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Woods Hole Oceanographic Institution

Ten-Inch Glass Ball ARGOS Transmitter using Seimac Ltd. Platform Terminal Transmitter

by

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Technical Report

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Approved for Distribution:

Philip Richardson

Philip Richardson, Chair
Department of Physical Oceanography

Table of Contents

Abstract

This is a description of the design and motivation for the newest generation of submersible ARGOS transmitters currently used by the Subsurface Mooring Operations Group at Woods Hole Oceanographic Institution as well as the general operations and assembly procedures.

Introduction

Since the mid 1980's the Subsurface Mooring Operations Group at Woods Hole Oceanographic Institution has been using ARGOS compatible PTTs (Platform Terminal Transmitters) in many different capacities, from data collection and location, to emergency beacons for sub-surface moorings.

Experience has shown that PTT's work very well to inform the user if a problem occurs and the top of the mooring surfaces prematurely. To date these transmitters have been the single piece of equipment responsible for the recovery of at least four subsurface moorings that, before the days of ARGOS, would have been lost because we would not have known that the mooring had surfaced ahead of schedule. There have been two different triggering mechanisms used, one utilizing a light sensor and the other a mercury tilt switch. Since the subsurface moorings are normally deployed below the level where light reaches, the light sensor system was adopted to eliminate any possible problems seen when using a pressure switch (i.e. no moving or mechanical parts to foul or fail). Some of the earlier transmitters were modified with mercury switches and mounted upside down on the bridle legs of surface buoys so that, should the mooring break and the buoy "turn turtle", the transmitter would turn on.

The early transmitters, used by us, were manufactured by Toyocom and Synergetics. These units were relatively large in size and required large housings to make operational. In 1993, after a demonstration from Seimac Ltd., Ocean Research Support, Dartmouth, Nova Scotia, Canada, we determined that the Seimac Smart Cat III transmitter could be easily programmed to be the next generation emergency "watch dog" beacon. There are other commercially available transmitters currently on the market, such as those made by North American Collection & Location by Satellite (NACLS) and Orca Instrumentation, but, with low cost being one of the primary considerations and with today's ever increasing economic constraints, the high price of these assembled units has made the in use almost prohibitive to us. By purchasing the various parts and assembling them in house, we are able to construct 3-4 PTTs for the cost of one complete transmitter from these other companies. Seimac also markets an assembled unit for about half what other manufacturers currently charge.

Another requirement was to use basically off-the-shelf items to make the PTT. Although the concept of using light sensors as the switch network for these transmitters is not a new one, Seimac was willing to create the antenna ground plane and light sensor network at a low affordable price that would work with their PTT. It was then decided that one of the best, low cost housings would be a 10 inch glass sphere from Benthos Inc. This glass sphere was selected due to its depth rating and inexpensive cost. To round out the design, a battery pack was designed in the shape of a horseshoe to fit inside the sphere.

The design has proven to be very flexible and useable. Since 1993 the glass ball ARGOS transmitter has been adapted to many different configurations, three of which are in current use:

1. Attached to a 60 " syntactic foam sphere	Figure 1
2. Attached to a three-ball float	Figure 2
3. Attached to a 48" syntactic foam ADCP sphere	Figure 3

Other applications could be considered depending on mounting constraints.

It is our intention to adapt the Seimac transmitter into an aluminum tube-type housing in the future. Although the transmitter is protected by plastic hard-hats, it has been seen that there is a slightly higher incidence of breakage of the glass enclosure.

To date none of the Seimac PTTs have been modified with the mercury switches mentioned earlier.

