Woods Hole Oceanographic Institution
Upper Ocean Processes Group

Technical Note

Buoy Meteorological Instrumentation
Part 2 — Volunteer Observing Ship — Sea Surface Temperature

The October 1995 UOP Technical Note gave an overview of the buoy meteorological instrumentation and described the three generations of Improved METeorological (IMET) instruments that have been developed and are being used by the UOP group. An extension of IMET technology is being used on Volunteer Observing Ships (VOS) and is the newest of the designs. This technical note will describe the VOS sea-surface temperature (SST) unit.

At present the bulk of surface observations from the ocean comes from the VOS of the World Weather Watch system. About 7,000 ships from 49 countries now participate. One problem associated with VOS is the relatively low quality of their instruments and uncertainties in the measurements associated with the equipment and observers. Data from a selected subset of 46 VOS in the North Atlantic were examined during the Voluntary Observing Ships Special Observing Project - North Atlantic (VSOP-NA) in order to identify and quantify biases in VOS data (Kent and Taylor, 1991; Kent et al, 1991). The results showed that there was considerable room for improvement in the measurements made on the VOS.

The VSOP-NA program also looked for patterns in the errors found in the VOS observations themselves. One of the most striking finding was the low quality of the data collected by the U.S. vessels relative to the ships of other nations, including sea-surface temperature data. In the area of sea-surface temperature, the best data came from U.K. ships that use a sensor mounted inside the ship's hull at the waterline, rather than sensors mounted at the sea water intake for engine cooling, the normal practice on U.S. ships. The design of the UOP Sea Surface Temperature (SST) unit, therefore, used the same sensor mounting configuration as the U.K. Meteorological Office sensor. Front end electronics were mounted at the sensor location with RS485 communications and power coming from a remote (six feet away) VOS self-powered, self-recording unit.

The sensor mount (Fig. 1) consists of a PVC ring that is epoxied to the hull of the ship just below the waterline. A matching plate is fastened with bolts to this ring and the plate has a copper disk at the hull surface with a PRT (platinum resistance thermometer) embedded in it. On the other side of the plate is a cavity with electronics that is sealed by a gasketed cover. The two-board electronics consists of an analog front end and an ultra-low-power microcontroller unit that can communicate to the data recorder via RS485.

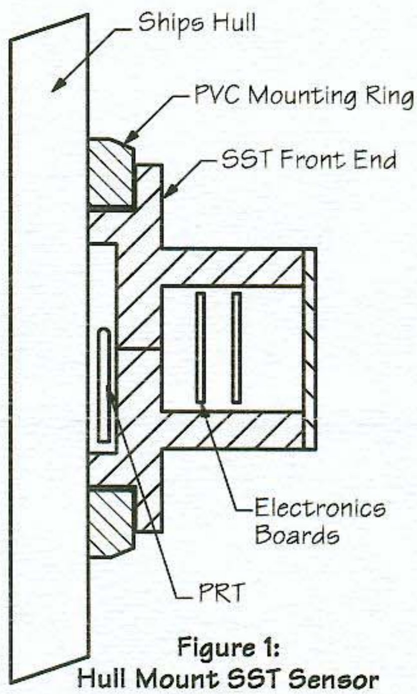

Figure 1:
Hull Mount SST Sensor

SYSTEM DESCRIPTION

The analog front end PC board (Fig. 2) uses an Anderson Circuit (NASA Tech Memo 104260-Oct 92). This provides a low noise interface to the PRT. The digital board (described below) digitizes the PRT and two precision reference resistors (Vishay 0.005% hermetic sealed, temperature stable resistors). Since the measurements are always made relative to the reference resistors, electronic drift is compensated for and an accuracy of five millidegrees C with a resolution of one millidegree is achieved. This is for a range of -10°C to +45°C.

The front end microcontroller PC board (Fig. 2) is sandwiched to the analog front end board via two single-row .100" center connectors. It includes the 16 bit A/D converter, RS485 interface and a small serial EEPROM for storage of calibration constants and miscellaneous configuration parameters. The low power microcontroller, currently a Microchip Technology PIC 16C56, operates at 2 MHz and total IDLE current consumption of the combined front end boards is less than 500 microamps at 12 vdc. Further power reduction in normal operation for VOS installations is achieved by turning off the front end power for all but 5 seconds out of each minute. A waterproof stuffing tube carries the underwater connector cable out of the PVC housing and interfaces to the data recorder, which provides switched +12 vdc power and RS485 communication. Note that this "internal" RS485 digital communications link follows a subset of the IMET standard communications protocol.

