6
                             Z:    -22042.3     -22086.2            44.0
                             Inc: -048 53 36   -048 56 29      000 02 54
```

ABSOLUTE MEASUREMENT 3

Date	14-Feb-02							
Circle Left	99	39	27	99.6575		F site Diff	-28.2	
Circle Right	279	39	29	279.6581				
Mean	189	39	27	189.6578				
FM True	281	31	1	281.5169				
TN Circle	178	8	26	178.1408				
						Flare D		
ED	18:58	92	5	32	92.0922	52.8		
WD	18:46	272	20	55	272.3486	57.5		
EU	18:51	272	19	57	272.3325	55.4		
WU	19:01	92	11	52	92.1978	51.3		
Mean	18:54	182	14	33	182.2428	54.3		
Declination		4	6	7	4.1019			
						Flare H	Flare Z	Flare F
NU	19:08	131	10	8	-48.8311	42.2	-33.4	29288.3
SD	19:13	311	14	19	-48.7614	41.8	-33.6	29288.1
ND	19:20	228	57	45	-48.9625	40.9	-34.0	29287.9
SU	19:17	48	53	8	-48.8856	40.9	-33.7	29287.8
Mean	19:14	-48	51	36	-48.8601	41.5	-33.7	29288.0
							Corrected	29259.8
	Flare	Absolute	Baseline					
H	41.5	19250.0	19208.6					
D	0.1615	4.1019	3.9405	3	56	25		
Z	-33.7	-22035.7	-22002.1					

Collimation	
Dec. d	-0.022
Dec. e	-0.085
Dec. Zo	-10.2
Inc. e	-0.064
Inc. Zo	18.7

ABSOLUTE MEASUREMENT 4

Date	14-Feb-02							
Circle Left	99	40	45	99.6792		F site Diff	-28.2	
Circle Right	279	40	42	279.6783				
Mean	189	40	43	189.6788				
FM True	281	31	1	281.5169				
TN Circle	178	9	42	178.1618				
						Flare D		
ED	19:52	92	2	6	92.0350	32.3		
WD	19:51	272	18	44	272.3122	32.9		
EU	19:58	272	15	56	272.2656	30.8		
WU	19:56	92	8	33	92.1425	31.4		
Mean	19:54	182	11	19	182.1888	31.9		
Declination		4	1	37	4.0270			
						Flare H	Flare Z	Flare F
NU	20:09	131	11	57	-48.8008	40.6	-33.1	29286.9
SD	20:10	311	14	14	-48.7628	40.5	-32.9	29286.8
ND	20:05	228	57	52	-48.9644	40.6	-33.0	29287.0
SU	20:07	48	55	50	-48.9306	40.6	-33.1	29286.9
Mean	20:07	-48	51	52	-48.8647	40.6	-33.0	29286.9
							Corrected	29258.7
	Flare	Absolute	Baseline					
H	40.6	19247.5	19207.0					
D	0.0948	4.0270	3.9322	3	55	55		
Z	-33.0	-22036.4	-22003.4					
Collimation								
Dec. d	-0.015							
Dec. e	-0.087							
Dec. Zo	-12.9							
Inc. e	-0.083							
Inc. Zo	9.2							

ABSOLUTE MEASUREMENT 5

Date	14-Feb-02							
Circle Left	99	40	38	99.6772		F site Diff	-28.2	
Circle Right	279	40	38	279.6772				
Mean	189	40	38	189.6772				
FM True	281	31	1	281.5169				
TN Circle	178	9	37	178.1603				
						Flare D		
ED	20:22	92	2	35	92.0431	24.8		
WD	20:20	272	16	46	272.2794	25.3		
EU	20:18	272	16	14	272.2706	26.2		
WU	20:17	92	7	10	92.1194	26.1		
Mean	20:19	182	10	41	182.1781	25.6		
Declination		4	1	4	4.0178			
						Flare H	Flare Z	Flare F
NU	20:28	131	12	1	-48.7997	40.7	-31.6	29285.9
SD	20:29	311	13	2	-48.7828	40.8	-31.6	29285.9
ND	20:31	228	57	1	-48.9503	40.6	-31.4	29285.7
SU	20:33	48	55	55	-48.9319	40.4	-31.4	29285.6
Mean	20:30	-48	51	58	-48.8662	40.6	-31.5	29285.8
							Corrected	29257.6
	Flare	Absolute	Baseline					
H	40.6	19246.2	19205.6					
D	0.0762	4.0178	3.9416	3	56	29		
Z	-31.5	-22036.1	-22004.6					

Collimation	
Dec. d	-0.017
Dec. e	-0.085
Dec. Zo	-7.2
Inc. e	-0.075
Inc. Zo	4.5

ABSOLUTE MEASUREMENT 6

Date	15-Feb-02							
Circle Left	99	40	32	99.6756		F site Diff	-28.2	
Circle Right	279	40	27	279.6742				
Mean	189	40	29	189.6749				
FM True	281	31	1	281.5169				
TN Circle	178	9	28	178.1579				
						Flare D		
ED	13:28	91	57	0	91.9500	-9.0		
WD	13:27	272	8	25	272.1403	-9.7		
EU	13:31	272	10	1	272.1669	-7.7		
WU	13:30	92	0	23	92.0064	-8.0		
Mean	13:29	182	3	57	182.0659	-8.6		
Declination		3	54	28	3.9080			
						Flare H	Flare Z	Flare F
NU	13:41	131	14	28	-48.7589	51.0	-12.5	29278.8
SD	13:43	311	16	5	-48.7319	51.2	-12.5	29278.8
ND	13:38	228	54	40	-48.9111	51.6	-12.7	29279.3
SU	13:39	48	53	36	-48.8933	51.6	-12.6	29279.1
Mean	13:40	-48	49	25	-48.8238	51.4	-12.6	29279.0
							Corrected	29250.8
	Flare	Absolute	Baseline					
H	51.4	19258.0	19206.7					
D	-0.0256	3.9080	3.9336	3	56	0		
Z	-12.6	-22016.7	-22004.2					

Collimation	
Dec. d	-0.021
Dec. e	-0.077
Dec. Zo	-2.5
Inc. e	-0.078
Inc. Zo	5.7

ABSOLUTE MEASUREMENT 7

Date	15-Feb-02							
Circle Left	99	40	17	99.6714		F site Diff	-28.2	
Circle Right	279	40	17	279.6714				
Mean	189	40	16	189.6714				
FM True	281	31	1	281.5169				
TN Circle	178	9	15	178.1544				
						Flare D		
ED	13:54	91	59	14	91.9872	2.6		
WD	13:53	272	10	4	272.1678	2.1		
EU	13:59	272	12	1	272.2003	4.7		
WU	13:57	92	2	42	92.0450	4.1		
Mean	13:55	182	6	0	182.1001	3.4		
Declination		3	56	44	3.9456			
						Flare H	Flare Z	Flare F
NU	14:04	131	14	20	-48.7611	50.6	-12.0	29278.1
SD	14:05	311	15	53	-48.7353	51.3	-11.8	29278.4
ND	14:09	228	54	54	-48.9150	51.3	-11.4	29278.2
SU	14:11	48	53	27	-48.8908	51.5	-11.4	29278.2
Mean	14:07	-48	49	31	-48.8256	51.2	-11.7	29278.2
							Corrected	29250.0
	Flare	Absolute	Baseline					
H	51.2	19256.9	19205.7					
D	0.0100	3.9456	3.9356	3	56	8		
Z	-11.7	-22016.7	-22005.1					
Collimation								
Dec. d	-0.023							
Dec. e	-0.073							
Dec. Zo	-2.1							
Inc. e	-0.077							
Inc. Zo	6.4							

AUXILLIARY FIXED MARK TRUE NORTH BEARING

Tumbledown Mt. FM	Circle Left	279	40	28	279.6744
	Circle Right	99	40	27	99.6742
	Mean	189	40	27	189.6743
Auxilliary FM	Circle Left	359	53	24	359.8900
	Circle Right	179	53	22	179.8894
	Mean	269	53	22	269.8897
Aux. FM Relative Bearing		80	12	55	80.2154
Tumbledown True North bearing		281	31	1	281.5169
Auxilliary True North bearing		1	43	56	1.7324

Appendix B Instrument Calibrations

This section details the calibrations carried out on the various instruments during the installation visit, plus a calibration of the fluxgate magnetometer prior to shipment to the Falkland Islands.

FLUXGATE MAGNETOMETER CALIBRATION, 2 MAY 2002

Date	2-May-01				
			Approx.H	17000	nT
Fluxgate	**Type**	**Serial No.**	Approx.Z	45000	nT
Sensor	FGE	S0216			
Electronics	FGE-89E	E0244			

Resisitor	**Serial:**	**Value:**	1001	**Ohms**
DVM	**Type:**	**Serial:**		**Calibrated:**
Temperature				

	Horizontal Component			Declination			Vertical Component		
	H+	**H0**	**H-**	**D+**	**D0**	**D-**	**Z+**	**Z0**	**Z-**
Vout	8.7115	-0.0429	-8.7677	8.6412	-0.0498	-8.7427	8.8822	0.097	-8.6784
R Voltage	90.154	0	-90.178	90.167	0	-90.178	90.167	0	-90.184
Vout Range		17.4792			17.3839			17.5606	
I Range		0.1801518			0.1801648			0.1801708	
Coil Const.		38600			38593			38601	
Field Range		6953.8613			6953.1015			6954.7742	
Flux. Calibration		397.83636	**nT/V**		399.97362	**nT/V**		396.04422	**nT/V**

ADC AND FLUXGATE MAGNETOMETER CALIBRATION, 14 FEBRUARY 2002

SDAS System	fkqa	**Observatory**	PST	**Date**	14-Feb-02		
Observer	CWT	**DVM Type**	Fluke 45	**DVM S/N**	7484037	**DVM Cal. Date**	25-Jan-02
Flux Elect. S/N	E0244	**Flux. Sensor S/N**	S0216				
Resistor S/N	FGAD.006	**Resistor Temp.**	8.2	**Resistor Value**	999.7		
X-coil constant	38600			**Approx. H-Field**	19000		
Y-coil constant	38593			**Approx. Z-Field**	-22000		
Z-coil constant	38601						

Applied Voltage	**H**	**Resistor Voltage**	**D**	**Resistor Voltage**	**Z**	**Resistor Voltage**	
+	8.823	90.302	8.9225	90.306	8.8944	90.272	
0	0.064	0	0.224	0	0.101	0	
-	-8.6789	-90.289	-8.4827	-90.291	-8.6813	-90.26	
Output Range	17.5019		17.4052		17.5757		
Resistor Current	0.1806452		0.1806512		0.180586		
Generated Field	6972.9045		6971.8716		6970.807		
Calibration	398.41	**nT/V**	400.56	**nT/V**	396.62	**nT/V**	
	251.00	**uV/0.1nT**	249.65	**uV/0.1nT**	252.13	**uV/0.1nT**	
Temperature Probe		**Scale:**	0.005	**V/deg.C**	**Offset:**	1.5153	**V at 0 deg.**

	Hout	**Hsetting**	**Dout**	**Dsetting**	**Zout**	**Zsetting**
H-North	0.0909	91	-0.0521	00	0.0928	A6
H-West	-0.0531	00	0.0986	91	0.1223	A6
H-South	0.0006	91	-0.0896	00	-0.0054	A6
H-East	-0.1075	00	0.0259	91	-0.0234	A6

Epsilon 1	-0.8	**Epsilon 2**	-0.7	**Epsilon 3**	1.0	**Epsilon 4**	1.5

ADC #01		**ADC Channel**		
Applied Voltage	**H**	**D**	**Z**	**T**
4.0003	4.0007	3.9995	3.9998	3.9999
0	0.0005	0.0005	0.0005	0.0005
-4.0006	-4.0002	-4.0002	-4.0002	-4.0005
8.0009	8.0009	7.9997	8.0000	8.0004
ADC Calibration	1.0000	0.9999	0.9999	0.9999

ADC #02		**ADC Channel**		
Applied Voltage	**H**	**D**	**Z**	**T**
8.0004	7.999	7.998	7.998	7.998
0	0.000	0.000	0.000	0.000
-7.9992	-7.996	-7.995	-7.995	-7.995
15.9996	15.995	15.993	15.993	15.993
ADC Calibration	1.000	1.000	1.000	1.000

MAIN OBSERVATORY PROTON PRECESSION MAGNETOMETER CALIBRATION

PPM Sensor		**PPM Electronics**				
Serial Number		**Type**	SM90R		**S/N**	61528
Cal Box	C2					
Proton Gyromagnetic Ratio				267515250	±40 T-1s-1	
Switch Setting	**Input Freq.**	**Cal Value**	**PPM Output**		**Error**	
7	833.33333	19572.67	19572.50		0.17	
9	1000	23487.20	23487.00		0.20	
6	1666.6667	39145.34	39144.97		0.37	
5	2000	46974.41	46974.03		0.38	
4	2500	58718.01	58717.55		0.46	
3	3333.3333	78290.68	78290.05		0.63	

AUXILIARY OBSERVATORY PROTON PRECESSION MAGNETOMETER CALIBRATION

PPM Sensor		**PPM Electronics**				
Serial Number		**Type**	GSM19		**S/N**	701595
Cal Box	C2					
Proton Gyromagnetic Ratio				267515250	±40 T-1s-1	
Switch Setting	**Input Freq.**	**Cal Value**	**PPM Output**		**Error**	
7	833.33333	19572.67	19572.58		0.09	
9	1000	23487.20	23487.12		0.08	
6	1666.6667	39145.34	39145.23		0.11	
5	2000	46974.41	46974.16		0.25	
4	2500	58718.01	58717.90		0.11	
3	3333.3333	78290.68	78290.51		0.17	

H.M.S ENDURANCE PROTON PRECESSION MAGNETOMETERS CALIBRATIONS

PPM Sensor		**PPM Electronics**				
Serial Number		**Type**	Elsec 820		**S/N**	147
Cal Box	C2					
Proton Gyromagnetic Ratio				267515250	±40 T-1s-1	
Switch Setting	**Input Freq.**	**Cal Value**	**PPM Output**		**Error**	
7	833.33333	19572.67	19572.80		-0.13	
9	1000	23487.20	23487.30		-0.10	
6	1666.6667	39145.34	39145.60		-0.26	
5	2000	46974.41	46974.70		-0.29	
4	2500	58718.01	58718.40		-0.39	
3	3333.3333	78290.68	78291.20		-0.52	

PPM Sensor		**PPM Electronics**				
Serial Number		**Type**	Elsec 820		**S/N**	GM109/A3
Cal Box	C2					
Proton Gyromagnetic Ratio				267515250	±40 T-1s-1	
Switch Setting	**Input Freq.**	**Cal Value**	**PPM Output**		**Error**	
7	833.33333	19572.67	19572.90		-0.23	
9	1000	23487.20	23487.40		-0.20	
6	1666.6667	39145.34	39145.70		-0.36	
5	2000	46974.41	46974.80		-0.39	
4	2500	58718.01	58718.60		-0.59	
3	3333.3333	78290.68	78291.40		-0.72	

Appendix C Software Configuration Files

System and data acquisition configuration files that have been created or modified specifically for the Port Stanley observatory QNX PC are listed in the following sections.

OPERATING SYSTEM SET-UP - SYSINIT.1

Location: /etc/config/sysinit.1

