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Woods Hole Oceanographic Institution

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A PULSED LIGHT COMMAND SYSTEM
FOR THE SCAMP PLATFORM AND ALVIN

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prepared by

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SCAMP Platform - Dockside Test

ABSTRACT

This report describes the pulsed light command system used on an ancillary platform designed to augment the task capabilities of the submersible ALVIN.

Deep submersibles are called on to perform increasingly complex tasks on the bottom of the ocean. Many tasks that are not within the capabilities of a specific submersible can be accomplished by using an ancillary platform. The submersible then assumes the roll of controller much in the same manner as a tug boat or even a tractor trailer cab in controlling the load carrying vehicle. The ancillary platform carries the load and provides for special task requirements. Control of this platform underwater then becomes the primary submersible task. Mating and unmating connectors at depth is one part of the task and is generally an unsatisfactory operation because alignment is difficult and electrical insulation resistance is of low quality. In addition most submersibles have a limited number of electrical wires penetrating the hull that can be made available for control purposes. Some type of command link is required that does not require hull penetrators, has reasonable alignment requirements, can be mated and unmated underwater many or unlimited times and provides good command reliability. Since most submersibles have viewports, a pulsed light transmitter through a viewport was reviewed and found to satisfy all of the requirements. There are no wiring modifications required and the transmitter unit can be easily installed and removed as required. An acoustic link was considered but this would have required some ships wiring. In addition, there are many acoustic devices on submersibles and interference would be an important consideration. Finally, the pulsed light technique has not been investigated as extensively as acoustic methods and is of interest as an alternative approach.

A project to evaluate the feasibility of ancillary platforms with a pulsed light command link was carried out. This project was called SCAMP for Self Contained Ancillary Modular Platform.

Introduction

The Self Contained Ancillary Modular Platform (SCAMP) provides a universal mounting base for large objects such as drills, sequence cameras and other scientific equipment. SCAMP is an aluminum structure with syntactic foam buoyancy blocks attached so that the submersible ALVIN can set on and attach to it. ALVIN and SCAMP can be launched at the surface and land on a pre-selected point on the ocean bottom. SCAMP is capable of anchoring itself to the bottom through the use of suction pods. SCAMP is trimmed and ballasted at the surface so that it always presents a balanced negative 100 pound load to ALVIN, for any equipment attached. Since ALVIN can place SCAMP in a position that is selected by direct observation on the bottom, information can be obtained or samples taken that would not be possible from a free fall device. After ALVIN has placed SCAMP on the bottom and activated the equipment, ALVIN is free to detach from SCAMP, perform other work in adjacent areas and return to re-attach to SCAMP. SCAMP has internal batteries and control contactors to provide power for all platform and science functions.

A pulsed light command system is used to send commands through ALVIN's bottom viewport to an optical receiver on SCAMP. The ability of the ALVIN pilot to control the platform and science equipment without interconnecting cables results in a versatile platform that can perform many science tasks with a minimum expenditure of submersible time. The pulsed light system eliminates the need for mating waterproof connectors to the submersible. The system described was built and operational feasibility shown by testing with ALVIN.

Figure 1 shows the system interconnection diagram as implemented during test. The command electronics was inside of the ALVIN sphere and this drove a General Radio Strobotac that transmitted light pulses through ALVIN's bottom viewport. The light pulses were received by the optical receiver and processed in the SCAMP electronics. The electronics provided control signals to the control contactors for activation of platform functions. Twenty two of a possible 100 commands were utilized during the

test and are given in Table 1. A system block diagram is given in Figure 2. The command electronics inside of ALVIN has a thumbwheel switch and a momentary command switch. The command is set into the thumbwheel switch and then transmitted when the momentary switch is pressed. The package has a power on-off switch and an "Emergency Rail Release"(00) command switch. When the (00) command switch is activated, continuous emergency rail release commands are transmitted. The light pulses are received by the light sensor on SCAMP and decoded in the electronics package. Electronic latches are set that control power contactors in the SCAMP control pod. The command is also transmitted to an LED display that is located within view of the ALVIN viewport. This feature was of great value during the system test and initial interface tests with ALVIN. Proper system operations could be confirmed by observing this display after initiating a command. Figure 3 is a photograph of the pulsed light system components.

