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A Partitioned Data Communications System

There are few scientists in the oceanographic community who handle any amount of digital data at sea who do not have access to stand-alone computer systems for scientific computation and data logging. However, one of their long-standing difficulties has been to gain ready access to vessel parameterization and its environs (navigation, speed, heading, sea surface temperature, etc.), during their cruise. Because of the fluidity of demands, applications, participants, etc., it has been difficult to picture a general solution to satisfy this data communication system requirement, which is compounded when researchers need to interface with data systems on ships foreign to them and which are sometimes in remote geographical places.

Today's large scale integrated (LSI) circuit technology presents the opportunity to re-appraise the hazy problem of shipboard data communications. This article is an attempt to again create some community interest in considering a common methodology for interactive shipboard data communications[1]. The solution to this problem, as envisioned by the Technical Planning and Development Group, at Oregon State University, is a partitioned, electronic system that allows the potential suite of twoscore shipboard sensors to be coupled by a standard data code to almost any computer system or data recorder.

[1] *Common Computer Interface Advantages*, Frank Evans & Roderick Mesecar, Working Conference on Oceanographic Data Systems, Woods Hole Oceanographic Institution, Nov. 1975.

July 1978

The goals of the proposed data communications system are:

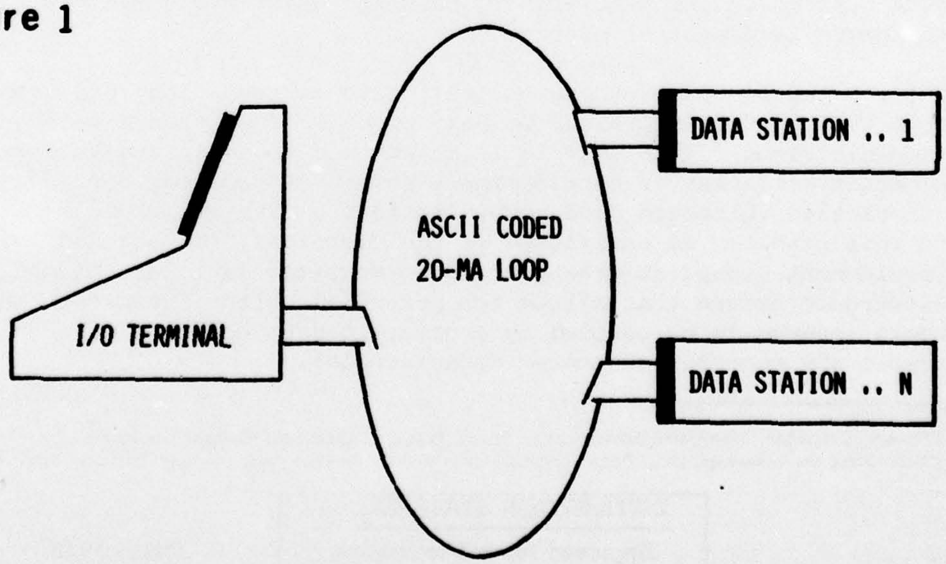
- Each sensor can be tested and calibrated independent of the rest of the system and have a digital output format.
- The system has good RFI immunity.
- The system can be easily configured and interacted with to meet the varied data needs of the scientists and their technical ability to interact with it.
- Provide an access to the identity and calibration of the sensors needed by the scientists to complement their data.
- A modularity where individual sensors can be moved from ship to ship without the need to develop a new interface, affect its calibration, or interfere with the function of the system it has been removed from.

The proposed shipboard system uses the serial ASCII, 20 mA current-loop for data transmissions and it has a layout similar to that shown in Figure 1. The component labeled "I/O Terminal" can be a teletype machine or any similar input/output device of higher intelligence configured, however, to send and receive 20 mA serial ASCII characters.

The electronic system partitioning was done at the sensor level where each associate data station has the following features:

- A means of assigning a unique address to the data station (a set of thumbwheel switches located at the station).
- A means of comparing the assigned address to an address which is transmitted over the serial loop by an I/O device or by another station on the loop.
- A means of converting the data obtained from the shipboard sensor into characters which can be transmitted over the serial loop.

Figure 1



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A Partitioned Data Communications System;
Direction Errors Induced by Case Magnetization for the RCM-5 Current Meter

272 268

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- A means of accomplishing the data transfer upon recognition of an address.

- A means of transmitting an alphanumeric message to provide a description of the data station and sensor.