```
#Image: /boot/sys/boot -v
#Image: /boot/sys/Proc32 -l 1
#Image: /boot/sys/Slib32
#Image: /boot/sys/Slib16
#Image: /bin/Fsys
#Image: /bin/Fsys.eide fsys -Ndsk0 -n0=hd0. -n5=cd0. eide -a1f0 -i14
#Image: /bin/mount -p /dev/hd0.0 /dev/hd0.0t77 /
#Image: /bin/sinit TERM=qnxm
#export NODE=1

# This file (/etc/config/sysinit.1) is the system initialisation file for
# QNX 4.25j (Patch E) running on a DSP Design TP400 PC configured for
# Geomag logging
# Chris Turbitt 11 October 2001

###########################################################################
# This section is the basic operating system setup
# Set the region and language for the keyboard (including Photon)
export KBD=en_GB_102.kbd
export ABLANG=en
export CON_KBD=UnitedKingdom

# Timezone set to GMT (all year). lso set QNX time to real time clock (hw)
# time
export TZ=wet00west-01,M3.5.0/2,M10.5.0/2
/bin/rtc hw

# Start the device manager - this must be started before any Dev.* devices
Dev -n 100 &
Dev.ansi -Q -n6 &
reopen /dev/con1

kbd $CON_KBD

# Start the serial port, parallel port and pseudo-tty drivers
# Note: ser3 and ser4 are on a Turbo I/O serial card
/bin/Dev.ser -N/dev/ser1 3f8,4 &
/bin/Dev.ser -N/dev/ser2 2f8,3 &
/bin/Dev.ser -N/dev/ser3 3e8,5 &
/bin/Dev.ser -N/dev/ser4 2e8,9 &