Word Structures

The circuit details will be reviewed one section at a time. A discussion of word structure will be given first since this determines most of the circuit functions. Several single pulse codes were evaluated and one code was breadboarded. Since there are several xenon arc tube strobes on ALVIN these single pulse systems were susceptible to light interference and possible false commands. The final structure was designed to provide a high level of command security and command inhibit in the presence of extraneous light pulses. The word structure is shown by Figure 4. The light pulse frequency is 500 hz. A "sub-bit" is 20 milliseconds long and has either 5 pulses or two pulses in the first 10 milliseconds. A "bit" consists of four "sub-bits" and is 80 milliseconds long. There are three "bit" formats. A logic "1" consists of 5 pulses, 2 pulses, 2 pulses and 2 pulses. A logic "0" consists of 5 pulses, 5 pulses, 2 pulses and 2 pulses. A "sync" bit consists of 5 pulses, 5 pulses, 5 pulses and 2 pulses. A "word" consist of 8 bits and is 640 milliseconds long. A command word consists of two BCD digits corresponding to the thumb-wheel command switch. A command word is started on the next "beginning of word" time after the momentary switch is pressed. When a command word is not being sent, all "sync" bits are transmitted.

Optical Command Transmitter/Coder

This function is contained on two circuit cards as shown in Figure 5. IC (1) provides a 500 hz oscillator to produce the sub bit pulses. IC (2) is a divide by 10 chip and IC (3) is a ripple counter. The outputs of the ripple counter are the beginning of word pulse and signals to IC's (4), (5) and (6) that generate the "0", "1" and "sync" formats as well as the data shift pulse. At each beginning of word pulse, the output of IC (8) flip-flop is sampled and if it is hi, the contents of the "1"'s and "10"'s thumbwheel switches are gated into the data register, IC's (11), (12), (13), and (14). IC (8) is set by the data xmit command switch. The shift register then has "1"'s and "0"'s shifted out to gate the bit format and thereby transmit the word. When there is no data being shifted, all

"sync" codes are transmitted. Switch S1 locks out the normal code and transmits a continuous (00) or emergency rail release command.

Strobotac

The General Radio Strobotac is capable of pulsing at the 500 hz rate in the externally driven mode. The unit is placed above the ALVIN bottom viewport and transmits the light pulses through the viewport to the SCAMP optical receiver.

Optical Receiver/Electronics

The optical receiver uses a photo diode as the light detector. A high gain amplifier is built into the sensor case. A CA3130 single voltage op-amp provides the required amplification. The initial design had op-amps inside of the electronics package but was susceptible to electrical noise and was replaced. The pulses go to both IC (2) and IC (1). IC (2) is a one-shot that provides a 12 millisecond pulse starting on the leading pulse of the series. This is designated signal (A) on the receiver timing diagram Figure 7 and schematic Figure 6. IC (1) is a counter from which a signal (E) indicates a 2 pulse series and signal (D) indicates a 5 pulse series.

Signal (B) is at the leading edge of signal (A) and is used to reset both flip-flops in IC (5) and provide a bit clock. The inverted signal (A) is signal (C) that is used to reset the pulse counter IC (1) and to provide a sub-bit clock pulse, signal (F) after being 'anded' with the "2 pulses present" signal. If there are 5 pulses then the "data one" flip flop IC (5) is set hi, otherwise it is set low. The counter IC (1) is reset after 12 milliseconds so that pulses arriving after the 5 pulse sub bit will not be recognized as good data.

The First Shift Register receives the 'hi' and 'low' sub bits that is gated by signal (F). The code is set up so that a bit pattern can only be recognized when all 4 sub bits are in place. IC (5) and IC (4) decodes the pattern

into BCD "1"'s and "0"'s or "sync" bits. The sync bits cause a complete reset of all counters. "1"'s and "0"'s are shifted to the second shift register and when 8 bits are shifted a "data strobe" is generated. The second shift register and decoder consists of 8 flip flops and two BCD to 10 line decoders, as shown in Figure 8.

The command-on/command-off latch uses two 'nand' gates as shown in Figure 9. To latch, both input lines and the "data strobe" must be high. One input line is from the "Ones" decoder and the second input line is from the "Tens" decoder. The ones and tens correspond to the thumbwheel switches. Thus the wiring from the decoders to the latches constitutes a "program" for the commands. Each latch circuit drives a contactor in the control pod. The command-on/timed-off latches use one 'nand' gate but instead of a flip flop uses a one-shot of preset time duration per Figure 10. This allows commands to be transmitted for specified times and automatically turn off. This feature is quite useful with a manipulator. A manipulator motion would be "on" as long as the switch were closed and would stop some set time after the switch was opened.

