

FALMOUTH SCIENTIFIC, INC.

OCEAN PRESSURE MODULE

Operating Instructions

Revision 2.1 Firmware Version 4.7

This manual covers the operational aspects of the FSI Ocean Pressure Module (OPM). FSI continuously strives to meet the full expectations of our customers and we welcome comments on the structure, content and the ability of this manual to answer your questions regarding our product. If you have any suggestions or comments please contact us. This document is provided with the understanding that future versions of this module may have additional commands and the function of the commands shown in this document may vary from the present operation.

NOTE: FSI OCEAN PRESSURE MODULES ARE RATED TO 7000M OPERATIONAL DEPTH ACTUAL OPERATIONAL DEPTH IS DEPENDANT UPON THE FULL SCALE RANGE OF THE PRESSURE TRANSDUCER. DO NOT EXCEED 125% OF FULL SCALE DURING USE OR CALIBRATION OR PERMANENT DAMAGE WILL OCCUR TO THE UNIT. AS WITH ALL HIGH PRESSURE INSTRUMENTATION OBSERVE CAUTION WHILE USING OR AFTER EXPOSURE TO HIGH PRESSURES.

LIMITED WARRANTY

One year from date of shipment, Falmouth Scientific, Inc., guarantees its products to be free of defects in materials and workmanship. Our CTD designated products are guaranteed for five years. In the event a product malfunctions during this period, the company obligation is limited to repair of the defective item at our factory, or the defective item may be replaced at our option. Instruments found defective should be returned to the factory prepaid and carefully packed, as customer will be responsible for freight damage.

Repairs or replacements under warranty will be at no cost to the customer for parts, labor, or return shipment from our factory to the customer. This warranty is void if in our opinion the instrument has been damaged by accident, mishandled, altered or repaired by the customer where such treatment has affected its performance or reliability. In the event of such abuse by the customer, all costs for repairs plus freight costs will be borne by the customer. All equipment supplied by FSI that is designed for use under hydrostatic loading has been certified by actual pressure testing prior to shipment. Any damage that occurs as a direct result of flooding is NOT covered by the FSI Warranty.

The customer will be charged a diagnostic fee plus all shipping costs if an instrument is returned for warranty repair and no defect is found by the factory. Incidental or consequential damages or costs incurred as a result of product malfunction are not the responsibility of Falmouth Scientific, Inc.

Equipment not manufactured by Falmouth Scientific, Inc., is supported only to the extent of the original manufacturer's original warranties. All OEM sensors which utilize electrodes (oxygen cartridges, pH, ORP, etc.) is warranted at the time of shipment, and shall perform upon initial installation within stated specifications. If the product proves to be defective within the OEM's warranty we will replace the product or defective part with a similar model, product or part, but only to the extent that the OEM will warrant.

All returned products must be accompanied by a Returned Material Authorization (RMA) number issued by Falmouth Scientific, Inc. Shipments will not be accepted without the RMA number.

RETURN PROCEDURE

It is necessary to contact FSI and obtain a Returned Material Authorization (RMA) number prior to returning equipment. The RMA number assists FSI in tracking the whereabouts and arrival recognition of returned goods. Please follow the procedure listed below when returning U.S. origin goods to prevent any delays or additional costs.

New Import Procedure/Returned American Goods

1. All shipments must be accompanied by two copies of your commercial invoice showing value of material and any reason for return.

Whenever possible, please send copies of the original export shipping documents with the consignment.

2. If the value is in excess of \$1,000.000, the following shippers oath must be sent with the invoices. (This can be typed on the invoice or on a separate letterhead).

"I, _____, declare that the articles herein specified are, the growth, produce, or manufacture of the United States; that they were exported from the United States; from the Port of _____, on or about _____; that they are returned without having been advanced in value or improved in condition by any process of manufacture or any other means, that no drawback, bounty, or allowance has been paid or admitted thereof.

Signed _____ "

3. If more than one part per consignment, a packing list must also accompany the shipment. It is acceptable to combine the commercial invoice and packing list with the contents of each carton clearly numbered and identified on the commercial invoice.
4. Consign all air freight shipments to Falmouth Scientific, Incorporated in care of Intercontinental Air Freight, Logan International Airport, East Boston, MA 02128.
5. If the equipment is property of FSI, please insure for full value.
6. Route via Logan International Airport only as the final destination.
7. Mail or Fax one invoice, packing list, and copy of the airway bill to FSI upon shipment.
8. Please refer to the FSI issued RMA number on all letters, documents, and correspondence.
9. Air freight must be prepaid on all returns.

