

Image Cover Sheet

CLASSIFICATION

SYSTEM NUMBER

507461

UNCLASSIFIED



TITLE

AN INEXPENSIVE LIGHTWEIGHT OCEAN ASCOUSTIC RESEARCH ARRAY

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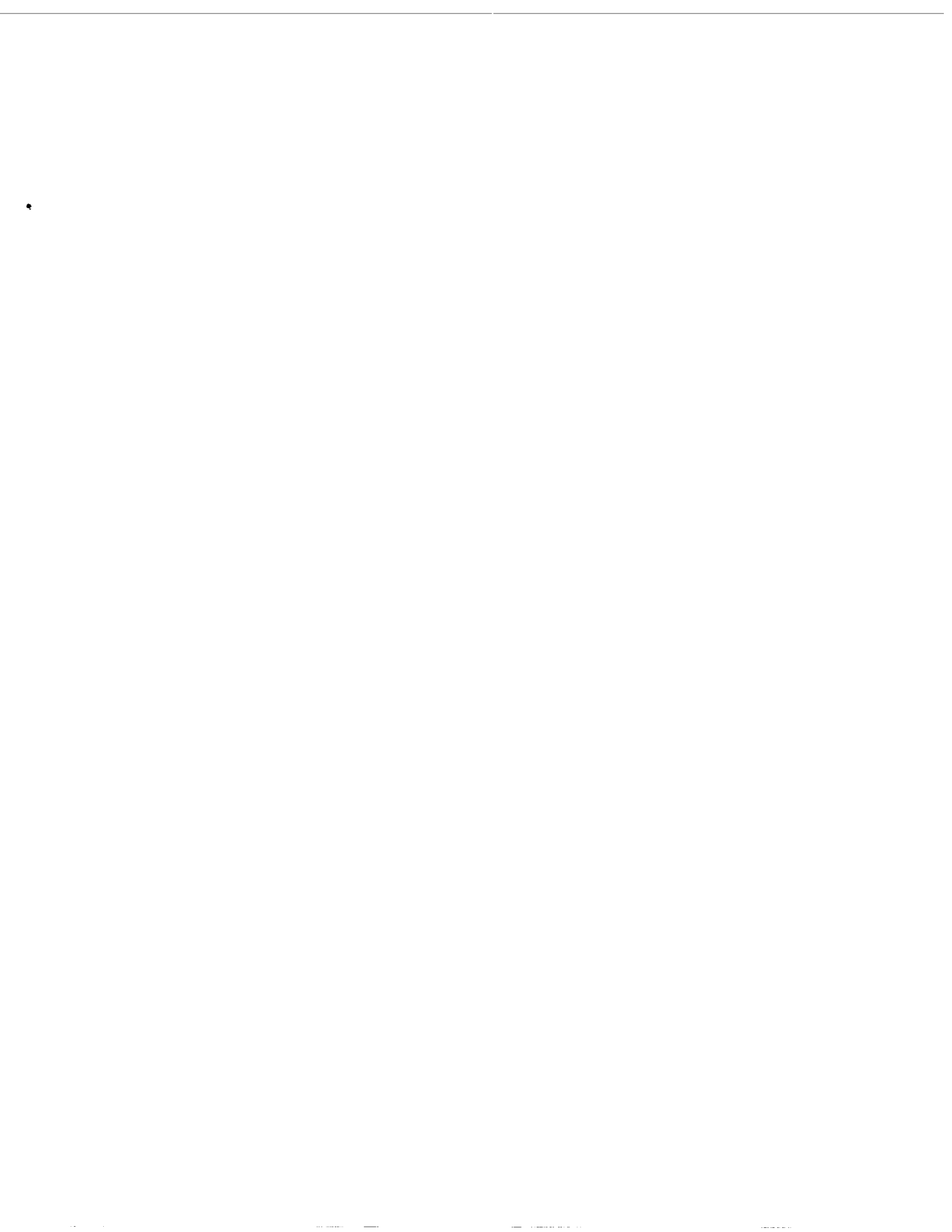
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An inexpensive lightweight ocean acoustic research array