Dev.par &
Dev.pty -n20 &

# Start the cron server
cron &

# Start the POSIX message queue
Mqueue &

# Start the floppy disk driver and the DOS file system manager for
# the floppy drive
/bin/Fsys.floppy -a3f0 -i6
Dosfsys  a=/dev/fd0 &

# Start the CD-ROM driver and set the CD-ROM drive to /cd0
#/bin/Iso9660fsys /cd0=/dev/cd0.0 &

# Make pipes faster by running them in memory
Pipe &

# Start the 8087 emulator
```

```
emu87 &

# Start the network name locator
nameloc &

# Add an alias to the pathname prefix tree for the default console
prefix -A /dev/console=/dev/con1

# Perform a consistency check on the QNX filesystem
chkfsys /


###########################################################################
# This section starts the network drivers and services. It should be
# entirely commented out unless a network card and TCP/IP software
# are installed

# Start the network device manager. This must be started before any Net.*
# devices
/bin/Net &
sleep 1

# Start the card-specific device driver by uncommenting one of the following
# Ethernet drivers
# Ethernet driver option 1: Intel PRO/100+ Ethernet card
#Net.ether82557 -pef00 -l1 -v &

# Ethernet driver option 2: DSP Design TB486 Ethernet port
#Net.crys8900 -l1 -v &

# Ethernet driver option 3: DSP Design TP400 Ethernet port
Net.ns83815 -pf800 -i11 -I0 -l1 &

sleep 1

# Start the network manager's logical-to-physical node ID mapping table
netmap -f

# If the file '/etc/config/bin/tcpip.1 exists, then execute it. This script
# starts the QNX TCP-IP managers
if test -f /etc/config/bin/tcpip.$NODE
then
      sleep 2
      . /etc/config/bin/tcpip.$NODE
fi


###########################################################################
# This section is used to automatically launch any applications at boot
# time

# If the file /etc/config/bin/ph.1 exists, start Photon
if test -f /etc/config/bin/ph.$NODE
then
. /etc/config/bin/ph.$NODE
else
tinit -t /dev/con1 &
tinit -T /dev/con[2-6] &
fi

# If required, start the SDAS acquisition
su sdas -c /home/sdas/bin/sdas.boot
```

INTERNET PROTOCOL SET-UP - TCPIP.1

Location: /etc/config/bin/tcpip.1

```
#! /bin/ksh

export SOCK=$NODE

/usr/ucb/Socket fkqa &
/usr/ucb/ifconfig lo0 localhost up
/usr/ucb/ifconfig en1 fkqa up
/usr/ucb/inetd /etc/config/inetd.1 &
```

```
/usr/ucb/route add default 195.248.193.250

# Attempt to map the users disk on mhub to /users. This will only be
# successful on the MH LAN
#sleep 5
#/usr/ucb/mount_nfs -v mhub:/local53/users/DISKA /users
```

SDAS GENERAL CONFIGURATION FILE - GENERAL.CFG

Location: home/sdas/config/general.cfg

```
# general.cfg - general SDAS parameters
#
# This file is in the form 'name value' - each of the name/value pairs
# is described below.

# ring_buffer_size - this should hold the size of the ring-buffer
# in hours: 1 day = 24, 1 week = 168, 28 days = 672
ring_buffer_size 40000

# log_buffer_size - this should hold the size of the error log buffer
# in days
log_buffer_size 30

# sdas_clock_params - this should contain any command line parameters
# needed by the sdas_clock program - enter 'sdas_clock -h' fro details
sdas_clock_params "-s /dev/ser1 -l '4800 -osflow -ihflow -ohflow -lkhflow +raw' -f 700 -q -c"

# prog_before_<n> - a list (with n starting at 1) of programs and their
# command lines that should be started / stopped by sdas before the
# main programs have been started / stopped - the format
# is "program description:command command-line..."
prog_before_1 "SDAS error logger:errlog -bc $SDAS_CONFIG_DIR/errlog.cfg"

# prog_after_<n> - a list (with n starting at 1) of programs and their
# command lines that should be started / stopped by sdas after the
# main programs have been started / stopped - the format
# is "program description:command command-line..."
prog_after_1 "SDAS data server:sdas_ds"
prog_after_2 "SDAS scheduler:schedule"

# Override some of the settings in ~/bin/sdas.setup
SDAS_HOME_DIR /home/sdas
SDAS_EXTRACT_DIR $SDAS_REC_DIR/data/archive
```

SDAS ACQUISITION DRIVER CONFIGURATION - ACQUIRE.CFG

Location: /home/sdas/config/acquire.cfg

```
# acquire.cfg - this database defines the acquisition programs
#                       it is read by the process controller
#                       it controls which acquisition programs will be run and
#                       what devices they will connect to
#
# field  | field        |
# number | name         | description
# -------+--------------+------------------------------------------------------
# 1      | id           | unique index number for the invocation of this
#        |              | acquisition process - this is used to link to other
#        |              | databases, e.g. channels.cfg - unless you have a
#        |              | good reason start at 0 and work up contiguously
#        |              | THESE NUMBERS MUST BE UNIQUE
# 2      | prog_name    | name of the acquisition program binary
# 3      | dev_name     | name of the IO device for acquisition (if any)
#        |              | the driver has its stdin/out redirected to this
#        |              | device
# 4      | buff_size    | size of the intermediate buffer between the
#        |              | device dev_name and the acquisition program -
#        |              | set to -1 for no buffer
```

```
# 5      | stty params | a list of parameters that will be sent to the stty
#        |             | program to configure the device before the
#        |             | driver starts - set to a blank string if stty is
#        |             | not needed
# 6      | mode        | some drivers can be used in more than one mode
#        |             | this parameter specifies the mode - it is passed
#        |             | to the driver as -m <mode>
# 7      | sample rate | some drivers allow you to specify the sample rate
#        |             | the rate may have a suffix of 'S', 'M' or 'H' to
#        |             | indicate that the rate is in hours, minutes or
#        |             | seconds - the is passed to the driver as -r <rate>,
#        |             | if the sample rate is not needed, enter -1
# 8      | address     | some drivers need an address parameter - this
#        |             | is passed to the driver as -a <address> - hex
#        |             | numbers may be used if prefixed with 0x
# 9      | clock_reqd  | enter "yes" if the SDAS clock is needed by this
#        |             | driver, enter "no" otherwise
# 10     | debug       | debug level - typically 0 for no debugging
#        |             | information

# an entry for the input emulator
#0  input_emm  ""  ""  ""  100s  -1  yes

# an entry for an ADAM 4017 adc running at 1Hz
0 adc /dev/ser2 -1 "baud=9600 +raw -osflow -ihflow -ohflow -lkhflow" ADAM_4017 1s 0x01 yes 0
1 ppm /dev/ser3 -1 "baud=1200 +raw -osflow -ihflow -ohflow -lkhflow" SM90R 6m 49 yes 0
2 filter /dev/null -1 "" GAUSS_90S -1 0 no 0
3 filter /dev/null -1 "" GAUSS_90S -1 1 no 0
4 filter /dev/null -1 "" GAUSS_90S -1 2 no 0
5 filter /dev/null -1 "" GAUSS_90S -1 3 no 0
6 filter /dev/null -1 "" GAUSS_90S -1 4 no 0
```

SDAS CHANNEL CONFIGURATION AND CALIBRATION - CHANNELS.CFG

Location: /home/sdas/config/channels/cfg

```
# channels.cfg - this database defines the channels that will be
#                        recorded - it is read by the ring buffer manager to
#                        map digitiser channels to SDAS channels - digitiser channels
#                not mentioned in this file will be ignored by the ring-buffer
#                manager and thus ignored
#
# field  | field          |
# number | name           | description
# -------+----------------+-------------------------------------------------
# 1      | sdas_chan      | unique index for the SDAS channel number - unless
#        |                | you have a good reason start at 0 and work up
#        |                | contiguously
# 2      | chan_name      | name for this SDAS channel
# 3      | chan_type      | a code for the type of channel
# 4      | units          | name of the physical units being used
# 5      | offset         | this gets subtracted from the channel data
#        |                | before it is stored
# 6      | scale          | the data is divided by this after the offset
#        |                | has been removed and before it is stored
# 7      | acquire.id     | acquire id (from acquire.cfg) for the acquisition
#        |                | process to which this channel spec. relates
# 8      | acq_type       | "main" or "aux" - many digitisers have two types
#        |                | of input - "main" inputs are the seismic data inputs
#        |                | typically 24-bit 100Hz, "aux" inputs are much slower
#        |                | and lower resolution, e.g. 8 bit, 1Hz
# 9      | acq_chan       | the channel number used by the digitiser driver
#        |                | typically 0-2 for "main" channels, 0-7 for "aux"
#        |                | channels

