METOCEAN Data Systems Limited

METOCEAN PROVOR

Argos Formats

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1. TEMPERATURE PRESSURE

1.1 Overview

The data transmission process begins as soon as an ascent profile is completed. It starts with the reduction of data using the bin compression (described in section 1.7). PROVOR then formats and transmits the data.

For a given descent-drift-ascent-transmit cycle, the transmission of all of the data will usually require several data messages of the same type.

To improve the probability of reception, data messages are transmitted several times. The number of repetitions depends upon the quantity of data to be transmitted, the transmission period and the programmed minimum transmission duration. Messages are sent in a random sequence in order to minimize the chance of accidental synchronization of one message with some form of transmission interference.

To provide the reception of a continuous profile, messages contain one data point in two. This data interleaving scheme shares the points of each profile between two Argos messages. This allows reconstruction of the profile when a message is lost.

Example:
Message N: { Data 1 ; Data 3 ; Data 5 ; Data 7 ; Data 9 ; . . . Data 21 }
Message N+1 { Data 2 ; Data 4 ; Data 6 ; Data 8 ; . . . Data 22 }.
The content of the Argos messages consists of a preamble of 28 bits, followed by:
- the 20-bit Argos PTT identification number
- the 8-bit Argos PTT identification complement
- the data frame, consisting of 31 words of 8 bits (248 bits).

Four types of messages are generated according to the content of the data frame:
Type 0001 : Descent profile message
Type 0010 : Submerged drift message
Type 0011 : Ascent profile message
Type 0000 : Technical message

Three types of messages all contain recorded physical measurements. The technical message contains data regarding the configuration and functioning of the float and its buoyancy control mechanism.

The message ID is formed from bits 9 to 12 of the data message frame. The formatting of the data message frame for each message ID is described in the pages that follow.

1.2 Descent Profile Message

Data	Format	Bit Numbers
ARGOS ID complement	8 bits	1 to 8
Message type	4 bits	9 to 12
CRC	16 bits	13 to 28
Date of the first PT measurement	9 bits	29 to 37
First pressure measurement	11 bits	38 to 48
First temperature measurement	15 bits	49 to 63
PT measurements	193 bits	64 to 256

1.2.1 Cyclic Redundancy Check

The CRC type used is the CRC-CCITT of which the polynomial is $X^{16} + X^{12} + X^5 + 1$. The exclusive OR of the result is tested. For computation purpose 8 bits set to 0 are added at the end of the message. The calculation of the CRC is carried out from bit 9 to the end of the message, the 16 bits reserved for the CRC being set to 0.

1.2.2 PT Data

The stored PT points are sent in the same order in which they were collected - that is, in order of decreasing depth for descent profiles. Measurements are sent in the sequence - pressure, temperature.

Only the first doublet is dated. It is dated with the time of the profile start. The time counts from the time of the descent at the beginning of the first cycle, which is time = 0. The least significant bit represents 1 minute.

Subsequent doublets correspond to alternating data points in the profile (for example, measurement numbers 1, 3, 5, 7, . . .). Interleaving data points are sent in another message. This technique minimizes the impact of the loss of any one data message.

The PT measurements starting from bit 64 (measurement numbers 3, 5, 7, etc.) are coded either as absolute measurements or as relative measurement. The first bit of each measurement is a format bit that indicates whether the reading is absolute (format bit = 0) or relative (format bit = 1).

1.2.2.1 Pressure Coding

Depending upon the value of the first bit, it is followed by either 6 or 11 data bits. If the difference between the current pressure measurement, P_n, and the previous pressure measurement, P_{n-1}, is less than 63 dbar, the difference, $|P_n - P_{n-1}|$, is expressed in 6 bits. Otherwise, the pressure measurement is coded in 11 bits as an absolute measurement. Pressure is reported in the range 0 dbar to +2047 dbar with a resolution of 1 dbar.

1.2.2.2 Temperature Coding

Depending upon the value of the first bit, it is followed by either 10 or 15 data bits. If the difference between the current temperature measurement and the previous temperature measurement $(T_n – T_{n-1})$ is included in the closed interval [-0.923 °C, +0.100 °C], the difference $–(T_n – T_{n-1}$ - 0.1 °C) is coded into 10 bits.
The decoding will carry out the following operation : $(- T_{transmitted} + 0.1$ °C)
Otherwise the measurement is absolutely coded in 15 bits with an offset of – 2 °C. The temperature is reported in the range -2°C to + 30.767°C, with a resolution of 0.001°C.