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Abstract: Research arrays built at DREA have been intended for repeated usage over indefinite periods of time. These arrays have necessarily been ruggedly built, which has increased both the weight and cost of the arrays. Even with rugged construction, regular and expensive maintenance has been required to guarantee the operability of these research array systems. In the modern-day laboratory where financial and people resources are shrinking, maintaining existing research arrays or building new systems has become increasingly difficult. In an effort to provide acoustic research array systems for the future, we are now considering lightweight arrays using newer technology that are relatively inexpensive compared with their predecessors. This paper describes a research effort aimed at developing a serial-digital technology and lightweight array system that is easily reconfigured for different research objectives. A prototype array, with miniaturized data acquisition system is currently under development and will be trialed in the last quarter of this year. This array represents a transition from the rugged systems of the past to lightweight, low-cost, possibly disposable systems of the future.

INTRODUCTION

This paper describes a current research effort to produce an inexpensive, easily maintained, reconfigurable acoustic research array and data acquisition system that will allow researchers more flexibility in the number of sensors and array system layout, and at the same time reduce both maintenance and production costs. Our first prototype array will be a transition between the large heavy arrays of the past and future systems that might eventually be light enough to deploy by hand from small boats. Such systems could potentially be disposable if costs were significantly reduced.

In order to reduce costs, the prototype array will make use of commercially-available hardware and software as much as is possible. The use of pressure cases will be kept to an absolute minimum further reducing the weight and cost of the array. As far as possible all application programming will be done in high-level windows based software, to reduce development and maintenance time.

PROTOTYPE ARRAY

The prototype array currently being constructed will be configured as a bottom-mounted horizontal line array (HLA). The array is intended for operation in shallow water up to several hundred metres deep. The array will consist of 16 hydrophone stations uniformly spaced along the planned 500 m aperture of the array. A small plastic pipe pressure case (schedule-80 PVC) will house the array control circuitry and a PC104-based data acquisition system. An external D-cell battery pack will supply operating power to the data acquisition unit (DAU) and array. A small surface float will be attached to an anchor weight to provide a surface location and recovery line for the array. Figure 1 shows a sketch of the array configuration.

Each hydrophone station will consist of a hydrophone constructed from a 2.54 cm diameter piezoelectric cylinder of length 2.54 cm (having sensitivity $-192 \text{ dB}/1\text{V}/\mu\text{Pa}$ after being potted), a low-noise pre-amplifier and anti-aliasing filter, a 12- to 16-bit analogue-to-digital convertor (A/D), time-division telemetry circuitry, and line drivers. Figure 2 shows a hydrophone station cast in epoxy resin that has been used for calibration and mechanical testing. The final version of the hydrophone station is expected to be smaller than the one shown, where the resin body is about 30 cm in length.

The pre-amplifier/filter circuitry operates on 0.14 mA and provides a pass-band of 0–900 Hz. The filter employed is a 24 dB/octave linear-phase low-pass Bessel filter. Forty-six decibels of gain is provided by a 2-stage amplifier integrated with the filter circuitry.

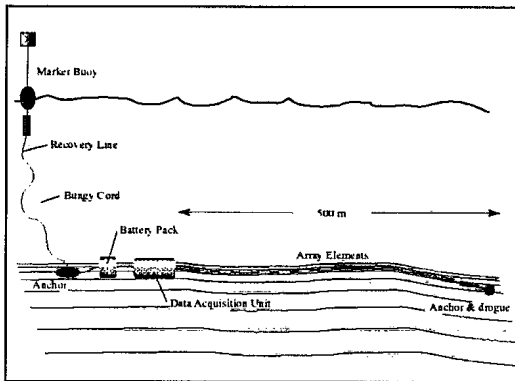


FIGURE 1. General layout of the prototype array currently being constructed.

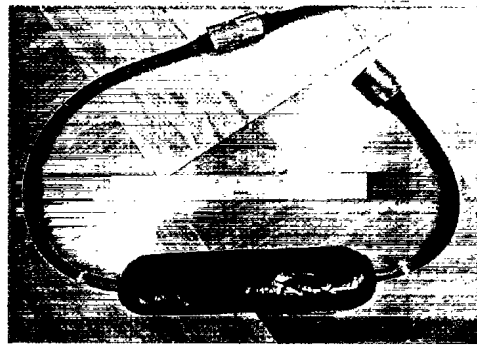


FIGURE 2. Test model hydrophone station cast in flexible resin. Future versions will be much smaller and the connectors will be potted in the epoxy body.