The feature that data can be transmitted over a single pair of wires from a separate data station, with a unique address, to a graded set of I/O terminals, forms a basic and versatile data communications system. Expansion of the data system is done simply by adding another data station (or more) with a two-wire connection. Because of the inherent RFI immunity of the 20 mA current-loop, input and/or output devices can be located many meters from each other.

At the moment, this system has only two styles of data stations. One has the appearance of a 3 1/2-digit digital multimeter with a visual display. The converter portion of this station is built around the Motorola MC 14433 chip and is limited to 25 conversions per second. Any sensor with a voltage, current, or resistance output can be interfaced to the data station by using the front panel function and range switches. Another portion of this same data station is based on the Motorola 6800 family of integrated circuits. It is totally unnecessary, however, that the implementation of a similar data communication system be done with the same family of circuits. The only system similarity required is that the data station features previously listed are adhered to, and that it matches the 20 mA current-loop with serial ASCII data format.

The second style of data station is to be equally convenient to interface to sensors with frequency outputs. Using two styles of data stations result in a minimum of inventory and a maximum of interchangeability. Each data station, with displays, occupies a space of 8 x 10 x 16 cm, and it can be duplicated for about three-hundred dollars.

The operator has a minimal number of instructions to follow to activate a response from the data station via the I/O terminal. When the operator enters the data station number (address), preceded by a # symbol at the I/O terminal, the data station will respond with the most recently converted data. If the same procedure is used, but entering # (station number plus 50), the station will respond with its programmed message. A typical data station readout on a teletype is shown in Figure 2. The station message can be updated with a new program and can contain information on the sensor manufacturer, calibration, etc. The message feature also makes it convenient for the user to get an immediate listing of all the active sensors currently in the data communications network incorporated with his data set.

Figure 2

DATA SOURCE
ADDRESS: 0-48

DATA

#37 - 001 #37 - 001 #37 - 000 #37 000
#37 - 000 #37 - 000 #37 - 000 #37 000
#87

OSU DATA SYSTEM
ANALOG STATION - DIGITAL MULTIMETER
PARAMETER AND RANGE USER SELECTABLE
USER REQUIRED TO RECORD THESE SETTINGS

MESSAGE

STATION MESSAGE ADDRESS
(DATA SOURCE ADDRESS + 50) : 50-98

NOT SHOWN:

#49 - SET SYNOPTIC DATA CONDITION
#99 - CLEAR SYNOPTIC DATA CONDITION

The data stations have individual clocking sources or the clocking is provided by the associated sensor. If it is advantageous to have a synoptic reading from all the data stations, the #49 address will latch them up so that they can be sequentially sampled without the accustomed time skew. The next time the data station is addressed, the latch is released. Or, a #99 command can also be used to release all stations at once, at which time each encoder will begin updating.

The data-taking process which has been described so far can be automated by substituting an intelligent terminal for the human/teletype combination. The terminal can be programmed to scan any sequence of channels, request all messages, take synoptic data at a given time or when a data value crosses a preprogrammed limit, plus do the general housekeeping necessary for data archiving.

After examining a number of data communication system concepts, it appeared quite advantageous for the partitioned data system to capitalize on the features of the ASCII coded 20 mA current-loop and the similar RS-232 voltage communication standard. The IEEE 488 interface standard was rejected because it does not offer the partitioning freedom needed to allow the system to "fallback" to a single data station and teletype terminal. However, it is possible to access the proposed data communication system through most commercial intelligent I/O terminals that feature the IEEE 488 interface.

The responsibility for control and maintenance of portions of the data communication system can also be partitioned. Individuals are now free to have data stations that move between the laboratory and ship. The ship personnel need only to maintain a limited stock of data stations and the I/O terminals. If the scientists need to integrate a new sensor into the existing suite onboard the vessel, they can be given a data station to select a suitable scale, and they can calibrate it at their leisure.

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John Vito received his BS in electrical engineering from the City College of New York in 1965. He has spent most of his professional career as a circuit designer/systems analyst, first at Raytheon Company, then at the University of California at Berkeley. He is presently a part of the Technical Planning and Development Group, at OSU, where he designs data acquisition and data transmission systems.

Direction Errors Induced By Case Magnetization For The RCM-5 Current Meter

Aanderaa recording current meter cases were, until recently, electroplated with nickel--possibly as corrosion protection. This nickel plating can be magnetized and cause errors in direction as measured by the RCM compass. This note should alert users that the direction errors introduced in this way can be greatly magnified when the RCM is used at pressures greater than about 2000 dbar. At high enough pressures the effect we describe here can actually "lock" compasses in a constant orientation.