0     PST         "H"                "uV"  0.0  1.0   0    main  0
1     PST         "D"                "uV"  0.0  1.0   0    main  1
2     PST         "Z"                "uV"  0.0  1.0   0    main  2
3   PST     "T"               "uV"  0.0  1.0   0 main    3
4   PST     "F"          "0.01nT"  0.0  1.0   1 main    0
5   PST     "H filter"   "0.1nT"  0.0  251.00   2 main    0
6   PST     "D filter"   "0.1nT"  0.0  249.65   3 main    0
7   PST     "Z filter"   "0.1nT"  0.0 -252.13   4 main    0
8   PST     "T filter"   "0.1dg.C"  1353900  500.0   5 main    0
9   PST     "F filter"   "0.1nT"  0.0  10.0   6 main    0
```

SDAS AUTOMATIC PROCESSING SCRIPT - SCHEDULE.CFG

Location: /home/sdas/config/schedule.cfg

```
# example schedule file for SDAS
#
# S. Flower, Oct 2001
#


# At one minute past each hour delete the tail end of the ring buffer
*:1:0           del_data

# At two minutes past each hour, extract data to floppy disk
*:2:0           extract -e -o -c flare.ext %d-%M-%y %h:00:00 3600
*:3:0           extract -e -o -c archive.ext %d-%M-%y %h:00:00 3600

# Just after midnight delete the tail end of the log
0:2:0           del_log
```

SDAS DATA EXTRACTION FORMAT DEFINITION (ARCHIVE) - ARCHIVE.EXT

Location: /home/sdas/config/archive.ext

```
# flare.ext - multiplexed configuration file
# for the SDAS extraction program
# designed to write one-minute data in
# Flare Plus format
# Chris Turbitt November 2000

# first we specify whether the data will be multiplexed or not
multiplexed

# we can use either ASCII or BINARY data - once specified this will be the
# data type used for header and data until a new directive is given
binary

# next we specify the data records
data
  # we can specify field and record separators
  #field separator " "
  #record separator "\n"
  missing data 99999

  # once again we specify the fields that will go into the record - all
  # the fields that were valid in the header section are valid here, as
  # well as the CHANNEL (followed by the channel number)
  field
    month
    zero pad
    width 1
  end of field
  field
    day
    zero pad
    width 1
  end of field
  field
    hour
    zero pad
    width 1
  end of field
  field
    minute
    zero pad
    width 1
  end of field
  field
    channel 5
    zero pad
    width 4
  end of field
```

```
  field
    channel 6
    zero pad
    width 4
  end of field
  field
    channel 7
    zero pad
    width 4
  end of field
  field
    channel 8
    zero pad
    width 4
  end of field
  field
    channel 9
    zero pad
    width 4
  end of field
  field
    literal "x"
  end of field


# finally we can specify how file names are to be constructed
filename

  # we can specify APPEND or OVERWRITE (the default) to control how
  # the file is opened
  append

  # we can use all the ONCE PER XXXX specifiers used for the header
  # to specify how often to create a new file, eg. for day files
  # use ONCE PER DAY - ONCE PER FILE is the default, meaning create a single
  # data file for each run of the extract program
  once per file

  # we can use the same fields as in the header section to construct
  # the filename
  field
    literal "$SDAS_EXTRACT_DIR/"
  end of field
  field
    year
    zero pad
    width 4
  end of field
  field
    month
    zero pad
    width 2
  end of field
  field
    day
    zero pad
    width 2
  end of field
  field
    literal ".fkqa"
  end of field
```

SDAS DATA EXTRACTION FORMAT DEFINITION (FLOPPY DISK) - FLARE.EXT

Location: /home/sdas/config/flare.ext

Note: This file is identical to /home/sdas/config/archive.ext, except that the filename is constructed using the following:

```
  field
    literal "/dos/a/"
  end of field
  field
    literal "fkqa"
```

```
end of field
field
  month
  zero pad
  width 2
end of field
field
  day
  zero pad
  width 2
end of field
field
  literal ".qnx"
end of field
```

Appendix D Router Configuration

In order to connect the BGS data recording equipment to the internet, Cable and Wireless of the Falkland Islands have installed an Ethernet link with a router, giving a single IP address. The router configuration is listed below.

Telnet Password: **limiting**
Enable Password: **unPack**
Router Configuration:

