Mem. S.A.It. Suppl. Vol. 2, 217

Memorie della
Supplementi

The AASTINO: Automated Astrophysical Site Testing INvincible Observatory

J.S. Lawrence, M.C.B. Ashley, M.G. Burton, P.G. Calisse, J.T. Dempsey, J.R. Everett, O. Maher, J.W.V. Storey, and T. Travouillon

School of Physics, University of New South Wales, NSW 2052, Australia
e-mail: jl@phys.unsw.edu.au

Abstract. The AASTINO is a remote observatory that has been deployed at the Italian/French base Dome C (75 S, 123 E, 3200 m) on the Antarctic plateau in January 2003. It is designed to run throughout the Antarctic winter without intervention. An extensive site testing program at the Amundsen-Scott South Pole station has shown that the atmosphere above the Antarctic plateau offers major benefits for performing astronomical observations in the infrared and submillimetre. The purpose of the AASTINO is to extend these site testing studies to Dome C, where it is believed even better conditions will be found. Data are available in real time (www.phys.unsw.edu.au/~mcba/aastino).

Key words. site testing – Antarctic astronomy – remote systems control

1. Introduction

The Automated Astrophysical Site Testing Observatory (AASTO) has been collecting atmospheric data from the US Amundsen-Scott South Pole station for the last decade, see for example (Storey, Ashley, Burton 1996). The AASTINO represents the next generation of remote site testing laboratory, designed to be deployed to more remote locations on the Antarctic plateau. It is a heavily modified Igloo Satellite Cabin manufactured by Malcolm Wallhead and Associates, Tasmania. It consists of an outer fibreglass casing with internal polyurethane sprayfoam insulation and is approximately 4 m X 6 m in size. There are eight floor panels and sixteen wall panels, of which six contain an instrument port on the roof and are built with a double fibreglass layer to provide additional mechanical strength. The shelter was assembled in January 2003 and is situated on a 2m high ice hill approximately 200 m from the new Concordia station at Dome C (see figure 1). The AASTINO has been running independently since the station closed for the winter on Feb 8, 2003.

2. Power generation

The primary source of heat and power for the AASTINO is a Whispergen Stirling engine, manufactured by Whispertech, New Zealand. This is an external combustion en-

Send offprint requests to: J.S. Lawrence
Correspondence to: jl@phys.unsw.edu.au

Fig. 1. The AASTINO assembled in front of Concordia station currently under construction

gine that uses compressed nitrogen as its working fluid and burns Jet A1 fuel. It is capable of providing up to 6 kW of heat energy and 900 W of electrical power at full power, but is run at half that level in order to conserve fuel. Engine heat is transferred to the room air via circulation of glycol (at ∼60 degrees) through a series of heat exchangers. Electrical power is used to charge a 200 Ahr 24 V battery bank. Two separate, totally independent engines are installed for redundancy. Each engine has its own micro-processor that provides semi-autonmous operation.

The secondary power source for the AASTINO is a pair of 150 W solar panels, which charge the battery bank by default. In the event of an engine failure, solar power can alternatively be dumped to a heat sink to keep the instruments warm. A 38 Ahr 24 V back-up battery bank is also installed which is isolated from the engine system but can be charged from the solar panels. This allows limited communications and computer control if the primary battery bank is flattened.

The thermal management system comprises a Eurotherm PID temperature controller, which monitors the room temperature with a Pt100 platinum resistance thermistor. Temperature is regulated via two 150 mm brushless fans which exhaust the room air via PVC ducting. As the AASTINO is well sealed, exhausting warm room air causes cold outside air to be drawn in. Additionally the inside room temperature is monitored with a series of Dallas Semiconductor temperature sensors on a 1-wire bus. This chain also provides analog to digital inputs and switches, which

