Webb Research Corporation

82 Technology Park Drive, E. Falmouth, MA 02536-4441 (508) 548-2077 FAX (508) 540-1686

USER MANUAL – APEX-TD PROFILER

APEX-TD INSTRUMENTS
Serial numbers: 58, 59, 64-72

REV DATE: 9/22/99
NOAA, AOML, Contract no. 50WCNR906031
WRC Job no. 638

I. ALKALINE BATTERY WARNING

The profiler contains alkaline "D" cells.
There is a small but finite possibility that batteries of alkaline cells will release a combustible gas mixture. This gas release generally is not evident when batteries are exposed to the atmosphere, as the gases are dispersed and diluted to a safe level. When the batteries are confined in a sealed instrument mechanism, the gases can accumulate and an explosion is possible.
Webb Research Corp. has added a catalyst inside of these instruments to recombine Hydrogen and Oxygen into H2O, and the instrument has been designed to relieve excessive internal pressure buildup by having the upper endcap release.
Webb Research Corp. knows of no way to completely eliminate this hazard. The user is warned, and must accept and deal with this risk in order to use this instrument safely as so provided. Personnel with knowledge and training to deal with this risk should seal or operate the instrument. Webb Research Corp. disclaims liability for any consequences of combustion or explosion.

II. Reset and Self Test

Profilers are shipped to the deployment site in Hibernate mode. Shortly before deployment, reset the profiler by passing a magnet over the marked location on the pressure case. The profiler will run a self-test, transmit for 6 hours with the bladder extended, and then begin its pre-programmed mission.

The six ARGOS transmissions during self-test and the transmissions during the initial 6 hour period contain data about the instrument and are outlined in (V) ARGOS DATA, part (C) TEST MESSAGE FORMAT.

Procedure:
- Hold the provided magnet at RESET position marked on the hull for several seconds.
- Note: The internal magnetic reed switch must be activated (held) for at least one second to reset the instrument. (This is to provide a safety against accidental reset during transport.) **Thus, if the float does not respond as below, the instrument was probably not reset.**
- The air pump will operate for 1 second.
- The PTT will transmit 6 times at 6 second intervals. Place the ARGOS receiver/beeper close to the antenna to detect transmissions.
- The piston pump will begin to operate. The piston will move to the retracted Ballast Position, if not already there, pause 2 seconds and then move to full extension.
- The bladder will expand, this should take 15 - 25 minutes.
- After the piston pump stops the air pump will come on and inflate the air portion of the bladder taking 20 - 30 seconds.
- The PTT will transmit at the mission specified ARGOS rate.

- 6 hours after reset, transmissions will cease, the piston pump will retract and the bladder will deflate, the profiler begins its programmed mission.

During self-test, the controller checks the internal vacuum sensor. If the internal pressure has increased above a preset limit (i.e. hull leakage caused loss of vacuum), the instrument will not pump. If you do not detect the 6 test transmissions, and if the bladder does not inflate, then the self-test has failed and the instrument should not be deployed.

III. Mounting Damper Plate

To aid surface following, a clear plastic damper plate is pre-mounted to the outside of the pressure case using 2 pvc collars, an O-ring, and titanium hardware.

IV. Deployment

- RESET instrument.
- SELF-TEST starts automatically (see above).
- When piston pump stops, air pump inflates, external bladder is full, PTT will transmit for 6 hours at ARGOS Repetition rate intervals. Normally 90 seconds.
- Six hours after reset, the piston pump will retract and bladder will deflate. Deploy before this time is up or reset the instrument again to re-initialize the 6 hour period. The purpose is to have the instrument on the surface and receive test transmissions.
- Pass a rope through the hole in the damper plate.
- Holding both ends of the rope, carefully lower the ALACE into the water.
- Take care not to damage the antenna.
- Do **not** leave the rope with the instrument, release one end and retrieve the rope.
- The float will remain on the surface until the 6 hour interval has expired.

V. ARGOS DATA

A. SERVICE ARGOS PARAMETERS

The user must specify various options to Service ARGOS. These choices depend on how the user wishes to receive and process data. Typical parameters are listed below:

- Standard location.
- Processing: Type A2 (pure binary input; hexadecimal output)
- Results Format: DS (all results from each satellite pass), Uncompressed.
- Distribution Strategy: Scheduled, all results, every 24 hours.
- Number of bytes transmitted (per message): 32

B. DATA FORMAT

Data is sent via ARGOS in 32 byte hex messages. The number of 32 byte messages sent depends on the programmed quantity of temperature measurements per profile. (See section (V) ARGOS DATA, part (E) CONSTANTS.)