The data recorder is a self-powered, self-recording unit that provides sample timing, control, data conversion, storage to memory, and output communications using the standard IMET protocol. It is currently based on the TattleTale Model 8 from Onset Computer, Pocasset, MA, USA. Total average power consumption for the unit including the front end is 2.5 milliamps so that the eight alkaline "D" cell battery will provide power for six months. Data storage is a four megabyte Intel Type 2+ flash memory card on a PCMCIA adapter also available from Onset Computer. The housing is an underwater design unit that is o-ring sealed and uses underwater mateable connectors.

The installation consists of epoxying the PVC ring onto the hull and mounting a quick disconnect housing bracket up to six feet away. The test installation on the VOS - *CALIFORNIA STAR* had the bracket epoxied to a rib stiffener. This installation was four decks below the main deck and at the waterline. The complete unit was removed from the ship and brought back to WHOI for data retrieval. Typically, a second unit is installed at the time the first unit is removed. The data is easily accessed on the unit with (IMET protocol) digital commands from a laptop computer, either in RS485 or in RS232 (however, RS232 mode takes more power than the RS485 mode). The data retrieved from the *CALIFORNIA STAR* was excellent and has been processed with the navigation data and made part of the ongoing oceanic data archives.

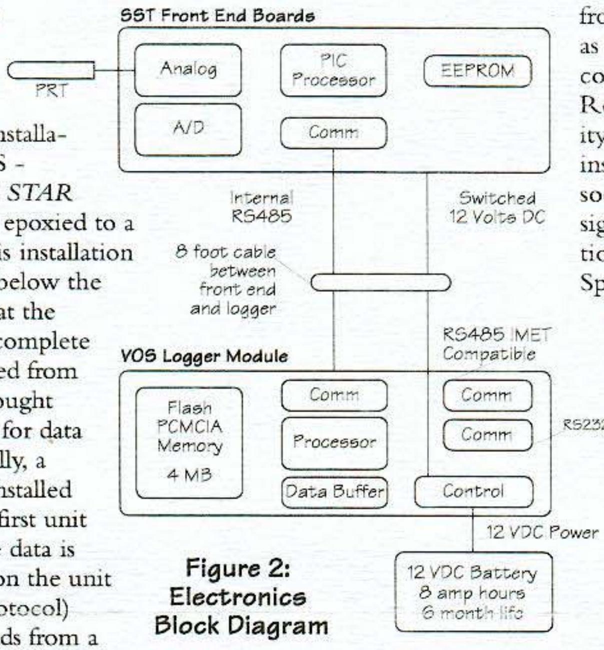

Figure 2: Electronics Block Diagram

FUTURE APPLICATIONS

One future need is to be able to connect the SST unit to a central data collection and/or satellite telemetry system via the IMET communications bus. However, this is difficult when working on a VOS with water sealed compartments that do not have access to cable ducts.

The architecture of the VOS SST front end (as well as the recently completed VOS Relative Humidity/Temperature instrument, and soon to be designed Precipitation and Wind Speed/Direction instruments) lends itself to several configuration scenarios. For example, a group of SST front ends, all individually addressable, may be strung together on a common RS485 link to create a fine scale, high accuracy SST measuring system over a distance of a few feet.

Another possibility, using the same electronics in a meteorological application, allows simultaneous measurement of two PRT's by the same interface, with one PRT mounted in an R.M. Young radiation shield while the second PRT is actively aspirated. In low or calm wind conditions, an aspirated PRT has been found to produce more accurate results. Adapting the VOS SST electronics for this use is straightforward, resulting in a single instrument producing high accuracy measurements in all wind conditions.

ACKNOWLEDGMENTS

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Note: Additional information and GIF images for this tech note as well as previous issues of the UOP Technical Note can be found on our homepage at http://uop.whoi.edu.

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