1.3 Submerged Drift Message

Data	Format	Bit Numbers
ARGOS ID complement	8 bits	1 to 8
Message type	4 bits	9 to 12
CRC	16 bits	13 to 28
Date of the first PT measurement	6 bits	29 to 34
Time of first PT measurement	5 bits	35 to 39
First pressure measurement	11 bits	40 to 50
First temperature measurement	15 bits	51 to 65
PT measurements	191 bits	66 to 256

1.3.1 Cyclic Redundancy Check

The CRC type used is the CRC-CCITT of which the polynomial is $X^{16} + X^{12} + X^5 + 1$. The exclusive OR of the result is tested. For computation purpose 8 bits set to 0 are added at the end of the message. The calculation of the CRC is carried out from bit 9 to the end of the message, the 16 bits reserved for the CRC being set to 0.

1.3.2 PT Data

Only the first PT point is dated. The day number counts from the day of the descent at the beginning of the first cycle, which is day number 0. The hour number is the hour of the first measurement. The least significant bit represents 1 minute.

The stored doublets are sent in the same order in which they were collected. Measurements within a doublet are sent in the sequence - pressure, temperature.
Subsequent doublets correspond to alternating data points in the profile (for example, measurement numbers 1, 3, 5, 7, . . .). Interleaving data points are sent in another message. This technique minimizes the impact of the loss of any one data message.

The PT measurements starting from bit 66 (measurement numbers 3, 5, 7, etc.) are coded either as absolute measurements or as relative measurement. The first (most significant) bit of each measurement is a format bit that indicates whether the reading is absolute (format bit = 0) or relative (format bit = 1).

1.3.3 Pressure Coding

If the difference between the current pressure sample, P_n , and the previous pressure sample, P_{n-1} , is included in the closed interval [-32 dbar, +31 dbar], the coding of the difference, $|P_n - P_{n-1}|$, is carried out into 6 bits two's-complement. Otherwise the pressure sample is coded in 11 bits as an absolute measurement. Pressure data is limited to the maximum value of 2,047 dbar.

1.3.4 Temperature Coding

Depending upon the value of the first bit, it is followed by either 10 or 15 data bits. If the difference between the current temperature measurement and the previous temperature measurement $(T_n – T_{n-1})$ is included in the closed interval [-0.512 °C, +0.511 °C], the difference $(T_n – T_{n-1})$ is coded into 10 bits two's-complement.
Otherwise the measurement is absolutely coded in 15 bits with an offset of – 2 °C. The temperature is reported in the range -2°C to + 30.767°C, with a resolution of 0.001°C.

1.4 Ascent profile Message

Data	Format	Bit Numbers
ARGOS ID complement	8 bits	1 to 8
Message type	4 bits	9 to 12
CRC	16 bits	13 to 28
Date of the first PT measurement	9 bits	29 to 37
First pressure measurement	11 bits	38 to 48
First temperature measurement	15 bits	49 to 63
PT measurements	193 bits	64 to 256

1.4.1 Cyclic Redundancy Check

The CRC type used is the CRC-CCITT of which the polynomial is $X^{16} + X^{12} + X^5 + 1$. The exclusive OR of the result is tested. For computation purpose 8 bits set to 0 are added at the end of the message. The calculation of the CRC is carried out from bit 9 to the end of the message, the 16 bits reserved for the CRC being set to 0.

1.4.2 PT Data

The stored PT points are sent in the same order in which they were collected - that is, in order of decreasing depth for ascent profiles. Measurements within a doublet are sent in the sequence - pressure, temperature.

Only the first doublet is dated. It is dated with the time of the profile start. The time counts from the time of the descent at the beginning of the first cycle, which is time = 0. The least significant bit represents 1 minute.

Subsequent doublets correspond to alternating data points in the profile (for example, measurement numbers 1, 3, 5, 7, . . .). Interleaving data points are sent in another message. This technique minimizes the impact of the loss of any one data message.

The PT measurements starting from bit 64 (measurement numbers 3, 5, 7, etc.) are coded either as absolute measurements or as relative measurement. The first bit of each measurement is a format bit that indicates whether the reading is absolute (format bit = 0) or relative (format bit = 1).

