Improved Meteorological Measurements from Buoys and Ships

**Improved Meteorological Measurements
from Buoys and Ships (IMET):
Preliminary Conventions and Standards
Data and File Formats**

by

Kenneth E. Prada

March 1990

Technical Report

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A handwritten signature in cursive script, reading "Robert C. Beardsley", is written over a horizontal line.

Robert C. Beardsley, Chairman
Department of Physical Oceanography

Abstract

Definitions of IMET data types, resolutions, recording methods and formats are described. These establish preliminary standards for use with IMET sensors and systems through the design, testing and early commercial production phases of the development effort.

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1 Introduction

The NSF/World Ocean Circulation Experiment sponsored program for Improved METeorological (IMET) measurements involves the development of improved sensors and recording systems. An IMET sensor system consists of a variable number of autonomous intelligent sensor modules and a control and recording computer. The sensors are connected to a communications network, typically RS-485 on a ship and open-drain CMOS on a buoy. The intelligent sensor modules collect and process data autonomously. Modules transmit these data over the network to the control computer when addressed.

The development effort also includes methods for acquiring, formatting and recording data from the sensor systems. This document describes the preliminary IMET standards and conventions specified for use in these functions. When the IMET systems reach final production status (early 1991), a final version of these formats and standards will be issued, and will accompany sensors modules and data collection systems as available from commercial sources.

2 File Name Conventions

A number of file types are associated with the IMET recording systems. Several of these are always present and used. Others are defined in anticipation of use in cruise or program specific circumstances. Detailed descriptions of individual file types and uses are contained in later sections of this document. Required file types as defined here are indicated with an asterisk.

Data file names reflect the chronologic sequence of the files. The date and time which make up the file name represent the UTC start time of the relevant file. The file types will reflect the data type. Thus the following examples:

YRMODAHR.MET	* Standard data file (new file each hour)
YRMODAHR.MOT	Motion sensor data file
YRMODAHR.NAV	Navigation data file
YRMODAHR.DIS	Dissipation sensor data file
YRMODAHR.TUR	Turbulence data file
YRMODAHR.PRC	Precipitation data file
YRMODAHR.CFG	* Sensor configurations file
YRMODAHR.SEN	* On-line sensor list
YRMODAHR.SNM	* Sensor Name list
YRMODAHR.ARG	ARGOS configuration list
YRMODAHR.LOG	* Error/Comment log

Additional file types may be defined as needed.

3 Standard Data File

3.1 File Name Convention

The file name will reflect the chronological relevance of the data.

YRMODAHR.MET

3.2 File Structure

Two data file formats are defined, for ship and buoy use. The only difference involves the number of variables that can be stored. The shipboard format contains provisions for up to 60 variables, the buoy 28 variables.

3.3 Data File Header Record - 1024 Bytes

Item	Bytes	Cumul	Example
Cruise/Buoy ID	16	16	OCEANUS 100
Date (YYMMDD)	06	22	880809
Time (HHMMSS)	06	28	121048
File Type	02	30	RS (research ship)
Expansion	34	64	
Variable #1 Format	06	70	%6.1f
Variable #1 Type	04	74	SWR
Variable #1 Units	06	80	W/M^2
.....			
Variable #60 Info	16	1024	

3.4 Data Record - Ship Format 512 Bytes

Item	Bytes	Cumul	Example
Record Number	04	04	1234
Date (YYMMDD)	06	10	880809
Time (HHMMSS)	06	16	121048
Status	16	32	
Variable #1 value	08	40	1234.678
Variable #2 value	08	56	123.5678
.....			
Variable #60 value	08	512	12345.78

3.5 Data Record - Buoy Format 256 Bytes

Item	Bytes	Cumul	Example
Record Number	04	04	1234
Date (YYMMDD)	06	10	880809
Time (HHMMSS)	06	16	121048
Status	16	32	
Variable #1 value	08	40	1234.678
Variable #2 value	08	56	123.5678
.....			
Variable #28 value	08	512	12345.78

3.6 Data Item Values

All data item values will be stored with decimal point indicators, even those values that are of integer type. In the case of integers, the decimal point will follow the integer value with no digits following the decimal point. This convention permits standardized reading of values and allows the use of flagged items, as described in the next section.

3.7 Data Item Flags

In order to indicate special conditions for certain stored values, a series of flags may be used as part of the data item value representation. These flags will always replace the decimal point with a non-numeric or non-alpha character. The flags may be used for a variety of purposes. For example:

- indicate selected best sensors from a suite of multiples
- indicate sensors with errors
- indicate sensors not currently operational
- indicate sensors beyond calibration specs

4 Sensor Configuration File

The sensors are defined in a configuration file that contains all pertinent information concerning each sensor in the IMET system.

4.1 File Name Convention

The file name will reflect the chronological relevance of the configuration. Since various configurations may exist on a data cartridge, data files must be properly related chronologically to a configuration file. Hence, a file name convention similar to the data files will be used. Thus:

YRMODAHR.CFG

4.2 File Structure

The file can contain definitions for up to 60 sensors. All 60 sensors need not be defined, but there must be a definition for each sensor in use. The file contents are ASCII and may be generated using a text editor. Each of the lines in the individual sensor groups will be terminated with a new line character <LF> (decimal 10), which may be preceded by a carriage return character <CR> (decimal 13). The byte count in the following list does not include the end of line characters CR or LF. When lines are longer than specified, they will be truncated to standard length.