```
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname bgf__flk
!
enable secret 5 $1$VB48$UXOtu9cxQRo900mAb8dOW0
enable password install
!
ip subnet-zero
ip domain-list horizon.co.fk
ip domain-name horizon.co.fk
ip name-server 195.248.193.250
ip name-server 194.119.128.71
!
!
!
interface Ethernet0
 description LAN
 ip address 195.248.193.233 255.255.255.252
 no ip directed-broadcast
!
interface Serial0
 description Leased 64K cct to C&W, shared port
 bandwidth 64
 ip unnumbered Ethernet0
 no ip directed-broadcast
!
ip classless
ip route 0.0.0.0 0.0.0.0 Serial0
!
!
line con 0
 transport input none
line vty 0 4
 password limiting
 login
!
end
```

Appendix E Cabling Details

Cable: C1	**Description:** Battery Supply		
Connector Name: CON4	**Cable Type:**		**Connector Name:**
Connector Type: 3-pin XLR Male	2-core unshielded		**Connector Type:** Crimp Eye
Pin	**Colour**	**Signal**	**Pin**
1	Brown	+12 V	Battery positive
3	Blue	0 V	Battery negative

Cable: C2	**Description:** Proton Magnetometer Power Supply (18 V)		
Connector Name: CON3	**Cable Type:**		**Connector Name:** Reg. Power In
Connector Type: 3-pin XLR Male	3-core unshielded		**Connector Type:** 3-pin XLR Female
Pin	**Colour**	**Signal**	**Pin**
2	Brown	+18 V	1
3	Green/ Yellow	0 V	3

Cable: C3	**Description:** Fluxgate Magnetometer Power & Signal		
Connector Name: CON5	**Cable Type:**		**Connector Name:** ADC Power In
Connector Type: 4-pin XLR Male	4-core Shielded		**Connector Type:** 4-pin XLR Female
Pin	**Colour**	**Signal**	**Pin**
1	Red	+18 V	1
2	Yellow	Data +	2
3	Blue	Data -	3
4	Green	0 V	4