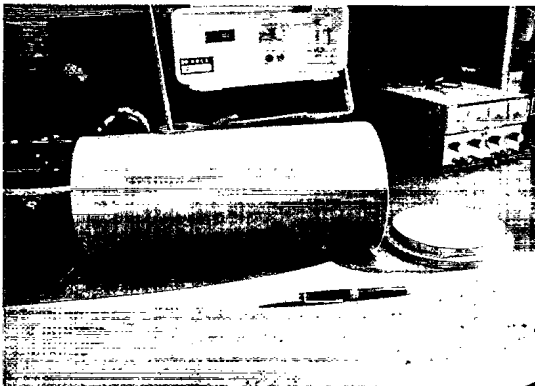


FIGURE 3. Photograph of an underwater pressure case constructed from schedule-80 polyvinyl chloride plastic pipe and sheet materials.

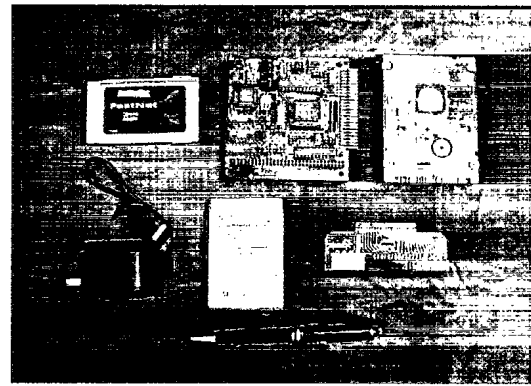


FIGURE 4. Photograph of some of the PC104 components that will be incorporated in the DAU. The pen shows the scale of the components which include ethernet, I/O, IBM 3GByte hard drive, and flash memory.

The A/D currently in use is a CS5317 delta-sigma 16-bit design by Crystal. This A/D draws approximately 20 mA and represents a relatively heavy current load. We are investigating replacing the A/D with a Burr-Brown ADS7822 12-bit A/D. This chip should require less than 1 mA at the desired clock rates (2500 samples/sec). Allowing the use of non-delta-sigma A/D's is the reason for incorporating an active filter in the pre-amplifier.

Digitized data from the A/D system is transmitted to the receiver unit through the use of a very simple time-division telemetry circuit. The current scheme allows for 16 channels/bus with 16-bit resolution, additional channels are handled by using multiple bus cables. Sampling and telemetry rates are derived from a low-frequency clock generated in the array control circuitry. This clock signal propagates through long arrays as if they were equipotential lines rather than transmission lines, thus simplifying the circuitry requirements. By varying the clock frequency the sampling rate can be adjusted within limitations imposed by the data telemetry rates sustainable along the array cables. Telemetry data is transmitted between hydrophone stations and the array receiver using a high-speed multi-point bus transmission line implemented with Analog Devices AMD1485 RS-485 transceivers. In current testing with older 485 integrated circuits we have achieved 900 kbaud over 550 m of #26 gauge twisted-pair cable.

The data acquisition unit (DAU) will be an autonomous system based on PC104 architecture. The DAU will also contain the array receiver/control unit. The prototype system will operate on a pre-programmed duty-cycle. The on/off cycle simplifies concerns about real-time programming and eliminates worry about disk noise as the drives will be in sleep mode during data acquisition. Figure 3 is a photograph of a pressure case for the DAU built from PVC pipe OD 16.8 cm. This pressure case was tested to over 4.8 MPa before catastrophic failure. Figure 4 shows some of the components that will be included in the DAU. The processor is a 486/100 MHz running Microsoft Windows 95. The data acquisition program is being developed in National Instruments LabView. This system provides 6 GBytes of hard disk storage which is adequate for more than 30 hours of operation with a 2-on/1-off duty-cycle.