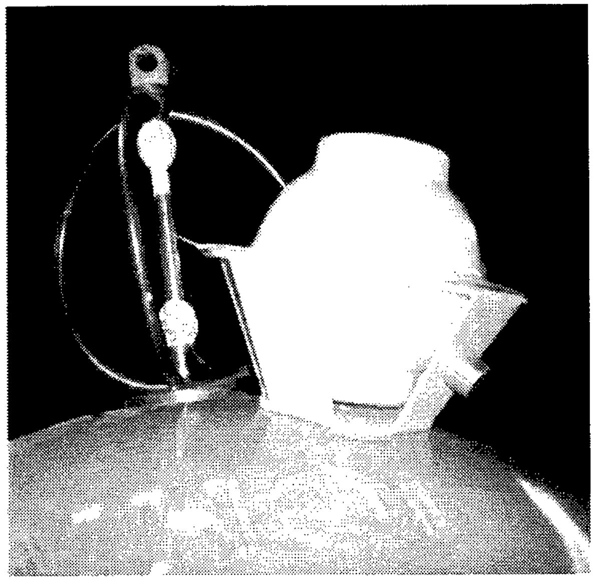


Figure #1

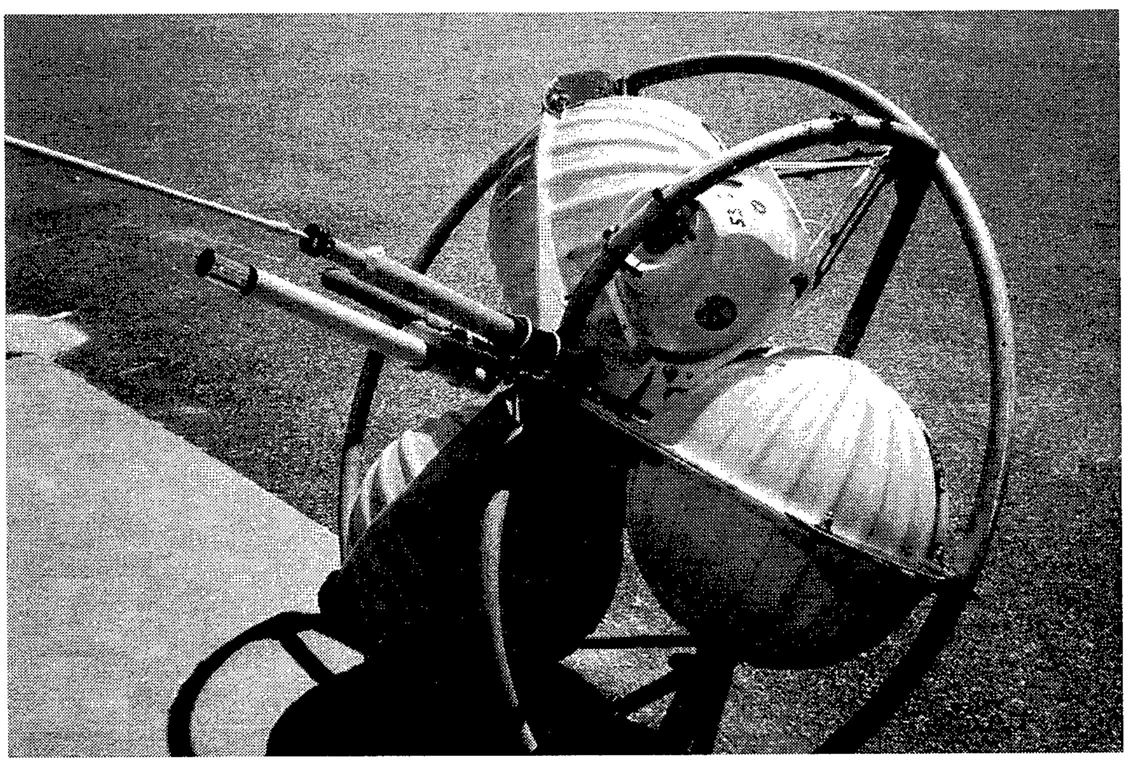


Figure #2

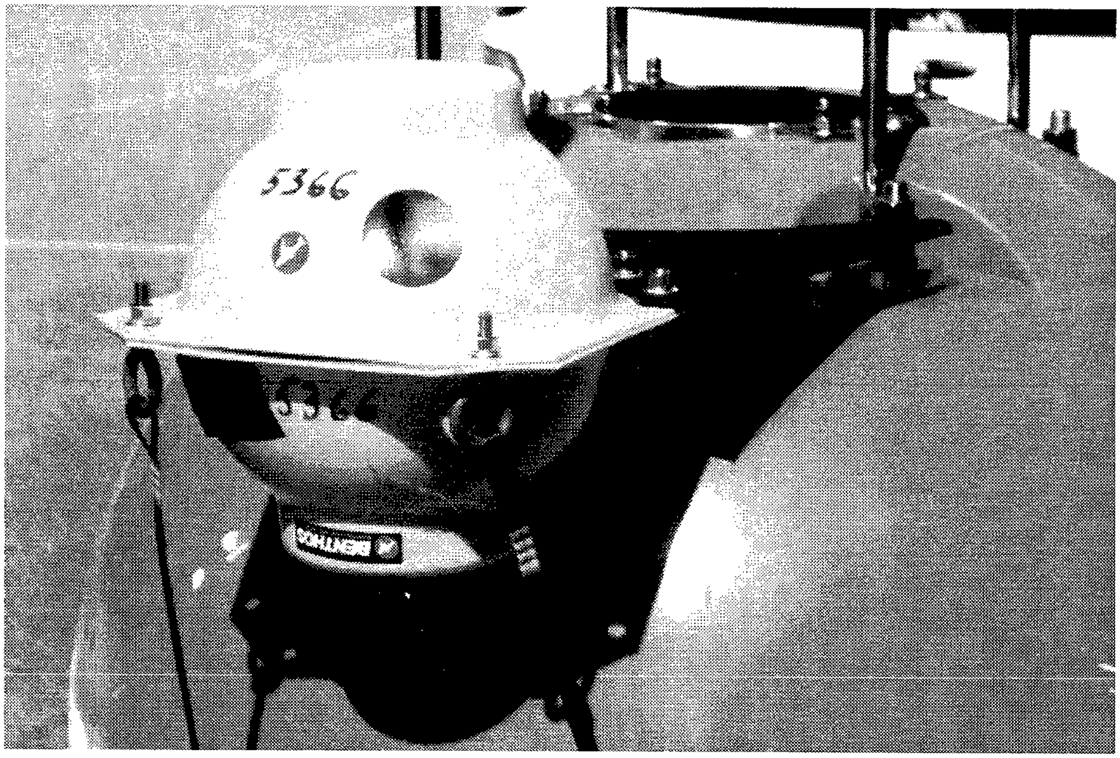


Figure #3

Application

Currently all subsurface moorings deployed by our group have an ARGOS compatible PTT attached to the top flotation member to alert us should something go wrong in mid deployment. It is normal procedure to attach the transmitter to the upper flotation since, should the mooring fail, we can expect this part of the mooring to be on the surface. We rigidly attach the transmitter to the float assuming that the float will surface upright due to the weight of chain or ballast below the float.

The battery capacity is such that the PTT will transmit signals to Service ARGOS every 90 seconds for a period of up to 13 months. In all instances when a transmitter has come to the surface, we have been able to find a "ship of opportunity" within 2 weeks to go out to recover the equipment on the surface.

We do not normally use Service ARGOS to monitor the platforms as there is a daily charge if they provide this service. Instead, we monitor the program a few times a week from in house to determine when the transmitter comes to the surface and subsequently plot the movement of the platform to assist in the recovery of the equipment.

The Seimac PTT is programmed to provide two different options using reed switches. By simply removing the on/off magnet, the transmitter will go into a deployment standby mode. In this mode, the transmitter will wait for 8 hours before starting to look for light on the three separate sensors. This allows enough time to deploy the mooring and let the transmitter get deep enough to not see light. The light sensors are connected and programmed into the Seimac controller in such a way that should any two of the three sensors detect light equivalent to that of a dimly lit room then the transmitter will turn on. The controller will sample the sensors every five minutes and when enough light is detected