Format for message number 1 only:
Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**, the total number of messages for each float data set is given in section D. Messages are transmitted in sequential order starting with 1 and incrementing by one for the data set.
- 03 **Message block number**, begins as 1 and increments by one for every ARGOS message data set. This, combined with the ARGOS repetition rate (section VI), allows the user to track surface drift. Byte 03 will roll-over at 256 and will reset to 1 on each new profile.
- 04 & 05 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
- 06 **Profile number**, begins with 1 and increases by one for every float ascent.
- 07 **Profile length**, is the number of two byte T measurements in the profile plus 4 for the four surface pressure and temperature measurements. Total number of bytes of T data from each profile depends on the sampling strategy chosen. This is described in section (V) ARGOS DATA, part (E) CONSTANTS.
- 08 **Profile termination flag byte**, can have the following values (hex):
  - 00 Pressure reached surface pressure.
  - 02 Pressure reached zero.
  - 04 Pressure did not reach next value in depth table for 25 minutes. (Does not terminate profile.)
  - 05 Pressure did not reach next value in depth table for 25 minutes, UP time expired before surface, and UP time was reset.
  - 08 Piston fully extended before surface
  - 10 UP time expired before surface and UP time was reset.
- 09 **Piston position**, recorded as the instrument reaches the surface. Range 12 - 248
- 10 & 11 **Bottom temperature**, sampled just before instrument begins ascent.
- 12 & 13 **Bottom pressure**, sampled just before instrument begins ascent.
- 14 **Battery voltage**, nominally 15 volts and decreases throughout the life of the float.
- 15 & 16 **Surface pressure**, as recorded just before last descent with an offset of +5db.
- 17 **Internal vacuum**, as recorded just before last descent. nominally 5 inches Hg
- 18 **Bottom piston position**, the linear pot count recorded at the target depth.
- 19 to 32 **Temperature** 2 bytes in sequence starting with the next index in the depth table after the bottom pressure.

Format for message number 2 and above:
Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**
- 03 to 32 **Temperature** 2 bytes in sequence.

*Note on the last message there will be 4 pressure and temperature measurements at the surface.

Message Format and Sampling Depths

BTYE #	MSG 1
10 & 11	1000
19 & 20	980
21 & 22	960
23 & 24	940
25 & 26	920
27 & 28	900
29 & 30	880
31 & 32	860

BTYE #	MSG 2	MSG 3	MSG 4
3 & 4	840	540	285
5 & 6	820	520	280
7 & 8	800	500	275
9 & 10	780	480	270
11 & 12	760	460	265
13 & 14	740	440	260
15 & 16	720	420	255
17 & 18	700	400	250
19 & 20	680	380	245
21 & 22	660	360	240
23 & 24	640	340	235
25 & 26	620	320	230
27 & 28	600	300	225
29 & 30	580	295	220
31 & 32	560	290	215

C. TEST MESSAGE FORMAT

The test message is sent whenever an **I2** command is given, the six transmissions during the startup cycle, and during the six hour surface mode period prior to the first dive. Each test message has 32 bytes, in hex unless otherwise noted, with the following format:

Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**, always 01.
- 03 **Message block number**, begins as 1 and increments by one for every ARGOS message.
- 04 & 05 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
- 06 **Profile number**, always 00.
- 07 **Message type flag**, 20 for test message, 40 for 6 hour surface message.
- 08 & 09 **Current pressure**.
- 10 **Battery voltage**, nominally at 15 volts.
- 11 **Internal vacuum**, nominally at 5 inches Hg.
- 12 **Piston Position**, a count value 12-248.
- 13 **Float status byte**, 08 for float up, 20 piston fully extended, 40 piston running.
- 14 **Hour**, the following is the time from startup (in decimal).
- 15 **Minutes**.
- 16 **Seconds**.
- 17 **ARGOS** repetition rate constant (multiply by 2, nominally 90 seconds).
- 18 **Up** time, intervals.
- 19 & 20 **Down** time, intervals.
- 21 **Trip interval** time, hours.
- 22 & 23 **Target pressure**, in centibars.
- 24 **Target piston position**, in counts.
- 25 **Depth correction factor**, in counts.
- 26 **Ballast piston position**, normally 24 counts.
- 27 **Fully extended piston position**, nominally 248 counts.
- 28 **OK vacuum count**, nominally 2 inches Hg.
- 29 **Initial piston extension**, in counts.
- 30 **Month**, software version number (in decimal).
- 31 **Day**, software version number (in decimal).
- 32 **Year**, software version number (in decimal).