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QUICK OPERATION MANUAL

The FSI Ocean Pressure Module (OPM) can collect data upon receipt by following the 3 easy steps listed below. Complete details and commands for operating the OPM can be found in the remaining sections of this manual.

- 1) Connect the supplied cable to the four pin connector located at the top end of the OPM. Connect the 25 Pin "D" connector to either serial port of your computer or to a terminal. Connect the two power leads to a regulated +12 VDC +1-2 VDC supply (Red Lead to 11+11, Green Lead to "-").
- 2) Configure your computer using a terminal emulation program such as PROCOMM or MIRROR or your terminal for 9600 Baud, 8 Data Bits, 1 Stop Bit, No-Parity.
- 3) Press the "Enter" (Carriage Return) or a CRT "Ji" the OPM will respond with a pressure value accurate to +1- .03% followed by a carriage return and a linefeed in the format
SNNNN. NNNN<CR><LF>.

SECTION 1.0

DETAILED INSTRUCTIONS FOR USE

COMMUNICATIONS:

Communications are via a 3 wire RS232, or a 3 wire RS-485 (Data and power return are common for both hardware protocols.

FACTORY SET COMMUNICATION PARAMETERS

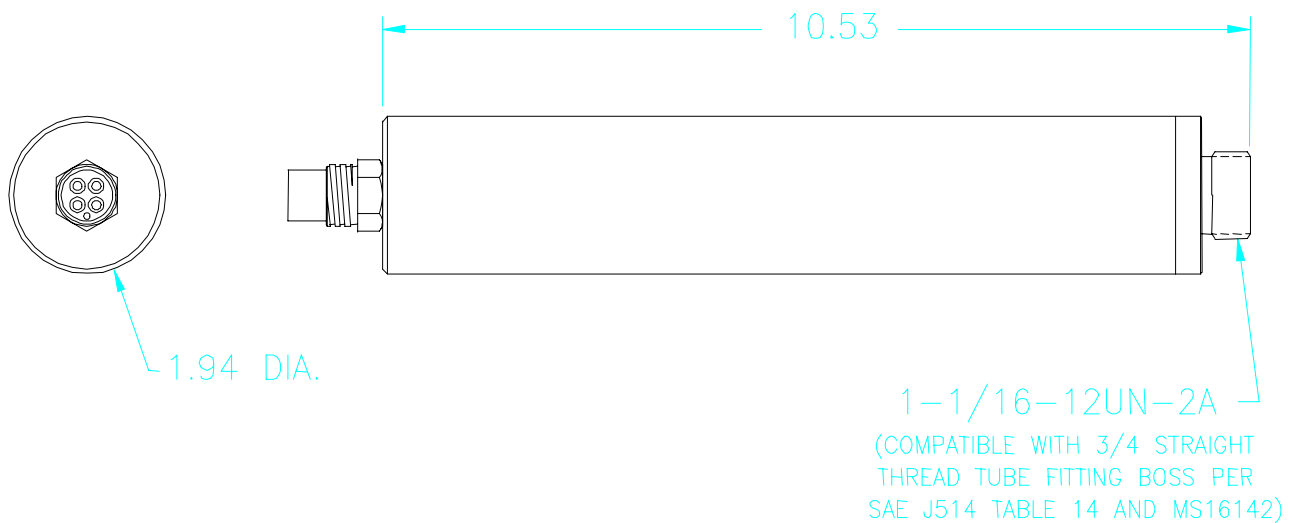
BAUD	9600
DATA BITS	8
STOP BITS	1
PARITY	NONE
DELAY	SHORT
POWER ON CONTINUOUS	OFF

Note: The user can change these parameters after power-up through the command set. The use of a terminal (or PC emulating a terminal with PROCOMM or MIRROR) with the OPM will allow the user to gain familiarity with the command set. Operation with a terminal prior to developing interface programs is highly recommended to allow the user to review and gain familiarity with each of the commands and its specific response.