to trigger the first transmission, the transmitter will remain on until the on/off magnet is applied or the battery is disconnected. This 8-hour delay is changeable at time of purchase according to user requirements. There is a second reed switch that, if closed with a second magnet prior to removal of the on/off magnet, will put the transmitter into test mode. This eliminates the delay time and the transmitter will then start transmitting immediately. Normal transmission is one position transmission every 90 seconds. Again this transmission interval is programmable according to user needs and Service ARGOS standards.

ARGOS GLASS BALL OPERATING INSTRUCTIONS

Description

The ARGOS glass ball is an ARGOS compatible Platform Terminal Transmitter (PTT) mounted in a Benthos 10 inch spherical glass instrument housing (Model 2040). The PTT and control circuit (Model Smart Cat III) are built by Seimac Ltd. and is designed to be used as a detection and tracking device for subsurface moorings that have released prematurely. The device is completely self-contained. The glass ball is housed in a hard-hat that is mounted in various ways to the top mooring flotation.

The device has two control switches, which are operated with magnets from outside the sphere. The POWER switch will close (turn on) when the magnet is removed. The TEST switch is closed when a magnet is placed on the switch.

When the mooring is deployed, the PTT will wait approximately 8 hours before it starts monitoring the photo detectors. When the mooring returns to surface, the PTT will start transmitting to Service ARGOS via NOAA satellites (at the next dawn if it surfaces at night).

The battery voltage level is included in the data field of the transmission. See below for further details.

For specifications on the instrument housing see the Benthos Instruction Manual.

For specifications on the PTT see the Smart Cat III User's Manual. Appendix C in the Smart Cat III Manual covers the Optical Recovery option on these PTTs.