The output of the second shift register also was buffered and displayed on a 2 digit LED display. The data strobe updates the display after each new command is sent. This display is cast in clear plastic and is located outside of the ALVIN viewport.

System Tests with ALVIN

Fabrication and laboratory testing of the pulsed light system was completed in early spring, 1975. The SCAMP platform complete with the pulsed light system was taken to Andros Island for submerged tests with ALVIN. The purpose of the tests was to prove the feasibility of unclamping and reclamping a platform to ALVIN and transmitting commands via pulsed light through the submersible viewports.

Dockside testing showed the feasibility of transmitting light pulses through the air-water interface. Some shading

of the receiver was required to prevent direct sunlight from saturating the light diode. The Strobotac was suspended over the light receiver with SCAMP in the water on the surface and all functions checked out. The command received display proved invaluable during this testing. Initially the pump motor noise caused system blanking. This was circumvented by putting the pump motors on the timed latch circuits so that the motors shut off after a predetermined time. After the motors shut off, other commands could then be transmitted.

SCAMP was floated underneath ALVIN by divers using flotation bags. Once SCAMP was in position, the light transmitter was used from inside ALVIN to command the rail clamps to lock on ALVIN. This operation proceeded very smoothly. ALVIN submerged and carried SCAMP to the bottom in shallow water. It took sometime after initial landing for the sediment to clear from the water. After the sediment had cleared sufficiently to evaluate the bottom, a rail release command was transmitted and indicated on the command display. The rail locks pumped down and ALVIN floated free of SCAMP. ALVIN propelled forward and then circled back to the SCAMP. The visibility was extremely poor but ALVIN slowly made visual contact and positioned itself above SCAMP and aligned the bottom viewport to the light receiver. A rail lock command was transmitted and was displayed on the command display. The rail locks clamped and divers inspected the mating. One ALVIN rail was properly in its rail clamp but the other was about 1" out of the clamp. The SCAMP was on a tilt and ALVIN could not seat properly. A rail unlock command was transmitted and properly received. After ALVIN was free from SCAMP, all three people in the sphere moved to one side of the sphere and the lift props were run at full speed. A rail lock command was transmitted but was not indicated by the command display. Many attempts were made to transmit but the receiver was being blanked and no command could be transmitted. The electrical noise from the lift props seems to have totally blanked the commands. ALVIN could not get seated without using the lift props and could not transmit commands with lift props on. Divers then used straps and clamped the SCAMP to ALVIN so that a retrieval could be made.

The design was reviewed and several areas of probable

noise susceptibility determined. These include insufficient isolation from the ALVIN main battery and receiver input line lengths being too long. The battery isolation was addressed by adding independent batteries in both the transmitter and receiver. The receiver had the preamplifier built into the sensor head thereby eliminating the line length noise pick up susceptibility.

Future Use

After the test program at Andros Island, SCAMP was returned to Woods Hole and stored in the warehouse. The concepts were successfully demonstrated and now the prototype hardware is available for specific applications. A project that would require SCAMP or some sub system of SCAMP would have to provide for interface and check out.

Table 1
SCAMP COMMANDS

10 's	1 's	
0	0	Emergency Rail Release
0	2	Emergency Rail Reset
1	1	Battery Enable
1	2	Battery Disable
1	3	Battery ON
1	4	Battery OFF (Reset)
2	1	Rail Lock ON
	2	Rail Lock OFF
	3	Rail Lock Pump UP (Fwd.)
	4	Rail Lock Pump DOWN (Rev.)
3	1	Suction Pods - Port - Suction
	2	Suction Pods - Port - OFF
	3	Suction Pods - Port - REVERSE
4	1	Suction Pods - Stb - Suction
	2	Suction Pods - Stb - OFF
	3	Suction Pods - Stb - REVERSE
5	1	Suction Pods - Aft. - Suction
	2	Suction Pods - Aft. - OFF
	3	Suction Pods - Aft. - REVERSE
6	1	Flood Light - ON
	2	Flood Light - OFF
7	1	Light on - 10 sec.

Figure 1 Block Diagram

Figure 2 Functional Diagram

Figure 3 System

Figure 4 Word Structure

OPTICAL COMMAND TRANSMITTER / CODER

Figure 5 Schematic

Figure 6 Optical Receiver

Figure 6a First Shift Register

FIG. 7 RECEIVER TIMING DIAGRAM

FIG.8 SECOND SHIFT REGISTER/DECODER

FIG.9 SIX LATCHES AND RELAY DRIVERS

FIG.10 ONE SECOND PULSER AND DELAY DRIVER