SPECIFICATIONS

PROBE:	Falmouth Scientific Titanium Pressure Sensor		
RANGE:	0 - 200	dBAR (300 PSIA)	RESOLUTION* .0005/.002
	0 - 1000	dBAR (1500 PSIA)	.003/.012
	0 - 2000	dBAR (3000 PSIA)	.006/.024
	0 - 3000	dBAR (5000 PSIA)	.008/.038
	0 - 7000	dBAR (10000PSIA)	.020/.087
ACCURACY:	+/- 0.03% of Full Scale		
STABILITY:	+/- 0.001% of F.S./month		
RESOLUTION:	16 BITS @ 32 SAMPLES/SEC 18 BITS @ 4 SAMPLES/SEC		
SAMPLING RATE:	4 - 32 Samples/Second Programmable		

* At ST=0, 4 samples per second / At ST=4, 32 samples per second. See the "ST" command detail for complete sampling speed versus resolution data.

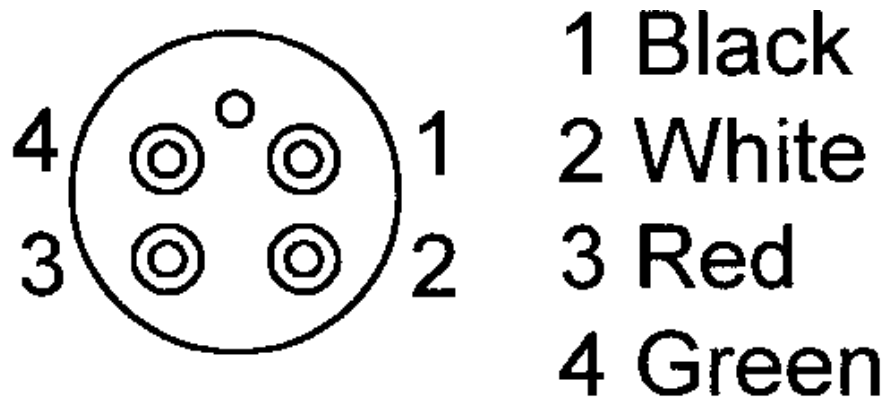


OUTLINE DRAWING FSI OCEAN PRESSURE SENSOR

SPECIFICATIONS (Continued)

RESPONSE:	10 milliseconds
POWER:	12 +/- 20% VDC @ 80 mAMPS (960 mwatt)
WARMUP:	OFF -> ON 30.0 seconds to first reading
PHYSICAL:	Pressure Rating: 10,000 psia or 2 * Range Size: 1.90" (48.2 mm) O.D. X 10.53" (267.5 mm) Long
MATERIAL:	Titanium 6AL-4V >1000 Meter Units Celcon <500 Meter Units
CONNECTOR:	SEA-CON VSG-4-BCL MATE: VMG-4-FS OR VMG-4-FS RA
DATA FORMAT:	PRESSURE IN DECIBARS (SNNNNN.NN) BAUD RATES: 4800 OR 9600 DATA BITS : 8 STOP BITS : 1 FORMAT: ASCII MODE : HALF DUPLEX
DATA OPTIONS:	OPTION 1: RS-232-C OPTION 2: RS-485

CONNECTOR RS-232C PIN DESIGNATIONS



CONNECTOR: SUBCONN MICRO 4 MCBH4F MATES WITH MCIL4M

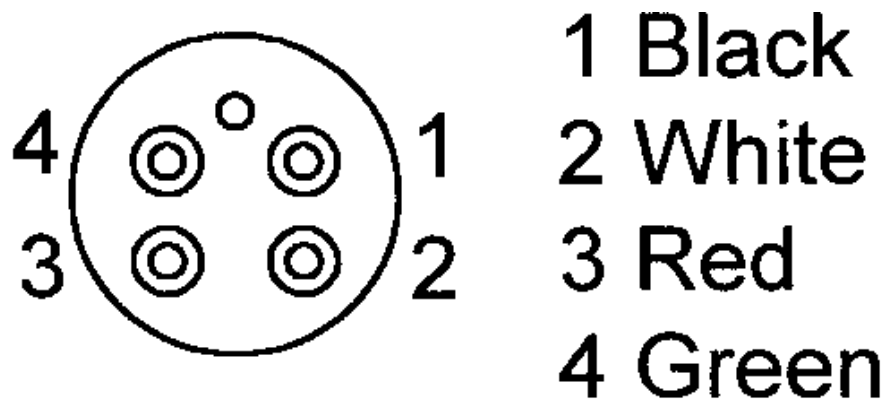
NOTE: Pin #2 as listed above is data from the users device to the OPM module. Pin #4 as listed above is data from the OPM to the users computer. The test cable provided will connect directly to the standard IBM/PC 25 pin serial port without the need to exchange pins 2 and 3. Consult the table for color code of the wires in the connecting pigtail. Pigtails and custom cables are available directly from FSI.