1.4.3 Pressure Coding

Depending upon the value of the first bit, it is followed by either 6 or 11 data bits. If the difference between the current pressure measurement, P_n, and the previous pressure measurement, P_{n-1}, is less than 63 dbar, the difference, $|P_n - P_{n-1}|$, is expressed in 6 bits. Otherwise, the pressure measurement is coded in 11 bits as an absolute measurement. Pressure is reported in the range 0 dbar to +2047 dbar with a resolution of 1 dbar.

1.4.4 Temperature Coding

Depending upon the value of the first bit, it is followed by either 10 or 15 data bits. If the difference between the current temperature measurement and the previous temperature measurement $(T_n – T_{n-1})$ is included in the closed interval [+0.923 °C, -0.100 °C], the difference $(T_n – T_{n-1} + 0.1$ °C) is coded into 10 bits.
The decoding will carry out the following operation : $(T_{transmitted} - 0.1$ °C)
Otherwise the measurement is absolutely coded in 15 bits with an offset of – 2 °C. The temperature is reported in the range -2°C to + 30.767°C, with a resolution of 0.001°C.

1.5 Technical Message

For each complete set of PT messages sent, the technical message is sent one and one-half times. Thus, for two complete sets of PT messages sent, there will be three technical messages.

Data	Format	Bit Numbers
ARGOS ID complement	8 bits	1 to 8
message type	4 bits	9 to 12
CRC	16 bits	13 to 28
descent start time	8 bits	29 to 36
number of valve actions at the surface	7 bits	37 to 43
float stabilisation time	8 bits	44 to 51
float stabilisation pressure	8 bits	52 to 59
number of valve actions in descent	4 bits	60 to 63
number of pump actions in descent	4 bits	64 to 67
end of descent time	8 bits	68 to 75
number of repositions	4 bits	76 to 79
time at end of ascent	8 bits	80 to 87
number of pump actions in ascent	5 bits	88 to 92
duration of pump actions at the surface	5 bits	93 to 97
number of descent PT messages	5 bits	98 to 102
number of drift PT messages	5 bits	103 to 107
number of ascent PT messages	5 bits	108 to 112
shallow/deep boundary isobar for descent profile	11 bits	113 to 123
number of descent slices in shallow zone	6 bits	124 to 129
number of descent slices in deep zone	8 bits	130 to 137
shallow/deep boundary isobar for ascent profile	11 bits	138 to 148
number of ascent slices in shallow zone	6 bits	149 to 154
number of ascent slices in deep zone	8 bits	155 to 162
number of PT measurements in drift	8 bits	163 to 170
float's time : hh (5 bits)+mm (6 bits)+ss (6 bits)	17 bits	171 to 187
pressure sensor offset	6 bits	188 to 193
internal pressure	3 bits	194 to 196
surface temperature	16 bits	197 to 212
profile ascent start time	8 bits	213 to 220
number of entrance in target range	3 bits	221 to 223
minimum pressure in drift (bars)	8 bits	224 to 231
maximum pressure in drift (bars)	8 bits	232 to 239
grounding	1 bits	240
not used	16 bits	241 to 256

1.5.1 Descent Data

- Descent start time is expressed in tenths of an hour since midnight.
- Number of solenoid valve actions at the surface until the crossing of the GAP threshold is an integer from 1 to 127 (modulo 128).
- Float stabilisation time after the crossing of the GAP threshold is expressed in tenths of an hour.
- Float stabilisation pressure after crossing the GAP threshold is coded in 8 bits with least significant bit = 1 bar.
- Number of solenoid valve actions carried out to reach the target pressure after crossing the GAP threshold.

1.5.2 Drift Data

- Minimum and maximum pressure in drift collected during the hydraulics measurements.
- Grounding detected during the dive (Boolean).

1.5.3 Ascent Data

- Time at end of ascent is the time at the end of the pump action after surfacing. It is expressed in tenths of an hour.
- Duration of pump action to acquire buoyancy at the surface (after crossing the threshold of 3 bar), expressed in 5 bits with least significant bit = 20 sec.
- Number of pump actions in ascent (at the target pressure until the crossing of the threshold of 3 bar), expressed in 5 bits.