Cable: C4	**Description:** GPS Receiver Power & Signal		
Connector Name: CON6	**Cable Type:** 4-core Shielded		**Connector Name:**
Connector Type: 5-pin XLR Female			**Connector Type:** 5-pin XLR Male
Pin	**Colour**	**Signal**	**Pin**
1	Red	+12 V	1
2	Yellow	Tx	2
3	Blue	Rx	3
5	Green	0 V	5

Cable: C5	**Description:** PPM Signal from Regulator Box		
Connector Name: COM4	**Cable Type:** 4-core Shielded		**Connector Name:** RS232 Out
Connector Type: 9-pin D-type Female			**Connector Type:** 9-pin D-type Male
Pin	**Colour**	**Signal**	**Pin**
2	Blue	Rx	3
3	Red	Tx	2
5	Green	0 V	5

Cable: C6	**Description:** ADC Signal		
Connector Name: COM2	**Cable Type:** 4-core shielded		**Connector Name:** CON8
Connector Type: 9-pin D-type Female			**Connector Type:** 9-pin D-type Female
Pin	**Colour**	**Signal**	**Pin**
2	Blue	Rx	2
3	Red	Tx	3
5	Green	GND	5

Cable: C7	**Description:** GPS Signal		
Connector Name: COM1	**Cable Type:**		**Connector Name:** CON7
Connector Type: 9-pin D-type Female	4-core shielded		**Connector Type:** 9-pin D-type Female
Pin	**Colour**	**Signal**	**Pin**
2	Blue	Rx	2
3	Red	Tx	3
5	Green	GND	5

Cable: C8	**Description:** PC Power		
Connector Name: POW-IN	**Cable Type:**		**Connector Name:** CON8
Connector Type: 9-pin D-type Female	2-core unshielded		**Connector Type:** 3-pin XLR Male
Pin	**Colour**	**Signal**	**Pin**
2	Brown	+12 V	1
3	Blue	0 V	3

Cable: C9	**Description:** Proton Magnetometer Power Supply (12 V)		
Connector Name:	**Cable Type:**		**Connector Name:** Power
Connector Type: 3-pin XLR Male	3-core unshielded		**Connector Type:** PT06W-08-33SN
Pin	**Colour**	**Signal**	**Pin**
1	Brown	+12 V	B