PIGTAIL COLOR CODES

PIN	COLOR
1	BLACK
2	WHITE
3	RED
4	GREEN

TEST CABLE PIN CONNECTIONS:
DB-25 FEMALE CONNECTOR
PIN 2 = RXD (DATA TO MODULE)
PIN 3 = TXD (DATA FROM MODULE)
PIN 7 = DATA GROUND

CONNECTOR RS-485 PIN DESIGNATIONS



CONNECTOR: SUBCONN MICRO 4 MCBH4F MATES WITH MCIL4M

NOTE: Consult the table below for color code of the wires in the connecting pigtail. Pigtails and custom cables are available directly from FSI

PIGTAIL COLOR CODES

PIN	COLOR]
1	BLACK
2	WHITE
3	RED
4	GREEN

TEST CABLE PIN CONNECTIONS:

DB-25 FEMALE CONNECTOR

PIN 2 = + RS-485 SIGNAL

PIN 3 = - RS-48b SIGNAL

PIN 7 = DATA COMMON

MANUAL NOMENCLATURE

Each command the OPM responds to has a "Description" on the following pages. The commands are listed in alphabetical order. Each of the "Descriptions" follow the format: The command appears at the top of the page. Below the command, Usage shows the exact syntax of the command. Mode indicates the operating mode the OPM must be in to respond to the command. Description outlines the command's effects. Return describes what, if anything the command returns. See Also references related commands. Example provides more information on the command, its use and implications.

COMMAND FORMAT NOTES:

- A terminating character must be received before entry processing starts.
- Commands may be terminated with either a LINE FEED (0Ah) or CARRIAGE RETURN (ODh) character. The second terminator is ignored.

Exception -> A module address used during address mode operations does not require a terminating character. See "SAOP" command detail.

- Responses from the module are terminated with both CARRIAGE RETURN and LINE FEED characters.
- Space characters (20h) received by the module are ignored.
- All characters received after the first terminating character are ignored until processing the entry is completed.
- Except where noted, command characters may be either UPPER or lower case.

Exception -> A module address used during address mode operations must use upper case "C". Additionally during "SC" Set Continuous data send operation the module will only recognize an upper case "S" Stop command, see "SC" detail.

- For any invalid command, the module will respond with "BAD COMMAND" with the "bell" character and with or without an error message depicting the nature of the error. A command is invalid if it is not recognized or if it is incomplete or parts are incorrect. Also where noted, some commands are only valid when the module is in a specific mode and invalid in the other modes.

OPERATION MODES

The OPM operates in one of three modes, these are, RUN mode, CAL mode or OPEN mode. The CAL mode provides functions used during calibration. OPEN mode is used to update calibration and other operational parameters. RUN mode is the normal operating mode from which pressure is obtained from the device. The unit always powers up in the RUN mode (if calibration parameters are incorrect or missing the unit will power up in the OPEN mode). All data requested in the OPEN mode will be responded to with a value of -5.000.

In the Table on the following pages is listed all commands and the mode under which it operates: (Note: some commands are listed under two or more Modes of operation). See detailed descriptions listed in the following sections of the manual for complete command operational usage and responses.

MODE			COMMAND
RUN	OPEN	CAL	DESCRIPTION
<CR>		<CR>	READ CURRENT DATA <CARRIAGE RETURN>
<LF>		<LF>	READ CURRENT DATA <LINE FEED>
***C	***C	***O	GOTO CAL MODE
***O		***R	GOTO OPEN MODE
	***R	***E	GOTO RUN MODE
	***E	***Q	WRITE CAL & OPERATION TO EEPROM
***Q	***Q		READ EEPROM & OPERATE PER FINDINGS
	?		LIST COMMANDS (HELP MENU)
SC 5		SC 5	SEND CONTINUOUS DATA STOP SENDING CONTINUOUS DATA
RT	ST=n RT	RT	SET DATA RATE (0=4,1=10,2=15,3=25,4=32) READ DATA RATE
	SB48		SET BAUD RATE TO 4800
	SB96		SET BAUD RATE TO 9600
	SB19		SET BAUD RATE TO 19200
	SCOP		SET CONTINUOUS DATA SEND ON POWER-UP
	CCOP		CLEAR CONTINUOUS DATA SEND ON POWER-UP
	RCOP		READ IF CONTINUOUS SEND SET
	SAOP		SET ADDRESS OPERATION
	CAOP		CLEAR ADDRESS OPERATION
	RAOP		READ IF ADDRESS OPERATIONS SET
	ADR		READ ADDRESS
	ADR=		WRITE ADDRESS (0 - 7)
	SSOT		SET SCALED OUTPUT (0-65,535)
	CSOT		CLEAR SCALED OUTPUT
	RSOT		READ IF SCALED OUTPUT SET
MODE	S/N	MODE	READ UNIT SERIAL NUMBER
	VER		READ FIRMWARE VERSION
	CDATE		READ CALIBRATION DATE
	MODE		READ OPERATIONAL MODE
	RCAL		READ CALIBRATION CONSTANT TABLE
	ROP		READ OPERATION TABLE
	ADO ADi	ADO	READ AID CHANNEL 0
		ADi	READ AID CHANNEL 1
		RO	SET MUX TO 0 REFERENCE
		R50	SET MUX TO 50 REFERENCE
		R100	SET MUX TO 100 REFERENCE
		RR	SET MUX TO PRESSURE CHANNEL