1.5.4 Housekeeping Data

- Pressure sensor offset is measured at the surface.
  least significant bit = 1 dbar
  range: -32 dbar to +31 dbar

- Internal pressure is measured at the end of the ascent and before the Mission start. Measurements are given in 25 mbar steps starting from 725 mbar and are coded in 3 bits:

000	#725 mbar
001	726 mbar to 750 mbar
010	751 mbar to 775 mbar
011	776 mbar to 800 mbar
100	801 mbar to 825 mbar
101	826 mbar to 850 mbar
110	851 mbar to 875 mbar
111	>875 mbar

- Surface temperature
  least significant bit = 0.001° C

1.6 Life Expiry Message

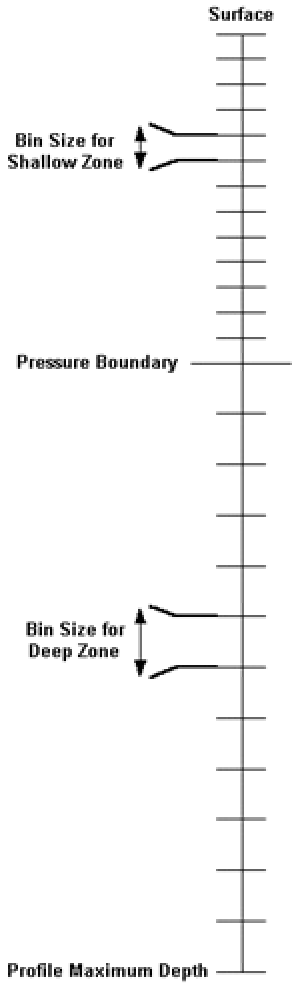
Life expiry messages are transmitted when the float is drifting on the surface and has completed transmission of all data from the last cycle of the Mission. Life Expiry mode continues until the recovery of the float or depletion of the battery.

These transmissions - unlike other transmissions - occur at 100-sec intervals. The content of the life expiry message is identical to the technical message.

1.7 The Bin Compression Method

Procedure for Creating a Reduced Model of PT Profiles

The bin compression method creates a reduced model of a descending or ascending profile by averaging the pressure temperature data according to the following bin pattern:



PROVOR floats collect data at approximately 1-meter intervals (sampling every 10 seconds) during the ascent from 2,000 meters or 0.4-meter intervals during the descent to drift depth. The PROVOR data processing procedure divides the water column into two regions - shallow and deep. The depth that divides the two regions is a programmable parameter called Pressure Boundary. All the samples recorded within each zone are then allocated to different bins, the bin sizes in the shallow and deep zones are programmable parameters as well. The compression algorithm averages the pressure and temperature values within those bins, the compressed data will therefore contain only one Pressure-Temperature doublet per bin.

PROVOR will be shipped from factory with the following default values:

Type of Profile	Descent	Ascent
Pressure Boundary (dbar)	200	200
Bin Size for Shallow Zone (dbar)	10	10
Bin Size for Deep Zone (dbar)	25	20

The customer should contact METOCEAN if these parameters require changing.

2. TEMPERATURE PRESSURE SALINITY (Sea-Bird)

2.1 Overview

The data transmission process begins as soon as an ascent profile is completed. It begins by selecting the drift data samples, which are inserted into the drift message. The process continues with the ascent message where the closest sample to the sample point is inserted into the ascent message. Finally, the technical message is created.

For a given descent-drift-ascent-transmit cycle, the transmission of all the data will usually require the capacity of several messages of the same type.

To improve the probability of reception, the transmission duration may be adjusted. The duration time depends upon the quantity of data to be transmitted and the transmission period. The transmission duration has an adverse effect on the float lifetime.

It is important that only the number of samples required for the experiment be taken, as this will maximize the float lifetime.

All messages are compliant with ARGOS 28 bit ID's.

NOTE: The salinity is coded with an offset of 25.000 psu. This 25.000 psu offset must be corrected by the user after reception of the Argos message.

NOTE: The temperature is coded with an offset of –5.000 °C. This –5.000 ºC offset must be corrected by the user after reception of the Argos message.

2.2 Ascent Messages:

2.2.1 Sample Points Type 1

There are 71 sample points based on pressure. These pressure points are indicated in the table below.