3	Green/ Yellow	0 V	A

<table>
<tr><td>Cable: C10</td><td colspan="3">Description: Proton Magnetometer Signal</td></tr>
<tr><td>Connector Name: RS232 In</td><td colspan="2" rowspan="2">Cable Type:
4-core Shielded</td><td>Connector Name: RS232</td></tr>
<tr><td>Connector Type: 9-pin D-type Female</td><td>Connector Type: PT06W-08-33PN</td></tr>
<tr><td>Pin</td><td>Colour</td><td>Signal</td><td>Pin</td></tr>
<tr><td>2</td><td>Blue</td><td>Rx</td><td>C</td></tr>
<tr><td>3</td><td>Red</td><td>Tx</td><td>A</td></tr>
<tr><td>5</td><td>Green</td><td>0 V</td><td>B</td></tr>
</table>

<table>
<tr><td>Cable: C11</td><td colspan="3">Description: Fluxgate Magnetometer Power</td></tr>
<tr><td>Connector Name: COM2</td><td colspan="2" rowspan="2">Cable Type:
2-core unshielded</td><td>Connector Name: Power</td></tr>
<tr><td>Connector Type: 4-pin XLR Male</td><td>Connector Type: 4-pin XLR Female</td></tr>
<tr><td>Pin</td><td>Colour</td><td>Signal</td><td>Pin</td></tr>
<tr><td>1</td><td>+18 V</td><td>Rx</td><td>1</td></tr>
<tr><td>4</td><td>0 V</td><td>Tx</td><td>4</td></tr>
</table>

<table>
<tr><td>Cable: C12</td><td colspan="3">Description: Fluxgate Magnetometer Signal</td></tr>
<tr><td>Connector Name: ADC Signal In</td><td colspan="2" rowspan="2">Cable Type:
2-core unshielded</td><td>Connector Name: Signal</td></tr>
<tr><td>Connector Type: 6-pin MIL Male</td><td>Connector Type: 6-pin MIL Male</td></tr>
<tr><td>Pin</td><td>Colour</td><td>Signal</td><td>Pin</td></tr>
<tr><td>A</td><td>Shield</td><td>GND</td><td>A</td></tr>
<tr><td>B</td><td>Red</td><td>H</td><td>B</td></tr>
<tr><td>C</td><td>Yellow</td><td>D</td><td>C</td></tr>