COMMAND TABLE CONTINUED

	AO A50 AbO BO B50 B100 CO C50 C100 TA TB TC TD		READ CALIBRATION TERM AO READ CALIBRATION TERM A50 READ CALIBRATION TERM AbO READ CALIBRATION TERM SO READ CALIBRATION TERM B50 READ CALIBRATION TERM 5100 READ CALIBRATION TERM CO READ CALIBRATION TERM C50 READ CALIBRATION TERM C100 READ CALIBRATION TERM TA READ CALIBRATION TERM TB READ CALIBRATION TERM TC READ CALIBRATION TERM TD
	CDATE= AO= A50= AbO BO-- 550= B100= CO= CSO= C100= TA TB= TC= TD=		WRITE CALIBRATION DATE WRITE CALIBRATION TERM AO WRITE CALIBRATION TERM A50 WRITE CALIBRATION TERM AbO WRITE CALIBRATION TERM BO WRITE CALIBRATION TERM B50 WRITE CALIBRATION TERM B100 WRITE CALIBRATION TERM CO WRITE CALIBRATION TERM C50 WRITE CALIBRATION TERM C100 WRITE CALIBRATION TERM TA WRITE CALIBRATION TERM TB WRITE CALIBRATION TERM TC WRITE CALIBRATION TERM TD

ADR

Usage

ADR

Mode

OPEN

Description

This command reads the present value of address in volatile memory.

Note: these values are held in volatile memory until the user issues the "***E" command at which time they are written into EEPROM (non-volatile memory). To ensure that current value is the one found in EEPROM (non-volatile memory) issue the ***Q command which will read the EEPROM and return the unit to the RUN mode. Re-enter the OPEN mode using the "***O" command and re-read the address using the "ADR" command.

See Also

SAOP, CAOP, RAOP, ADR= ROP

Returns

address = 2 "where 2 equals ADR

Example

ADR<CR>

address = 1 "Reads ADR which is equal to 1

ADR=

Usage

ADR=n Where n = integer 0 - 7

Mode

OPEN

Description

This command writes the value of the address to the OPM. Note: these values are held in volatile memory until the user issues the "***E" command at which time they are written into EEPROM (non-volatile memory).

See Also

SAOP, CAOP, RAOP, ADR, ROP

Returns

No Return

Example

ADR=1 "Enters ADR as 1

ADO

Usage

ADO

Mode

CAL, or OPEN

Description

Reads the value of the 10 bit internal AID convertor. The convertor channel 0 monitors the internal temperature of the electronics. This value is used to assist in correction of dynamic temperature effects on the pressure transducer. Consult the calibration section of the manual for complete details regarding user re-calibration.

Returns

No Return

Example

ADO	"ENTER COMMAND
348	"ADO VALUE

AD1

Usage

AD1

Mode

CAL, or OPEN

Description

Reads the value of the 10 bit internal AID convertor. The convertor channel 0 monitors the internal temperature of the pressure transducer. This value is used to assist in correction of both static and dynamic temperature effects on the pressure transducer. Consult the calibration section of the manual for complete details regarding user re-calibration.

Returns

No Return

Example

ADi	"ENTER COMMAND
723	"ADI VALUE

Carriage Return or Linefeed

Usage

The single character Carriage-Return, character (13d) or (ODh) or Ctrl M.