Modes of operation

Delay Mode: To put the unit in delay mode simply remove the magnet from the POWER switch. After approximately 8 hours the PTT will go into Sleep mode.

Sleep Mode: The unit monitors the photo detectors once every 5 minutes. When two of the three detectors sense sufficient light, the PTT will start transmitting every 90 seconds* until power is removed or the battery is sufficiently depleted.

Test Mode: To skip the delay period (and start transmitting) place a magnet on the TEST switch then remove POWER magnet. (The power magnet must have been in place for at least 60 seconds to ensure the transmitter powered down.) The unit will start transmitting every 90 seconds*. The TEST magnet must be kept in place to maintain the TEST mode.

* This value has been known to vary between 90 and 110 seconds.

Power budget

The 10.5 volt battery has the capacity of 21 Ahr (amphere hours)
The PTT uses 0.52 Ahr per year when in sleep mode and 1.52 Ahr per month when in Test mode (transmitting).

Deployment Durations

Mode	Actual	70% Safety Factor
Test mode: continuous transmitting	13.8 months	9.7 months
2 year deployment: Sleep mode for 2 years	13 months	9 months

These figures are based on a 90 second transmit interval, a Sleep mode current of 60μA, and Test mode average current of 2.11mA.

Reading the data field

A Telonics ARGOS receiver can display the battery level value in either decimal (N mode) or hexadecimal (D mode) format. The following is a printout of N mode display.

03-19-96 13:27:32 ID 05366 NA
198 000 000 000

The first line has the date and time of transmission then the ID number of the PTT. The **NA** indicates NORMAL (decimal) mode and ALL meaning all transmissions are displayed.

The second line contains the data field starting with the first byte which is the battery level.

This is a printout of the D mode display:

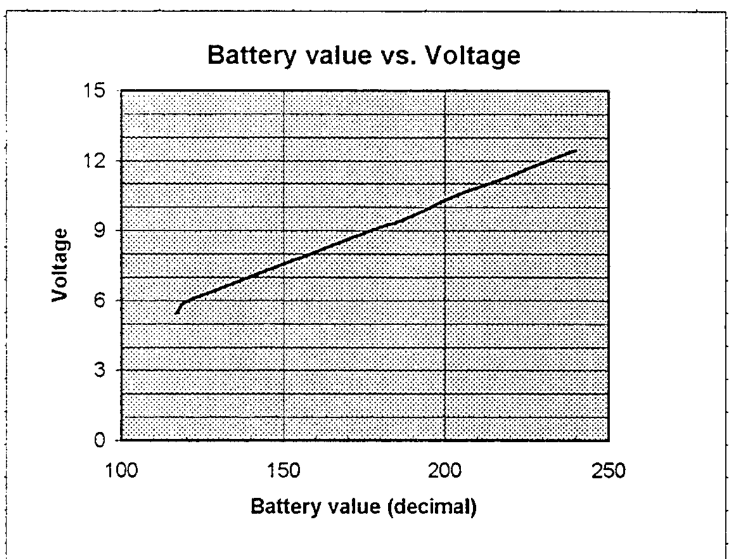
03-19-96 13:33:28 ID 05366 DA
FF FE 2F 05 3D 9B CA 00
00 00
CT 277 DB 004 PO 98

The first line is similar to the N mode except the **DA** indicates DIAGNOSTIC mode. In the second line **FF FE 2F** is always present followed by **05 3D 9B,** which is the indirect hexadecimal equivalent of the ID number. The next four pairs of digits constitute the 4-byte data field, the first byte of which is the battery level value in hex. The last line is information generated by the Telonics receiver regarding the transmission.

CT (carrier time) is the duration of the carrier signal.
DB (data bytes) is the number of bytes in the data field.
PO (power output) is the power level of the transmission where 100 equals approximately 1 watt.

Remote monitoring of battery voltage

Description: The PTT converts the battery voltage into a value between 0 and 255 (255 being higher voltage) and transmits the value as the 1st byte of the data field. In this application the battery value will range from 216 (D8 hex) for a new battery to ??? (?? hex) for a battery at end of life. This corresponds to 11.2V to 9.85V as measured on the battery leads (after the isolation diode).



Battery replacement

Disassembly

Follow the instructions in the Benthos manual for opening and resealing the sphere.
Place a magnet on the POWER switch. Loosen the two ¼-inch nuts on the antenna plate and remove the plate. Remove the spacers and PTT. Unplug and lift out the battery.