RCM's used in deep-sea research at Bedford Institute of Oceanography were observed to change their direction calibrations over time by as much as 10 degrees. The nickel plating was blamed for this, but it was not understood just how the changes occurred. When several long records from RCM deployments at 4000 dbar and greater showed nearly constant directions which were not physically reasonable, we began to feel that high pressures might have something to do with the compass problem, although there was no particular mechanism that suggested itself. However, we were concerned enough that a special nonmagnetic pressure bomb was fabricated to test the possibility. The nonmagnetic pressure bomb, fabricated from 6061-T6 aluminum, with its mounting frame, is shown in Figure 1. It was designed to maintain 5.1×10^6 Pascal (equivalent to 5000 m water depth) and to be portable enough to fit on the B.I.O. compass-swing table. (Additional details about this fixture can be obtained from the designers: Jean-Guy Dessureault and Donald Knox in the Metrology division at B.I.O.)

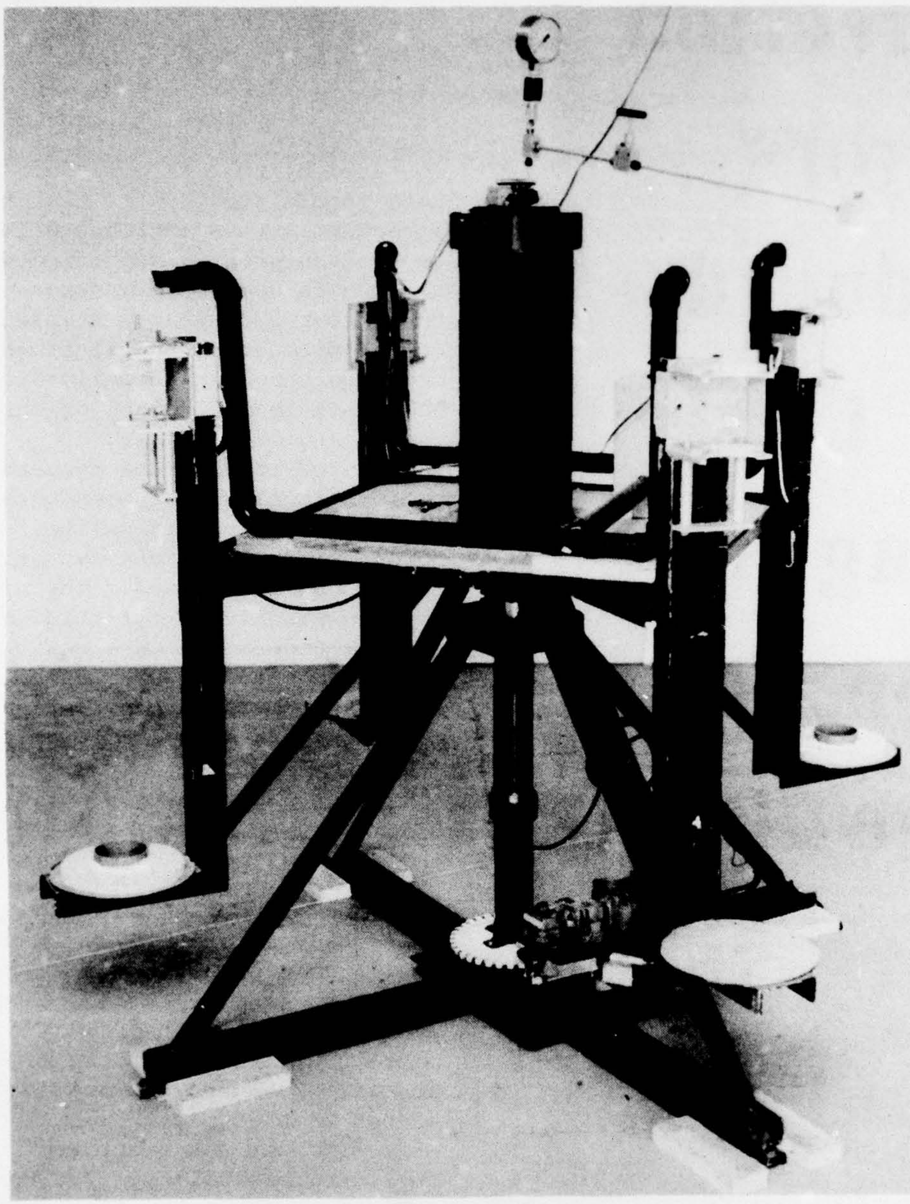

Figure 1

We discovered that pressure had a remarkable effect on direction error, as shown in Figure 2, giving compass calibration for RCM 1946 at several different pressures. We now understand this effect: mechanical stress can change the magnetic permeability of nickel and its hysteresis properties, and at high pressure the compass magnets can significantly magnetize the nearby nickel plating and are in return affected by the resulting field. A more complete description of our