The single character Linefeed, character (10d) or (OAh) or Ctrl J.

Mode

RUN, CAL or OPEN

Description

Sending a carriage-return or Linefeed character alone, is a request for the module to send data. Data from the module is always a single decimal number. What this number represents is determined by the current operating mode.

Returns

In the RUN mode, the number will either be a pressure value in the desired pressure scale. The rate of new data availability is based on the acquisition integration period specified (see ST command).

In the CAL mode, the number will represent the raw measurement for the selected calibration parameter.

In the OPEN mode a request for data will always return a -5.0000.

See Also

SC, SCOP, CCOP, RCOP, ROP, S

Example

<CR>

0. 234<CR><LF>

“Carriage Return

“Pressure Followed by Carriage Return & Line Feed

CAOP

Usage

CAOP

Mode

OPEN

Description

This command clears the UNIT FROM address mode operations. The unit will revert to sending pressure upon return to the RUN mode with the entry of the SC, a <CR>, or a <LF>, without the issuance of an attention character and the units address. (Note: This command must be followed by the ***E command prior to turning the power off or the unit will power up and run as per the setting currently stored in EEPROM.)

See Also

SAOP, RAOP, ADR, ADR=, ROP

Returns

No Return

Example

CCOP

Usage

CCOP

Mode

OPEN

Description

This command clears the module to send continuous data on power up. (Note. This command must be followed by the ***E command prior to turning the power off or the unit will power up and run as per the setting currently stored in EEPROM.)

See Also

SC, SCOP, RCOP, ROP, S

Returns

No Return

Example

CSOT

Usage

SSOT

Mode

OPEN

Description

This command clears the output of scaled data from the module. The unit will revert to sending pressure in dBars upon return to the RUN mode after entry of this command. (Note: This command must be followed by the ***E command prior to turning the power off or the unit will power up and run as per the setting currently stored in EEPROM.)

See Also

SSOP, RSOP, ROP

Returns

No Return

Example

MODE

Usage

MODE

Mode

RUN, CAL or OPEN

Description

This status command reads from the module it's current operating mode. If the module is in the calibration mode, the currently selected calibration parameter is included.

Returns

For RUN mode:

RUN MODE

For CALibration mode:

CAL MODE

For OPEN mode:

OPEN MODE

Example

In the CALibration mode with the module selected to measure the pressure transducer, a MODE command would return the following.

```
MODE<CR>  
CAL MODE
```

nnnnn

Usage

AD
A50
Abo
BO
B50
BIOO
CO
CSO
CIOO
TA
TB
TC
TD
CDATE
VER
S/N

Mode

OPEN

Description

These commands read specific calibration data from the module. Note these values are the values held in volatile memory until the user issues the "***E" command at which time they are written into EEPROM (non-volatile memory). The user cannot change the s/N or version numbers.

Returns

As Specified

Example

AO<CR>
AO=-4.312123

nnnnnn =

Usage

AO=fp (fp Floating Point)
A50=fp
AIOO=fp
BO=fp
B50=fp
BIOO=fp
CO=fp
C50=fp
CIOO=fp
TA=fp
TB=fp
TC=fp
TD=fp
CDATE=DDMONYY (15MAY90)

Mode

OPEN

Description

These commands write calibration constant data to the OPMS. Note: these values are held in volatile memory until the user issues the "***E" command at which time they are written into EEPROM (non-volatile memory). Floating point numbers can be entered as exponential.

Returns

No Return

Example

AO=-4. 233456 "Enters AO as -4.233456
A50=3. 562345E3 "Enters ASO equal to 3.562345E3

RAOP

Usage

RAOP

Mode

OPEN

Description

This command reads the module address mode operation. Note: if the unit is presently in the address mode operation, the units address preceded by the attention character must be transmitted to allow the unit to enter the “addressed unit open status”.

See Also

SAOP, RAOP, ADR, ADR=, ROP

Returns

address mode set
address mode not set

Example

RAOP(LF/CR)
address mode set

RCAL

Usage

RCAL

Mode

OPEN

Description

This command reads all calibration data from the module. Note these values are the values held in volatile memory until the user issues the YI***E" command at which time they are written into EEPROM (non-volatile memory). The user cannot change the S/N or version numbers.