Sample Point	Pressure (dbar)	Sample Point	Pressure (dbar)	Sample Point	Pressure (dbar)
1	2000	27	700	53	190
2	1900	28	680	54	180
3	1800	29	660	55	170
4	1700	30	640	56	160
5	1600	31	620	57	150
6	1500	32	600	58	140
7	1400	33	580	59	130
8	1300	34	560	60	120
9	1250	35	540	61	110
10	1200	36	520	62	100
11	1150	37	500	63	90
12	1100	38	480	64	80
13	1050	39	460	65	70
14	1000	40	440	66	60
15	975	41	420	67	50
16	950	42	400	68	40
17	925	43	380	69	30
18	900	44	360	70	20
19	875	45	340	71	10
20	850	46	320		
21	825	47	300		
22	800	48	280		
23	780	49	260		
24	760	50	240		
25	740	51	220		
26	720	52	200		

2.3 Messages

The closest sample to the sample point, based on pressure, is transmitted. The transmitted sample includes the temperature, salinity, and pressure readings. The temperature reading is in 16-bit absolute formats. The salinity and pressure readings are in 15-bit absolute formats.

Sample point is included in the technical message. The tables below illustrate the remaining 70 sample message formats. Please note that the Sample Points type dictates the required number of messages that are transmitted.

Data	Field Length (Bits)
ARGOS ID	8
CRC	8
Message ID	8
T1	16
S1	15
P1	15
T2	16
S2	15
P2	15
T3	16
S3	15
P3	15
T4	16
S4	15
P4	15
T5	16
S5	15
P5	15
Spare	2

2.4 Drift Messages

The data will be coded in the same format as the ascent messages (see table below for format). The maximum number of drifting messages will be limited to 25 messages, which represent a total of 125 samples.

For example:
Drift Sampling Period of 12 hours: maximum time on drifting depth / cycle is 60 days.
Drift Sampling Period of 1 hour: maximum time on drifting depth / cycle is 5 days.

If the maximum number of samples is over this limit, only the first 125 data points will be transmitted.

Only drift messages with data will transmitted. For example: if we have 10 drift samples, two drift Argos messages will be transmitted.

Data	**Field Length (Bits)**
ARGOS ID	8
CRC	8
Message ID	8
T1	16
S1	15
P1	15
T2	16
S2	15
P2	15
T3	16
S3	15
P3	15
T4	16
S4	15
P4	15
T5	16
S5	15
P5	15
Spare	2

2.5 Technical Message

For each complete set of STD messages sent, the technical message is sent one and one-half times. Thus, for two complete sets of STD messages sent, there will be three technical messages.

Technical Message		
Data	**Field Length (Bits)**	**Resolution**
ARGOS ID	8	
CRC	8	
Message ID (1)	8	
Descent Start Time	8	0.1 hour
Number of Valve Actions At Surface	8	
First Stabilization Time	8	0.1 hour
Number of Valve Actions in Descent	4	
Number of Pump Actions in Descent	4	
End Of Descent Time	8	0.1 hour
Number of Repositions	8	
End Of Resurfacing Time	8	0.1 hour
Number of pump actions in Ascent	8	
Number of pump actions at Surface	8	
Float Time Hour	5	1 hour
Float Time Minute	6	1 minute
Float Time Second	6	1 second
Pressure Offset (512 cbar offset)	10	0.1 dbar
Internal Vaccum (700 mbar offset)	6	5 mbars
Number of Ascent Messages	8	
Number of Ascent Samples	8	
Number of Drift Messages	8	
Drift Data Sampling Period	8	1 hour
Number of Drift Samples	8	
Date 1st Drift Sample	11	
Time 1st Drift Sample	8	0.1 hour
7V Battery Voltage (40 dV offset)	6	0.1 V
14V Battery Voltage (80 dV offset)	7	0.1 V
Ascent Profile Number	8	
1st Point Temperature (-5.000 ºC offset)	16	0.001 degC
1st Point Salinity (25.000 psu offset)	15	0.001 PSU
1st Point Pressure	15	0.1 dbars
Spare	1	

2.6 Cyclic Redundancy Check

The CRC type used is the CRC-CCITT of which the polynomial is $X^{16} + X^{12} + X^5 + 1$. The exclusive OR of the result is tested. The calculation of the CRC is carried out on

the 256 bits of the message. During the calculation the CRC and Message ID fields are blank. Only the lower byte, 8 bits, is transmitted.