D. CRC

Because ARGOS data may contain transmission errors, the first byte of each message contains an error checking value. This value is a Cyclic Redundancy Check (CRC), and is calculated as a function of the message content (bytes 2 to 32).

- For each message, calculate a CRC value
- Compare the calculated CRC to the transmitted CRC (byte no. 1)
- If the calculated and transmitted CRC values are not equal, the message has been corrupted and should be deleted before further data processing.

Below is a sample program (in BASIC) to calculate the CRC value for a message. This program can be provided upon request in Basic, Fortran or C.

```
DECLARE FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER)
'CRC routine to check data validity in ARGOS message.
'Bathy Systems, Inc. RAFOS Float data transmission.
'3 December, 1990.
'The 1st of 32 bytes in an ARGOS message is the CRC.
'The function CRC will compute CRC for byte 2 through 32.
'Hasard is used for Random because Random is reserved by BASIC.
'Stored as file CRC in C:\RAFOS\RAF11.
DECLARE SUB Hasard (ByteN AS INTEGER)
DEFINT A-Z
DIM in(32) AS INTEGER
'RAF11F message number 08 HEX ID 11502 01-02-93   CRC is O.K.
A$ = "8F00081C8E47239148A4D2E9743A1D0E070381C06030984C2693492492C964B2"

        N = 32
        FOR I = 1 to N
                in(I) = VAL("&H" + MID$(A$, 2 + I - 1, 2))
        NEXT I
        PRINT in(1); CRC(in(), N);

FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER) STATIC
DIM ByteN as INTEGER
        I = 2
ByteN = in(2)
                DO
                        CALL Hasard(ByteN)
                        I = I + 1
                        ByteN = ByteN XOR in(I)
                LOOP UNTIL  I = N
        CALL Hasard (ByteN)
        CRC = ByteN
END FUNCTION

DEFINT A-Z
SUB Hasard (ByteN AS INTEGER) STATIC
x% = 0
        IF ByteN = 0 THEN ByteN = 127: EXIT SUB
        IF (ByteN AND 1) = 1 THEN x% = x% + 1
```

```
        IF (ByteN AND 4) = 4 THEN x% = x% + 1
        IF (ByteN AND 8) = 8 THEN x% = x% + 1
        IF (ByteN and 16) = 16 THEN x% = x% + 1
        IF (X% AND 1) = 1 THEN
                ByteN = INT(ByteN / 2) + 128
        ELSE
                ByteN = INT(ByteN / 2)
        END IF
END SUB
```

E. CONSTANTS

The pressure is measured every 6 seconds. Temperature only is measured and stored starting with the next index in the depth table after the bottom pressure. Both pressure and temperature are stored at the surface and then three more times, one minute apart.
Two hex bytes are stored for each sensor. The decimal numbers from the TD sensors are converted to hex for compression in the ARGOS transmission as follows:

Temperature: first 5 digits, 1 milli-degree resolution.
Pressure: first 5 digits, 10 cm resolution.

To convert the hex ARGOS message back to decimal numbers:

	hex	→	dec	=	converted	units
Pressure:	1D4C	→	7500	=	750.0	decibars
Temperature:	23CA	→	9162	=	09.162	C
	4E20	→	20000	=	20.000	C
	FFFE	→	65534	=	-0.002*	C
	FC16	→	64534	=	-1.002*	C

*When a temperature begins with an F in hex (F…) then convert to decimal and subtract 65536. This will give the temperature below 0 C.

Voltage (V) = counts/10 + .6 (counts is in decimal number) nominally 15 V and decreasing.
Vacuum (inHg) = counts *-0.376 + 29.15 (counts is in decimal number) nominally 5 inHg.