Returns

As Specified

Example

```
RCAL< CR>
S/N = 13
VER = 2.0
CDATE = 19DEC89
AD = -6.261975
A50 = 667.495000
AbO = 1335.872000
BO = 9.660000e-03
B50 = 3.400000e-03
B100 = 9.9900000e-04
CO = -1.000000e-07
C50 = -9.810000e-07
C100 = 1.097000e-06
TA = -7.000000e-01
TB = 1.00034e-00
TC = -4.739000e-06
TD = 5.000000e-09
```

RCOP

Usage

RCOP

Mode

OPEN

Description

This command reads the modules continuous data on power up setting.

Returns

continuous set
continuous not set

Example

RCOP (LF/CR)
continuous set

ROP

Usage

ROP

Mode

OPEN

Description

This command reads all operational data from the module. Note these operational settings are the values held in volatile memory until the user issues the "***E" command at which time they are written into EEPROM (nonvolatile memory).

Returns

As Specified

Example

ROP<CR>

TAU = 1

continuous cleared

scaled output cleared

address op cleared

"continuous on power-up cleared; see SCOP

"scaled output in RUN mode cleared: see SSOT

"address mode operations cleared; see SAOP

RR

Usage

RR

Mode

CAL

Description

While the unit is in the CAL mode it sets the unit to output the value of the pressure channel RR. This value is a relative number scaled in a range of -250 to 250 counts. The unit will transmit the RR value upon the receipt of a carriage return or a line feed. The SC (set continuous) command is also valid and the RR value will be sent until S (stop) is received. Consult the calibration section of the manual for complete details on user re-calibration of the module.

Returns

No Return

Example

***C	"ENTER CALIBRATION MODE
RR	"SET RR REFERENCE FOR OUTPUT
<CR>	"SEND CARRIAGE RETURN
249.9883	"RR VALUE

RSOT

Usage

RSOT

Mode

OPEN

Description

This command reads the modules status of transmitting scaled data while in the RUN mode.

See Also

SSOP, RSOP, ROP

Returns

scaled output set
scaled output not set

Example

RSOT(LF/CR)
scaled set

RT

Usage

RT

Mode

RUN, CAL or OPEN

Description

The **RT** command requests the current data collection interval.

Returns

A single numeric digit from 0 to 4 representing the current integration interval. The data transfer maximum rate is as listed in the table found listed in the ST description. Note, in continuous mode the data is sent at this rate. In non-continuous mode operation data will be transmitted at the rate requested by the user's host device. If the user request data faster than the update rate then a -1 will be returned by the module if a new value for pressure has not been calculated and the last calculated value has been sent.

The form of the return is:

n -> A single numeric digit from 0 to 4. The table below provides the actual data rate represented by each numeric value.

ST SETTING	INTEGRATION TIME	DATA RATE
0	105 ms	4 Hz
1	64 ms	10 Hz
2	50 ms	15 Hz
3	29 ms	25 Hz
4	24 ms	32 Hz

See Also

ST

RO

Usage

RO

Mode

CAL

Description

While the unit is in the CAL mode it sets the unit to output the value of the zero reference Ra. This value is a relative number scaled to approximately 250 counts. The unit will transmit the RO value upon the receipt of a <CR> carriage return or a <LF> line feed. The SC (set continuous) command is also valid and the RO value will be sent until "S" (stop) is received. Consult the calibration section of the manual for complete details on user re-calibration of the module.

Returns

No Return

Example

***C	ENTER CALIBRATION MODE
RO	SET RO REFERENCE FOR OUTPUT
<CR>	SEND CARRIAGE-RETURN
241.3425	RO VALUE

R50

Usage

R50

Mode

CAL

Description

While the unit is in the CALibration mode it sets the unit to output the value of the mid scale reference R50. This value is a relative number scaled to approximately 0 counts. The unit will transmit the R50 value upon the receipt of a carriage return or a line feed. The SC (set continuous) command is also valid an the R50 value will be sent until S (stop) is received. Consult the calibration section of the manual for complete details on user re-calibration of the module.

Returns

No Return

Example

***C	ENTER CALIBRATION MODE
R50	SET R50 REFERENCE FOR OUTPUT
<CR>	SEND CARRIAGE RETURN
0.3983	R50 VALUE

R100

Usage

R100

Mode

CAL

Description

While the unit is in the CAL mode it sets the unit to output the value of the full scale reference R100. This value is a relative number scaled to approximately -250 counts. The unit will transmit the RIOO value upon the receipt of carriage return or a line feed. The SC (set continuous) command is also valid and the RIOO value will be sent until S (stop) is received. Consult the calibration section of the manual for complete details on user re-calibration of the module.