<tr><td>D</td><td>Green</td><td>Z</td><td>D</td></tr>
<tr><td>E</td><td>Blue</td><td>T</td><td>E</td></tr>
</table>

Figure 1 ‘Tinytalk’ Temperature Data

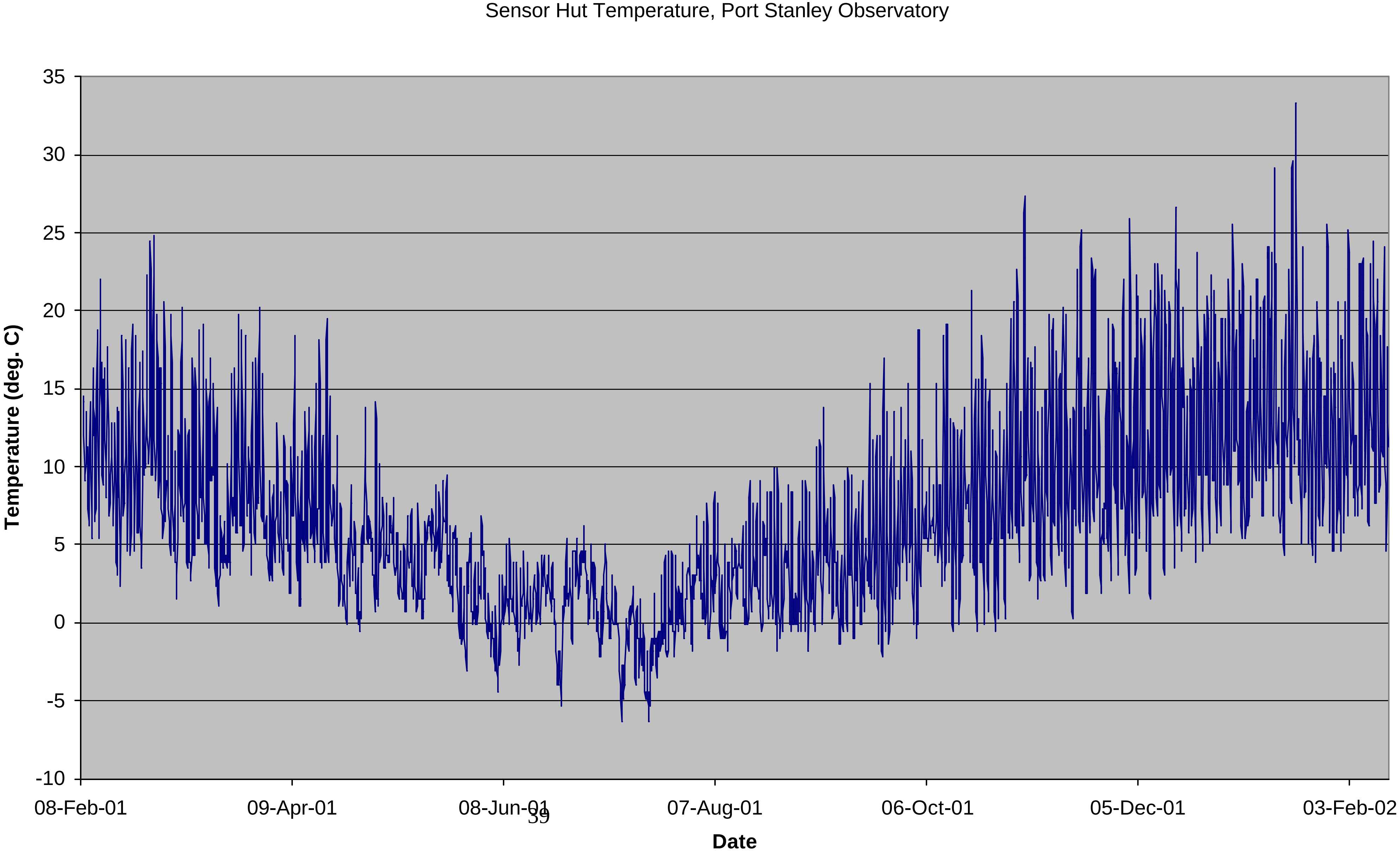


Figure 2 Observatory Layout

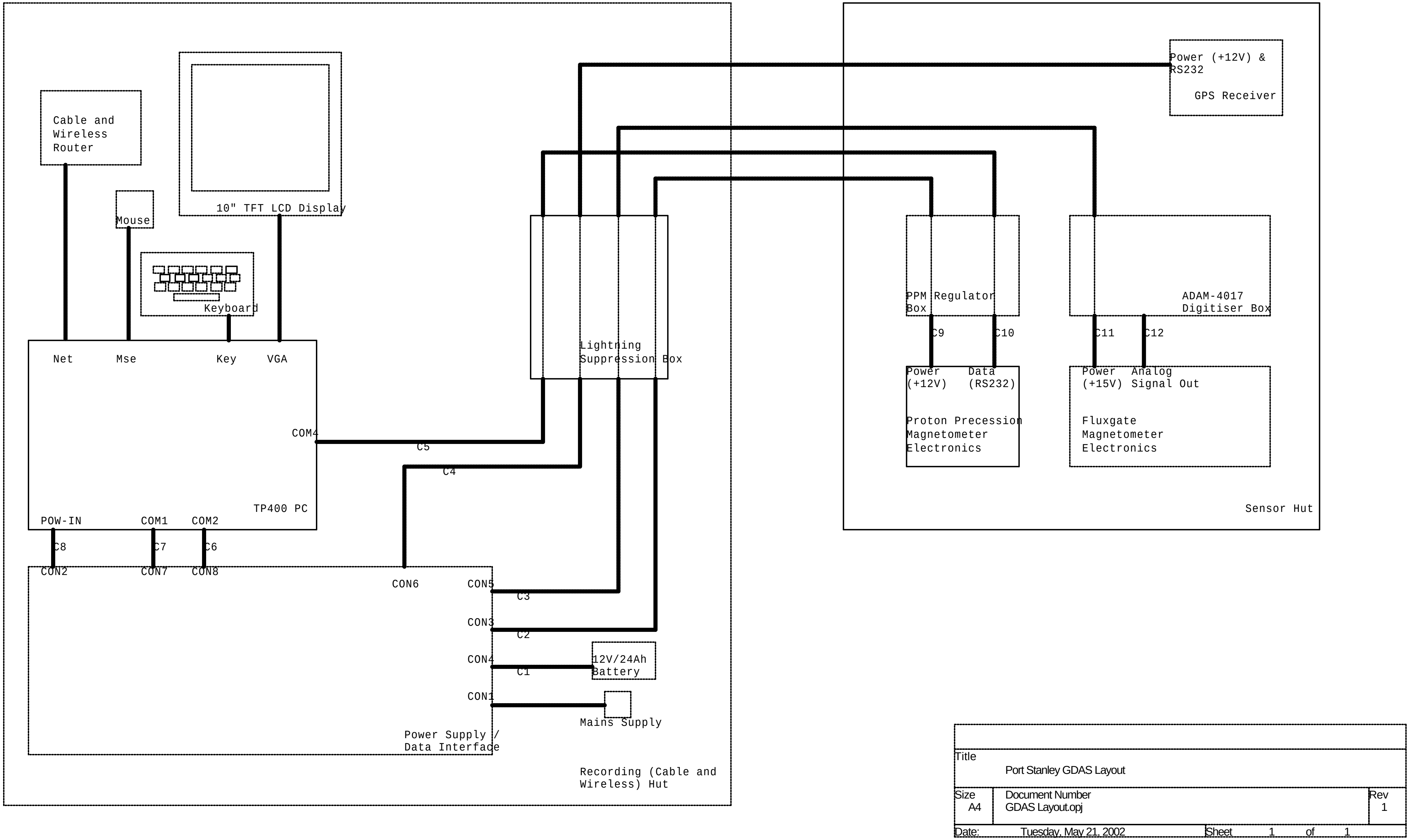


Figure 3 Mains Power Supply Panel Layout

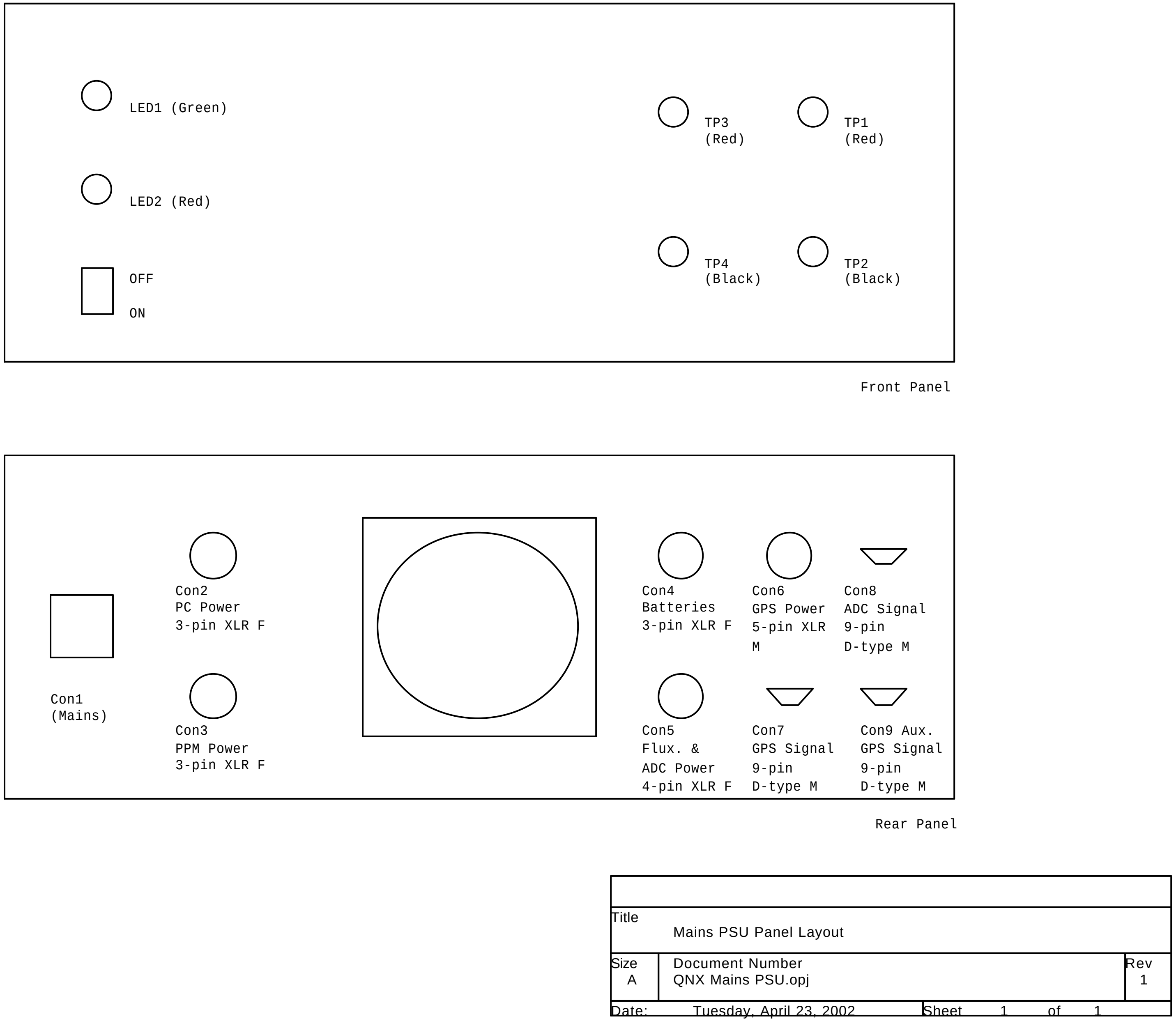
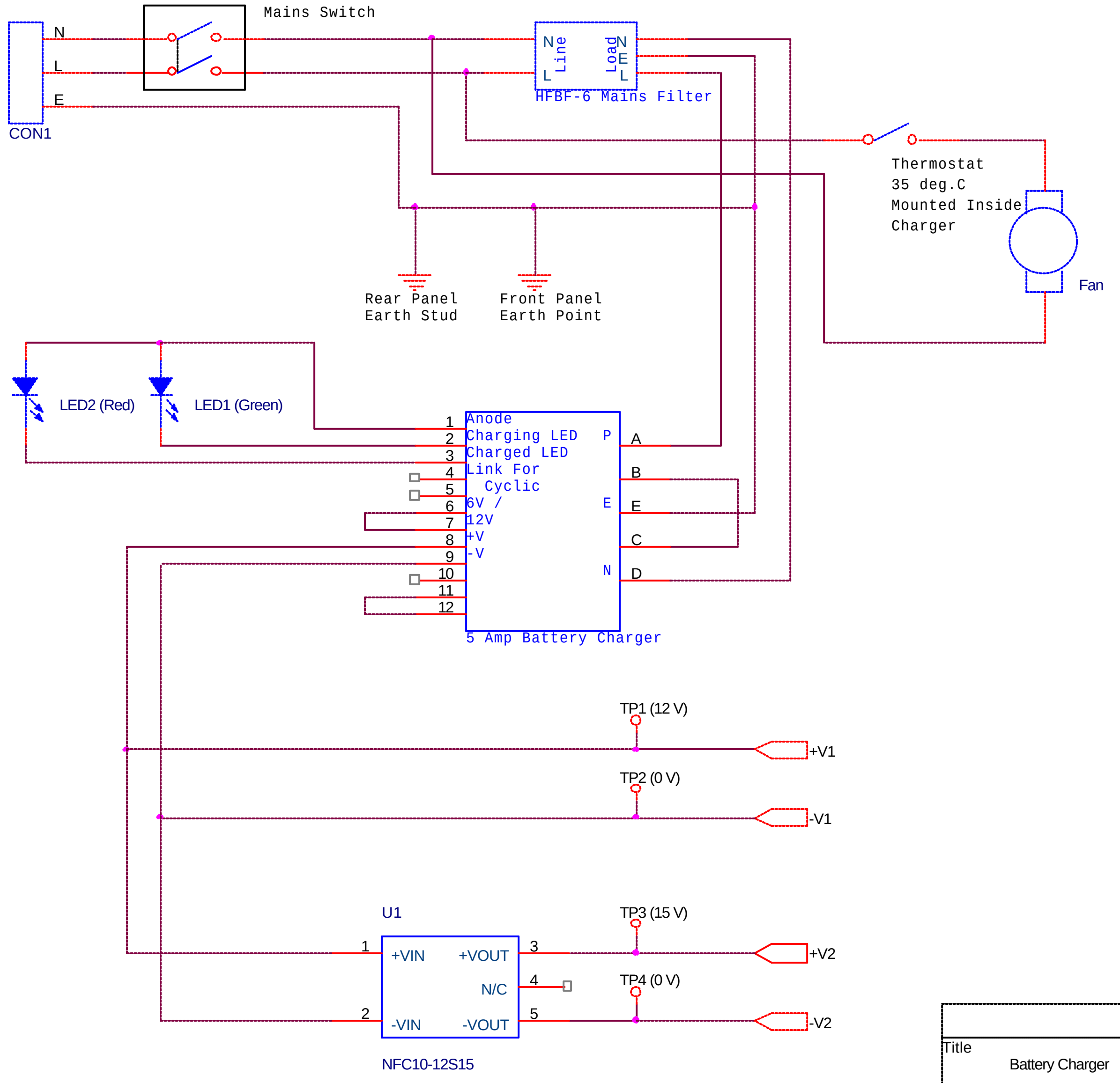


Figure 4 Mains Power Supply Battery Charger



Title	Battery Charger				
Size A	Document Number QNX Mains PSU.opj				Rev 2
Date:	Tuesday, April 23, 2002	Sheet	1	of	1

Figure 5 Mains Power Supply Connectors

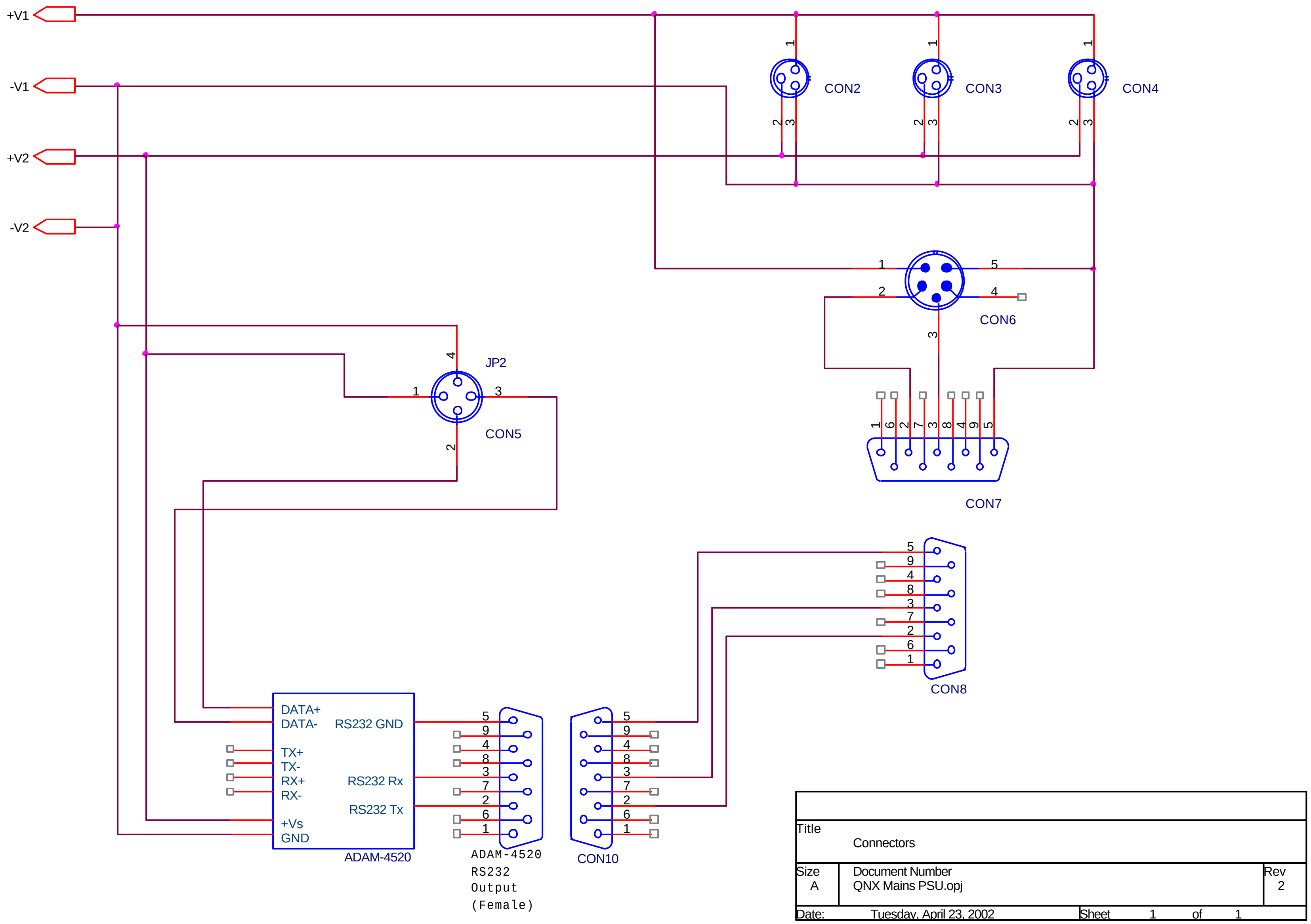
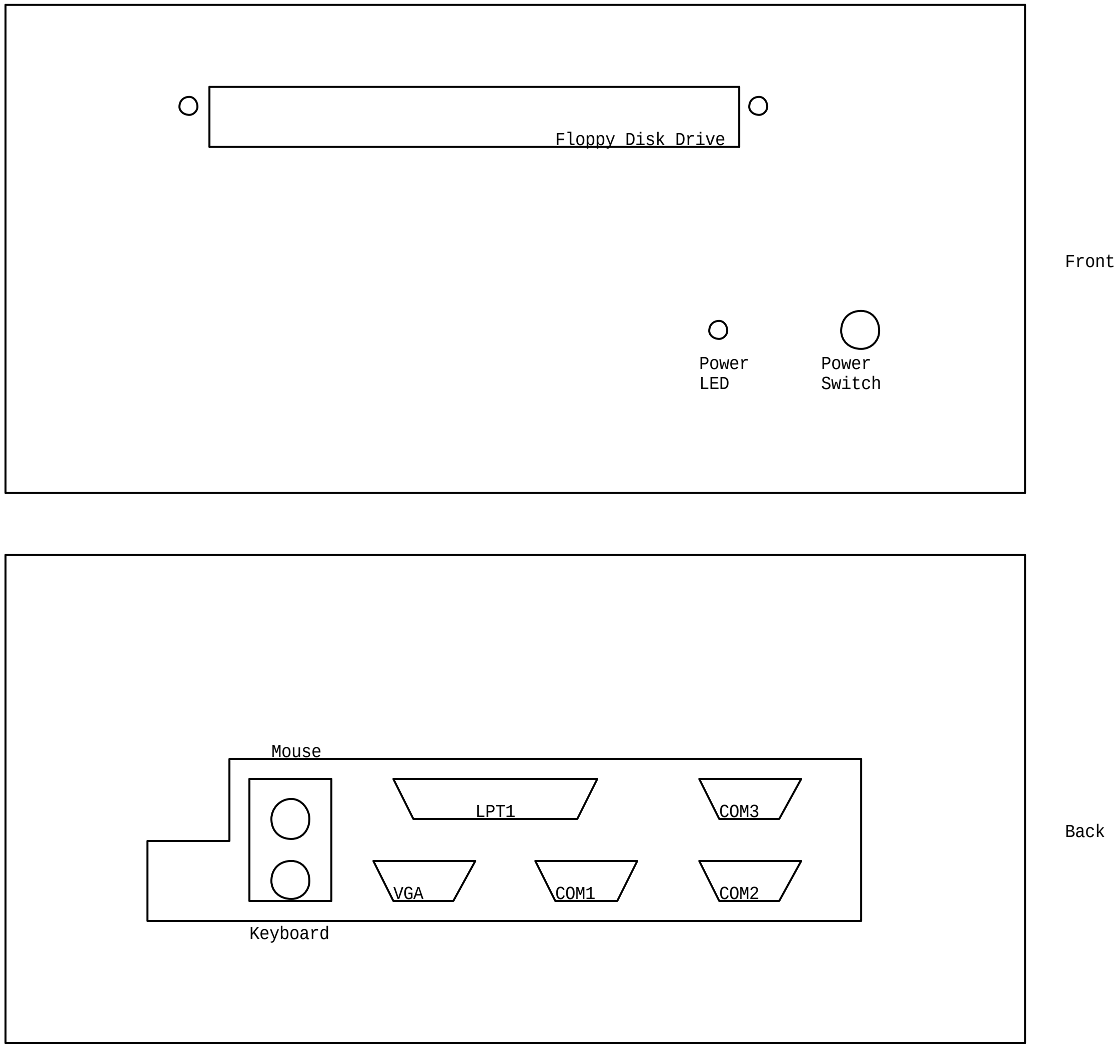
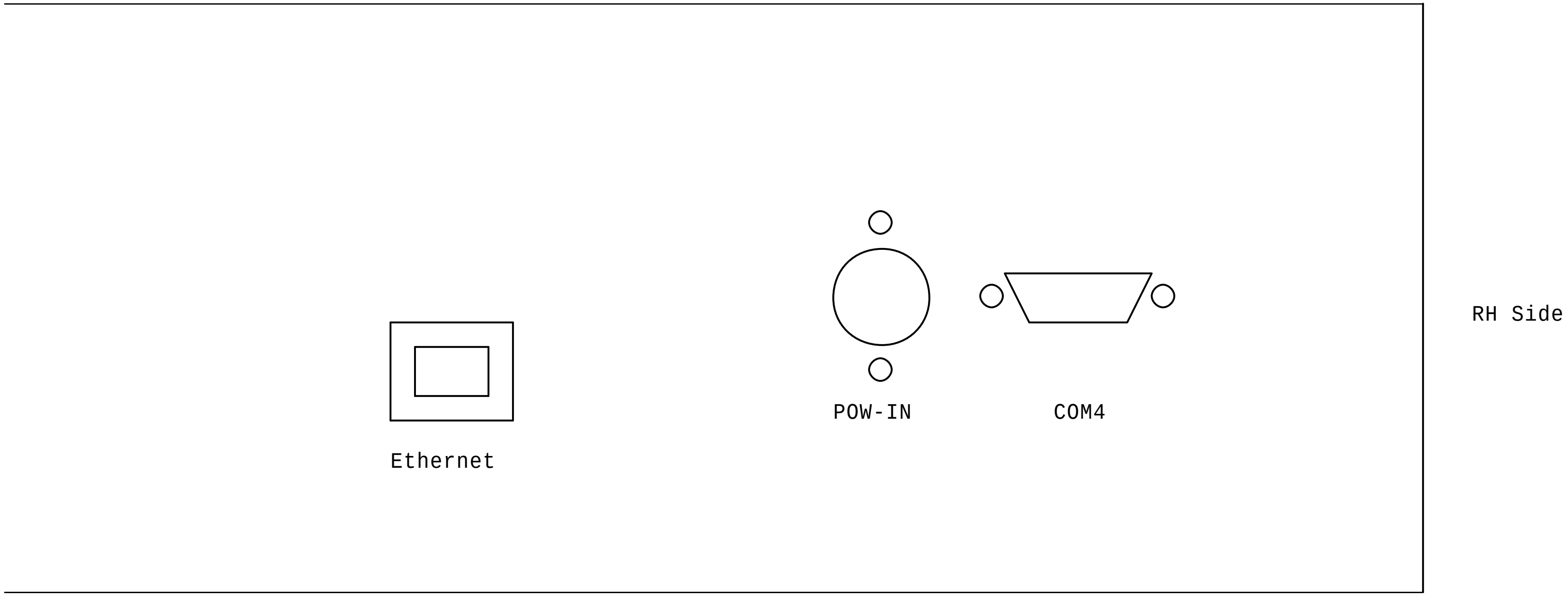


Figure 6 TP400 PC Panel Layout – Back and Front



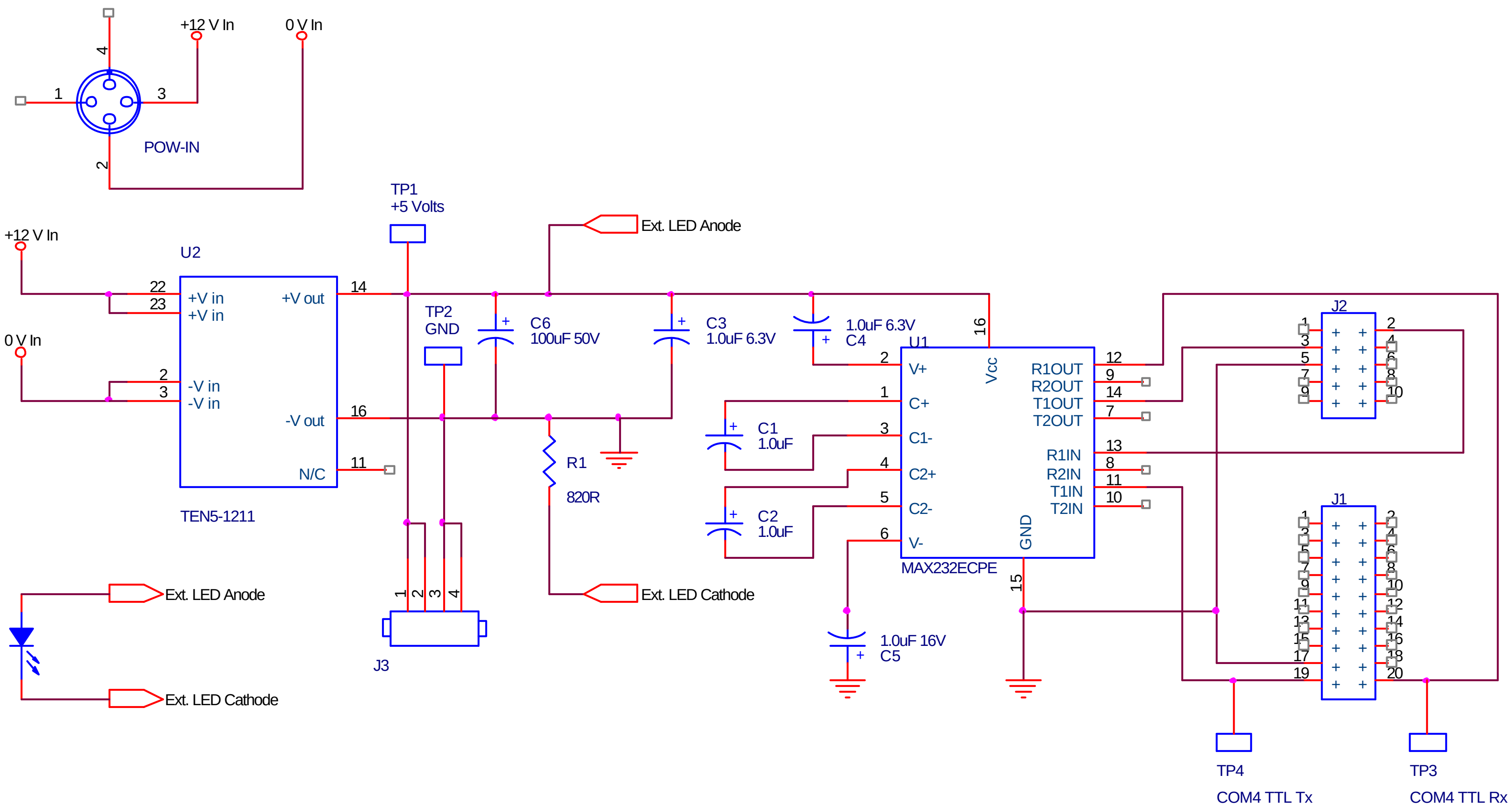
Title	PC Panel Layout - Front & Back	
Size A	Document Number TP400 PC.opj	Rev 1
Date: Tuesday, May 21, 2002	Sheet 1 of 1	

Figure 7 TP400 PC Panel Layout – Right-hand Side



Title	PC Panel Latout - RH Side				
Size A	Document Number TP400 PC.opj				Rev 1
Date:	Tuesday, May 21, 2002	Sheet	1	of	1

Figure 8 TP400 Power Supply and COM4 Circuit Board



Parts:
U1 Maxim MAX232ECPE (RS 225-8510)
U2 Traco TEN5-1211 (RS 293-2707)
J1 tyco 20-way low profile straight mount IDC (RS 461-770)
J2 tyco 10-way low profile straight mount IDC (RS 461-742)
J3 tyco 4-way single row, straight mount HE14 header (RS 531-986)

Title	TP400 PowerSupply and COM4 RS232		
Size A	Document Number TP400 PC.opj		Rev 1
Date:	Tuesday, May 14, 2002	Sheet 1 of 1	

Figure 9 Lightning Suppression Box