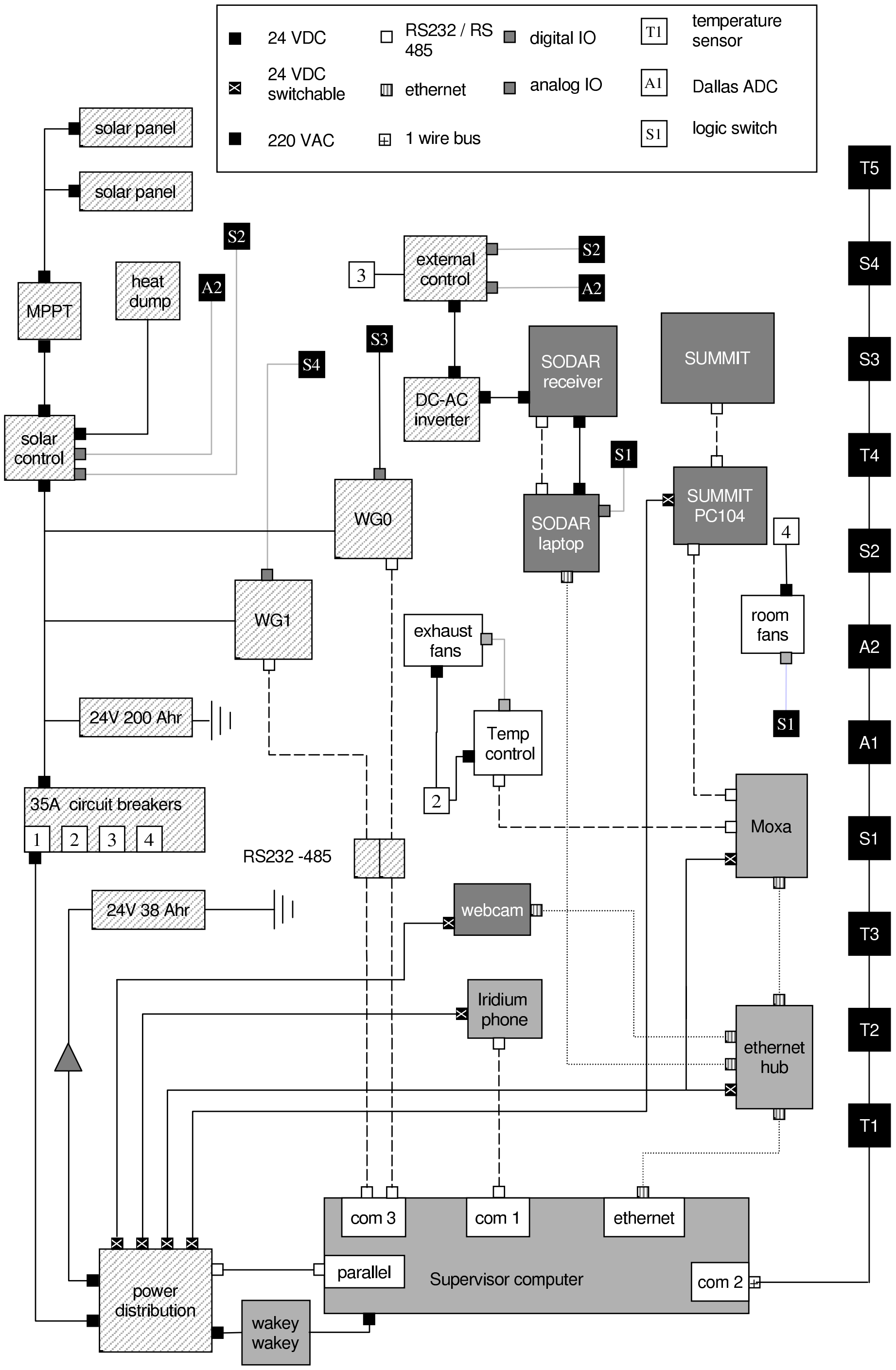

Fig. 2. Schematic of the AASTINO control system. Each of the AASTINO sub-systems (power generation and distribution, thermal management, intrumentation, computing and communication, and the Dallas chain) is shaded differently. WG0 and WG1 refer to the engines (Whispergens), MPPT is a Maximum Power Point Tracker, and the Moxa is a serial to ethernet link.

allows a number of internal air circulation fans to control the room temperature stratification.

3. Command and Control

A central "Supervisor" computer is used to control all of the AASTINO systems (see figure 2). This computer consists of a PC104 stack (NatSemi Geode processor with 1.5 GB compact flash) with a series of perl, C, and shell scripts running on a GNU/ Linux operating system. The Supervisor automatically connects to a computer in Sydney several times per day via the Iridium satellite network. An electronic "wakey-wakey" circuit automatically re-boots the Supervisor computer in the event of a hang or if communication is not received.

The supervisor computer communicates with the various AASTINO sub-systems via either a local ethernet hub (with RS232 and RJ45 communication lines) or directly via a number of (RS232) com ports. A parallel port link to a power distribution circuit combined with several logic switches in the dallas chain provides the capability to power-cycle any of the internal systems.

Separate scripts on the Supervisor control the instruments and the webcam, the Iridium communication system, the engine management and solar power control system, the room temperature regulation system, and the Dallas Semiconductor chain. All scripts are designed to run the complete AASTINO system (including engine management and instrument data collection) automatically in the event of a communications failure.

4. Instruments

The AASTINO currently houses two instruments, but is designed to accommodate several more in the future. The first, SODAR, is an acoustic radar that measures the distribution of turbulence throughout the lowest 900 m of the atmosphere. After two months of data collection it has shown that the thickness of the boundary layer at Dome C is consistently lower than previously observed at the South Pole (Travouillon et al. 2003). The second instrument, SUMMIT, measures the opacity of the atmosphere at 350 mm. To date it has shown that Dome C has the lowest and most stable opacity of any site in the world (Calisse et al. 2003). Additionally, a webcam is installed that is automatically collecting several images per day.

5. Conclusions

The AASTINO is a fully autonomous observatory that has currently been running for more than two months at Dome C station on the Antarctic plateau - one of the harshest and most remote locations on the Earth. This project has so far proved a demonstration of the feasibility of the Stirling engine as a power source for such applications and has proved the robustness of a unique command and control system. Additionally it has provided valuable information on the atmosphere above Dome C that supports the justification for developing an astrophysical observatory at this site.

Acknowledgements. The UNSW Antarctic astronomy program is indebted to the ARC and the AAD for financial support, and the Italian PNRA, French IPEV, and US NSF for logistic support.

References

Calisse, P.G., Ashley, M.C.B., Burton, M.G., Phillips, M.A., Storey, J.W.V., Radford, S.J.E, & Peterson, J.B, 2003 in Astronomy from Concordia (Capri, Italy)

Storey, J.W.V., Ashley, M.C.B., and Burton, M.G. 1996, PASA, 13, 35

Travouillon, T., Ashley, M.C.B., Burton, M.G., & Storey, J.W.V. 2003, in Astronomy from Concordia (Capri, Italy)