Item	Bytes	Example
Sensor Address	08	SWR01
Sensor Manufacturer	16	WHOI
Sensor Model	16	SWR-MK1
Sensor Serial	08	89-001
Number of Cal Variables	02	01
Cal Variable #1 Format	06	%6.1f
Cal Variable #1 Desc	04	SWR
Cal Variable #1 Units	06	W/M^2
.....		
Cal Variable #n Info	16	
Number of Raw Variables	02	01
Raw Variable #1 Format	06	%4x
Raw Variable #1 Desc	04	A/D
Raw Variable #1 Units	06	BITS
.....		
Raw Variable #n Info	16	
End of Sensor	02	**
.....		
End of File	02	\$\$

Each sensor description group can vary in length dependent on the number of variables per sensor. The End Of Sensor (EOS) indicator, "***", is used to separate sensor groups. The description file can also vary in length dependent on the number of sensors defined. An End Of File (EOF) indicator, "\$\$", is used to denote that there are no further sensors defined.

4.3 Sensor Module Address

This field contains the 5 character address to which the sensor responds. This address should consist of three characters that define the module type and a two digit number (00-99), e.g. WND01. This method allows a user to quickly identify the data type. It also allows more than one module of the same type to exist in a single system network.

4.4 Sensor Module Manufacturer

This field contains the name of the manufacturer of the sensor module. This name may not be the same as that of the sensor manufacturer. IMET distinguishes a difference between sensor and sensor module vendors.

4.5 Sensor Module Model Number

This field contains the sensor module model number information.

4.6 Sensor Module Serial Number

This field contains the manufacturers serial number for the module.

4.7 Variable Description Information

A sensor module may produce more than a single variable. These may be both calibrated and raw values. The configuration file contains information concerning the number, type, and format of each variable supplied by a module. Calibrated variables are listed first, followed by raw variables.

4.7.1 Number of Variables

This is the number of variables transmitted by a sensor module upon receiving a send data command. The table contains a format, description, and units for the number of the variables defined here. There are two parts to the table, one group of descriptions for calibrated variables, and a second group for raw variables. When there are no raw variables, the raw variable count will indicate zero.

4.7.2 Variable Format

This field contains a 'C' language type format descriptor for the variable sent by the sensor. For example %6.1f would imply a floating point variable of minimum length 6 characters with one decimal place to the right of the decimal point.

4.7.3 Variable Description

This field contains the name or description of the sensor variable, e.g. TMPA for air temperature. The field is limited to 4 characters, so the description should be explicit as possible within this limitation.

4.7.4 Variable Units

This field contains a description of the variable's measurement units, e.g. degC would imply degrees Celsius while m/s would indicate meters per second. This field is limited to 6 bytes.

4.7.5 Multiple Variables

Where more than one variable is sent by the sensor, the variables will be sent in the order indicated in the table, separated by spaces. Three basic data requests to a sensor are possible; send calibrated data, send raw data, or send calibrated and raw combined. When the combined mode is requested, the calibrated data will be sent first in the order established in the table and space separated followed by a colon and the raw variables also in table designated order and space separated as the following example shows.

%6.1f %8.2f : %6d %4d

5 Sensor Names File

This file contains the names of all module types that might be found on a system. It is used as a module name base when polling the sensor network to determine modules actually in residence. Each name is three characters long and resides on a separate line. The lines must be terminated with either a LF (NL) character (10 decimal) or a CR-LF combination (13 decimal - 10 decimal). The following is an example of a basic suite of names.

WND
TMP
HRH
BPR
SWR
LWR
SST
PRC

6 **On-Line Sensors File**

This file contains the identification responses of all sensors determined to be on-line at the generation time of the file. Each module response consists of a number of lines (22) that contain information pertinent to the individual module. Each module group of lines is terminated by a '\$\$' line indicating the end of a sensor group.

This file provides the information that determines the contents of the configuration (.CFG) file.

7 **Error/Comment Log File**

This file contains free field text information that constitutes a log of errors generated by the program or comments provided by the system user. The file should contain only ASCII text in discrete line format with proper line terminators. This requirement enables easy output to standard console or terminal displays.