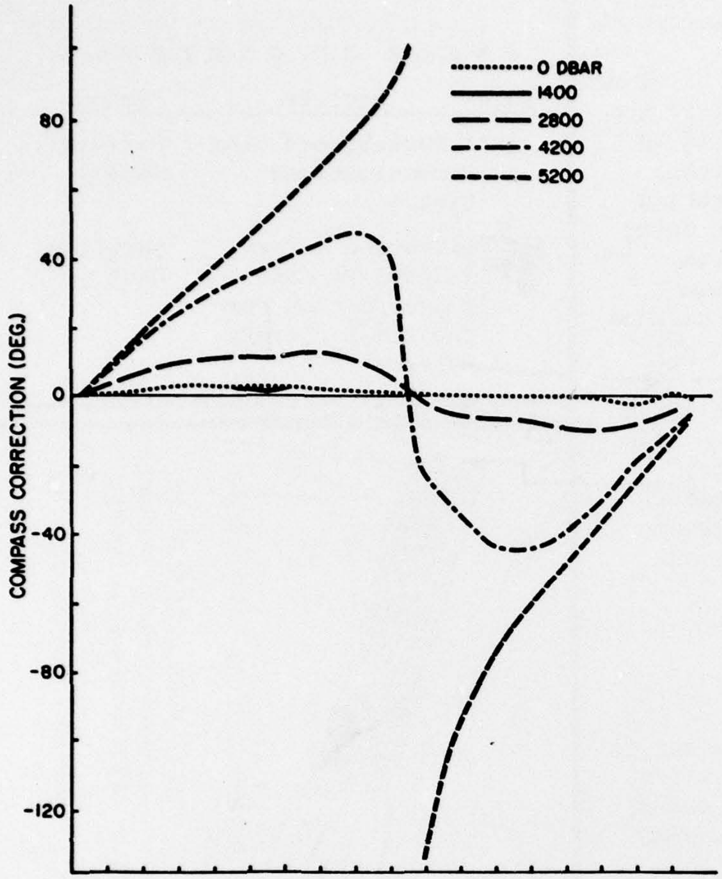

Figure 2

Calibration curves for RCM 1946 giving compass correction as a function of case orientation for pressures from atmospheric to 5200 dbar. The curves give the correction which must be added to the observed compass reading to give case orientation and they were obtained by pressurizing the current meter while it was oriented to true north.

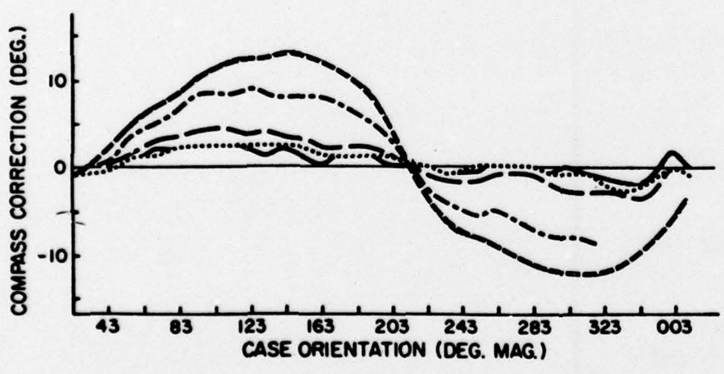

Figure 3

Calibration curves for RCM 1946 at atmospheric pressure after each of the tests illustrated in Figure 1.

findings has been submitted to *Deep-Sea Research* for publication.

The shifting compass calibration curves are also explained by pressure-induced effects. Figure 3 illustrates the compass calibration for RCM 1946 at atmospheric pressure <u>after</u> the instrument had been cycled to each high pressure.

Somewhere near serial number 2500, the manufacturer stopped the practice of completely plating the RCM with nickel, and the unplated instruments do not show the effect we demonstrated with RCM 1946. A visual inspection at the inner wall of the pressure case quickly shows if an individual instrument was nickel coated, and the direction problem can be avoided simply by not using coated cases at high pressures. However, old data may have been contaminated by this rather strange effect.

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