Testing

Check the new battery voltage. Should be 11.2 V ± .2 V

Load check

Place a magnet on the POWER switch and connect the coax cable to a Telonics Receiver.
Plug in the power connector. Place a magnet on the TEST switch and remove the POWER magnet. This will put the PTT in Test mode.
Place a voltmeter on the battery and monitor the voltage drop during transmission.
Should drop to 10.9 V ± .2 V

Current check

Put the receiver in the Diagnostics Mode to measure the output power.
Place a milliammeter in the battery supply to measure the current draw. Tape a magnet over both switches and plug in the battery.
Remove the power magnet and monitor the transmissions.
Quiescent current should be less than 80μA (usually about 60μA).
Every 90 seconds a transmission should occur. Power level should be at least 100 (1 watt) and current should be less than 15 mA (usually about 10.5 mA) during the last 5 seconds before transmission.
Check Delay Mode quiescent current. Should be 50 μA ± 10 μA
Remove both magnets.

Assembly

Slide the spacers on the standoffs. If the spacers are not above the shoulder of the standoff, use shims under the spacer. Install the PTT and bolt on the antenna plate.
Reseal the sphere and install it in the hard-hat.
Place a magnet on the POWER switch.

ARGOS GLASS BALL ASSEMBLY PROCEDURES

Assembly

The three major components, battery, transmitter, and antenna, are mounted to the battery base, which is glued to the lower sphere with silicon room temperature vulcanizing (RTV). The reed switches are glued similarly to the glass sphere.
The proper alignment of all the components will allow easy operation of the reed switches even when mounted in the sphere bracket. To aid in constructing the PTT the drawings* show the position of the alignment mark. When the device is assembled with all the marks aligned properly, the holes in the lower hard-hat will expose the reed switches, and the photo detectors will line up with the holes in the upper hard-hat.

*Any drawings referenced in this report are available upon request.

Parts, supplies, and tools

	Qty	Description	Manufacturer
Parts			
	1	7.25" battery base (see Dwg. K0050)	local
	2	standoffs (see Dwg. K0031)	local
	2	spacers (see Dwg. K0031)	local
	var.	shims, 3/8" nylon washers	local
	1	12" X 18" X 1/16" rubber sheet	local
	1	label	local
	1	white foam block (see Dwg. K0035)	local
	1	PTT with Antenna Plate	Seimac
	1	10.5V battery, Model 900155-21	Pro Battery
	1	10" spherical glass instrument housing, Model 2040	Benthos
	1	10" hard-hat with hardware	Benthos
		glass ball sealing tape	Benthos
		glass ball sealing putty	Benthos
	2	reed switches, DRT-DTH-445	Hamlin
	10	wire ties or lacing	local
		22 gauge hookup wire, red, black	local
		3/32" heat shrink tubing	local

	1	BNC adapter, right angle	local
	1	3 conductor, female connector #03-06-1032	Molex
	1	3 conductor, male connector #03-06-2032	Molex
	2	0.062" pins, female #02-06-5103, gold 18-24 ga.	Molex
	2	0.062" pins, male #02-06-6103, gold 18-24 ga.	Molex
	2	¼"-20 X ¾", 316 stainless bolts	local
	2	¼"-20 X ¾", 316 stainless set screws with allen head	local
	2	¼"-20, 316 stainless locknuts	local
	6	¼" 316 stainless flat washers	local
Supplies			
		silicon RTV	local
		Threadlock #271	Loctite
		Primer-T	Loctite
Special tools			
		25/64" transfer punch	
		base fixture jig	
		0.062" pin crimpers, HTR 1719C	Molex
		hole saws, 1¾", 2¼"	
		1" plug cutter	

Perforate the hard-hats

Refer to Dwg. K0029.
Place an alignment mark centered on one edge of each hard-hat.
On the lower hard-hat use a 2.25" hole saw to cut two holes 90° apart and 1.75" from the edge.
On the upper hard-hat cut three holes 120° apart and 2.5" from the edge. Cut a fourth hole in the center of the top.
Deburr all edges.

Prepare the battery base

Refer to Dwg. K0030
Drill out the battery mounting holes to 25/64". Using a transfer punch transfer the battery mounting holes to the battery base. Put these holes on a diameter line. Drill them 0.25".
Then drill out the center of the disk with a 1.75" hole saw.
Cut the rubber sheet as shown. Make the holes with the plug cutter.

Assemble the battery base

Refer to Dwg. K0032.

Apply Primer T to the standoffs, bolts, set screws, and flat washers.