Appendix A - Basic Sensor Suite Data Types and Formats

ID	DESCRIPTION	UNITS	FORMAT	EXAMPLE
BPR	Barometric Pressure	mb	xxxx.xx	1013.21
HDP	Humidity - Dew Point	°C	xxx.xxx	17.627
HIR	Humidity - Absolute Humidity	g/m ³	xx.xx	11.02
HRH	Humidity - Relative Humidity	%	xxx.x	75.3
LWR	Long Wave Radiation	W/m ²	xxxx.x	112.8
	Temperature 1	°C	xxx.xxx	21.597
	Temperature 2	°C	xxx.xxx	22.073
PRC	Precipitation	mm/hr	xxxx.x	205.1
SWR	Short Wave Radiation	W/m ²	xxxx.x	1004.9
SST	Sea Surface Temperature	°C	xxx.xxx	23.671
TMP	Air Temperature	°C	xx.xxx	25.223
WND	Wind - U	m/s	xx.x	14.5
	Wind - V	m/s	xx.x	-10.7
	Wind - W	m/s	xx.x	1.4
	Wind - Speed	m/s	xx.x	19.4
	Wind - Direction	deg	xxx.x	347.3

Appendix B - IMET Basic Sensor Suite Variables Min/Max/Resolution

VARIABLE	UNITS	MIN	MAX	RES
BAROMETRIC PRESSURE	mb	850	1050	0.1
HUMIDITY - RELATIVE	%	0	100	0.1
AIR TEMPERATURE	°C	-40	45	0.001
SEA SURFACE TEMPERATURE	°C	-5	45	0.001
WIND DIRECTION	deg	0	360	0.1
WIND SPEED	m/s	0	60	0.1
PRECIPITATION	mm/hr	0	1000	0.1
LONG WAVE RADIATION	W/m ²	250	600	0.1
SHORT WAVE RADIATION	W/m ²	0	1400	0.1

Appendix C - Storage Consumption Examples

The following figures show disk use for each format, ship and buoy. The figures are based on 120 megabytes of usable storage of which a negligible amount is used for miscellaneous information storage. Storage allocation for special files is not considered here. All space is allocated to standard met files as described earlier.

Ship File format

Sample rate:	one data record per minute
File Use per hour:	31,744 bytes (31 kb)
File Use per day:	761,856 bytes (744 kb)
Days per ctdg:	160 (120Mb cartridge)

Buoy File format

Sample rate:	one data record per minute
File Use per hour:	15,360 bytes (15 kb)
File Use per day:	368,640 bytes (360 kb)
Days per ctdg:	341 (120 Mb cartridge)

Appendix D - Sensor Module Standard Command Set

The following table lists the minimum standard set of commands required for a sensor module.

- A Address acknowledge
 - returns address of module, <CR> <LF> <ETX>
 - e.g. WND01 <CR> <LF> <ETX>
- B Output both calibrated and raw data values
 - outputs both calibrated and raw data values, as follows:
cal1 cal2 ... caln : raw1 raw2 ... rawn <CR> <LF> <ETX>
 - see the format command for numeric format
- C Output calibrated data
 - outputs calibrated values, as follows:
cal1 cal2 ... caln <CR> <LF> <ETX>
- H Help (optional)
 - a multiple line response with the text of the first line of each command description in this document as the help line, with each line terminated <CR> <LF> and final line terminated <CR> <LF> <ETX>.
- A - Address acknowledge <CR> <LF>
 - ...
 - ... etc.
 - ...
- T - Enter Test Mode <CR> <LF> <ETX>
- I Report ID information
 - displays the text information stored in EEPROM
 - see example in Appendix E.
- R Output raw values
 - outputs raw values, as follows:
raw1 raw2 ... rawn <CR> <LF> <ETX>
 - see the format command for numeric format
- T Enter test mode
 - responds with continuous scans of data in the 'B' command response format, except <CR> <LF> terminator only. For example:

34.123 : 1234H <CR> <LF>
34.123 : 1234H <CR> <LF>
34.123 : 1234H <CR> <LF>
34.123 : 1234H <CR> <LF>
.
.
.
- the command terminates on receipt of an esc character. The last scan sent is terminated by <CR> <LF> <ETX>.

Appendix E - IMET Module Identification Format

Each Sensor Control Module responds to an identification (I) command. The response from a module will contain information in ASCII text form as outlined in the following table. The maximum length of each line is indicated in the table. Each line should be terminated with either a NL (LF) character (10 decimal) or a CR-LF combination (13 decimal-10 decimal).

MODADR:	(5 bytes text) Module address
MODMFG:	(16 bytes text) manufacturer
MODMOD:	(16 bytes text) model number
MODSER:	(8 bytes text) serial number
MODDAT:	(8 bytes text) date of manufacture
SENMFG:	(16 bytes text) manufacturer
SENMOD:	(16 bytes text) model number
SENSER:	(8 bytes text) serial number
SENDAT:	(8 bytes text) date of manufacture
SFTMFG:	(16 bytes text) program origin
SFTNAM:	(16 bytes text) program name
SFTREV:	(8 bytes text) serial number
SFTDAT:	(8 bytes text) date of revision
SFTPCE:	(4 bytes text) pace time for characters (ms)
CALFAC:	(16 bytes text) calibration facility name
CALPER:	(16 bytes text) calibration individual
CALDAT:	(8 bytes text) calibration date
DATFRM:	(64 bytes text) calibrated data output format
DATDES:	(64 bytes text) calibrated data output description
DATUNI:	(64 bytes text) calibrated data output units
RAWFRM:	(64 bytes text) raw data output format
RAWDES:	(64 bytes text) raw data output description
RAWUNI:	(64 bytes text) raw data output units

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