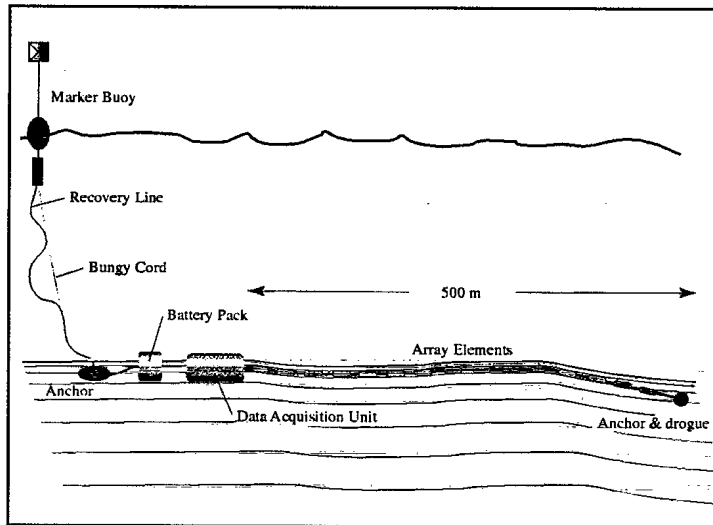
We plan to sea-test the prototype array in summer 1998 in preparation for acoustic experiments scheduled for autumn 1998.

An inexpensive lightweight ocean acoustic research array

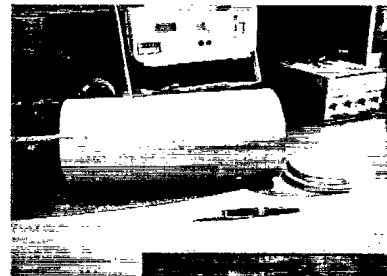
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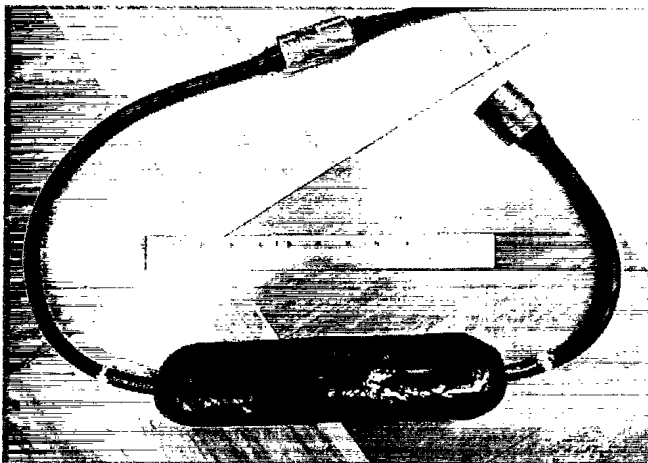
Abstract: Research arrays built at DREA have been intended for repeated usage over indefinite periods of time. These arrays have necessarily been ruggedly built, which has increased both the weight and cost of the arrays. Even with rugged construction, regular and expensive maintenance has been required to guarantee the operability of these research array systems. In the modern-day laboratory where financial and people resources are shrinking, maintaining existing research arrays or building new systems has become increasingly difficult. In an effort to provide acoustic research array systems for the future, we are now considering lightweight arrays using newer technology that are relatively inexpensive compared with their predecessors. This paper describes a research effort aimed at developing a serial-digital technology and lightweight array system that is easily reconfigured for different research objectives. A prototype array, with miniaturized data acquisition system is currently under development and will be trialed in the last quarter of this year. This array represents a transition from the rugged systems of the past to lightweight, low-cost, possibly disposable systems of the future.



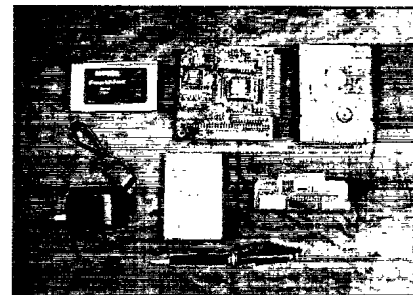
Prototype array format.



PVC pressure case before and after testing.



Test model hydrophone station in flexible resin.



PC104 data acquisition system components.

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