Allow 5 minutes to dry.

Apply Loctite 271 (red) to bolts, set screws, and flat washers.

Assemble the standoffs to the base and insert the set screws into the standoffs.

Confirm the beveled edge of the base opposite the standoffs.

Clean the inside surface of the lower sphere to ensure it is free of dirt and grease. Apply an ample bead of silicon RTV sealant to the beveled edge of the base and place in the bottom of sphere. Use the base fixture jig to ensure the base is square with the edge of the sphere. Use drawing K0033 for proper orientation of the standoffs to the sphere alignment mark.

Install the reed switches

Refer to Dwg. K0033.

Mark the glass with a felt tip marker where each switch will go. Place the POWER label on a piece of cellophane tape and place the tape just below the mark on the glass.

Do the same for the TEST label.

Using **two** needle nose pliers bend the leads of the reed switches so the switch will lay next to the glass sphere and the solder connections can be made later. Apply a bead of RTV to the switch body only and place each switch on the mark.

Allow the RTV to cure at least 6 hours.

Prepare the antenna plate

Refer to the same drawing.

With the photo detector connector on the left, place an alignment mark on the top edge as shown.

Remove the through plate BNC coupler.

Draw a diameter line through the center of the plate and the left photo detector. Using a transfer punch mark the battery mounting holes on the antenna plate and drill them 0.25".

NOTE: Protect the detectors during this task.

Reinstall the coupler and connect the right angle BNC adapter.

Clean the plate where the label will go and apply the label.

Protecting the transmitter

Refer to Dwg. K0035.
The transmitter is wrapped in the rubber jacket to isolate it from the cells in the battery, and the foam block provides pressure to hold the transmitter between the plate and battery base.
Cut the rubber jacket as shown and secure it around the transmitter with electrical tape.
Cut the foam block from white foam as shown. One dimension needs to be sized to fit.

Assemble the battery and transmitter

Refer to Dwg. K0032.
Place the rubber sheet on the base and slide on the battery down.
Place the spacer on the standoff. If the top of the spacer is not above the shoulder of standoff, shims will be necessary to secure the battery when the antenna plate is installed. Place the shims (3/8" nylon washers) between the battery and the spacer.
Install the transmitter.
Check the reed switches to ensure the POWER switch is normally closed and the TEST switch is normally open.
Wire the switches and battery connector as shown in Dwg. K0034.
Use wire lacing to organize the wires. Do not wire tie the coax to any other wires. Do not connect the battery yet. Cover the solder joints with heat shrink tubing and then completely cover the switches and solder joints in RTV.

Testing

Check the new battery voltage. Should be @ 11.2 V.

Load check

Place a magnet on the POWER and TEST switches and connect the coax cable to a Telonics Receiver.
Plug in the power connector. Remove the POWER magnet. This will put the PTT in Test mode. Place a voltmeter on the battery and monitor the voltage drop during transmission.
Should not drop more than 0.5V during transmission.
Put the receiver in the Diagnostics Mode to measure the output power.
Every 90 seconds a transmission should occur. Power level should be at least 100 (1 watt) ± 5.
Place a milliammeter, in the battery supply to measure the current drain. Tape a magnet over both switches and plug in the battery.
Remove the power magnet and monitor the transmissions.
Quiescent current should be between 60 and 80 μA.
Current should be less than 15 mA (usually 10.5 mA) during the last 5 seconds before transmission.

Laod check cont.

Note: The internal resistance of some ammeters may cause the PTT **not** to transmit properly.
Restart the PTT without the TEST magnet in place to measure the Delay Mode quiescent current. Should be @ 50 μA.
Remove both magnets.

Complete the assembly

Install the foam block and antenna plate. Secure with two locknuts.
Check that the battery is secure and that no wires are bound or pinched.
Check that the coax has no sharp bends and is not tied to any other wires.

Assemble the spheres

Follow the instructions in the Benthos manual to assemble the spheres. Glue some pieces of scouring pads inside the hard-hats so the sphere will be held snuggly when the hard-hats are bolted together. Mark the hard-hats with the PTT number. Temporarily bolt the hard-hats together with 2 or 4 bolts. Place a magnet on the POWER switch.

Sun-up Test

Place the PTT outside where it will not be exposed to any nighttime artificial light source but will be exposed to first light of the morning. Wait until late in the day to remove magnet so that it will start monitoring the photo detectors after sunset. Set up the Telonics receiver to monitor that PTT and hook up a printer to get a hardcopy of the first transmission the next morning.

Acknowledgements

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