Returns

No Return

Example

***C	ENTER CALIBRATION MODE
RIOO	SET RIOO REFERENCE FOR OUTPUT
<CR>	SEND CARRIAGE RETURN
-238.7321	RIOO VALUE

SAOP

Usage

WARNING: PRIOR TO ENTRY INTO THE ADDRESS MODE OPERATION THE USER SHOULD DETERMINE BOTH THE ADDRESS OF THE UNIT AND RECONFIRM THE PRESENT OPERATING BAUD RATE. THE ISSUE OF THIS COMMAND REQUIRES THE UNIT TO BE ADDRESSED IN ORDER TO ESTABLISH COMMUNICATION.

SAOP

Mode

OPEN

Description

This command sets the module to enter address mode operations. The unit will initially enter the "open communication mode" when the command is transmitted until an attention "#" character is received at which point the unit will only re-enter the "open communication mode" when its valid address has been received. The OPM will remain in the "closed communication" mode it is in until it is "re-opened" by the receipt of its address. (Note: This command must be followed by the ***E command prior to turning the power off or the unit will power up and run as per the setting currently stored in EEPROM.) The unit will send data at the baud rate and frequency as set by the current value found in EEPROM.

An OPM is placed in the "open communication" mode (ready to receive commands by the receipt of its address while operating in "Addressed Operations". The OPM address is the attention character followed by "P" and the current AOR value: As an example:

#P2 "Where AOR--2"

Upon receipt of the correct address the OPM will respond with the current value of pressure in dBars or scaled counts dependant upon the mode of operation the unit is in. Note the use of a Capital "P" will set then OPM in the "open for communications mode", where it will remain until another attention "#" is received. To ask the OPM for a single value of pressure and then return to the "not open for communication mode", a Lower case "p" should be sent preceding the address. As an Example:

#p2 "Where AOR--2"

Will return only a single value of pressure and the unit will revert immediately to a "not open for communication mode", use upper case "P" if more commands are required to be sent to the OPM.

NOTE: A modules address command is NOT followed by a <CR> or a <LF>. The OPM will respond with 1 scan of data (within 200 micro seconds) after receipt its address. The unit will not transmit the next value unit it completed the next measurement cycle. The time for each measurement cycle is based upon the present setting of "Tau", see "ST" command.

To exit address mode operations enter the "open communication" mode by sending its address, enter the OPEN mode using the ***O command. Give the unit the "CAOP" clear address operations command. verify that address mode operations has been cleared by either the "RAOP" or the "ROP" command. If you want the unit to continue to operate from power up without addressing send the ***E command to store the present operation in EEPROM prior to turning the unit off.

See Also

CAOP, RAOP, AOR, AOR=, ROP

Return

Example

#P2+1234.5678<CR><LF>

SB19

Usage

SB19

Mode

OPEN

Description

This command sets the modules data transfer rate to 19200 baud. The unit changes to this rate upon the receipt of the command. All further communication must then be performed at 19200 baud. Note: this rate is not written into EEPROM until the ***E command is issued to the module. The unit will power up at the last baud rate specified and then saved by the combination of SB19 and ***E. (Note: Unless otherwise specified all units are shipped at 9600 baud). FSI recommends that the unit be used in the 9600 or 19200 baud mode whenever possible by the host device.

Returns

No Return

Example

SB19	unit now communicates at 19200 baud
***E	stores current baud rate in EEPROM

SB48

Usage

SB48

Mode

OPEN

Description

This Command sets the modules data transfer rate to 4800 baud. The unit Changes to this rate upon the receipt of the Command. All further Communication must then be performed at 4800 baud.

Note: this rate is not written into EEPROM until the ***E command is issued to the module. The unit will power up at the last baud rate specified and then saved by the combination of SB48 and ***E. (Note: Unless otherwise specified all units are shipped at 9600 baud). The 4800 baud transfer rate incorporates a 30 millisecond turnaround delay. This delay is incorporated to allow low power data loggers time to prepare for receipt of data from the OPM after a request has been sent. FSI recommends that the unit be used in the 9600 or 19200 baud mode whenever possible by the host device.

Returns

No Return

Example

SB48	unit now communicates at 4800 baud
***E	stores current baud rate in EEPROM

SB96

Usage

SB96

Mode

OPEN

Description

This command sets the modules data transfer rate to 9600 baud. The unit changes to this rate upon the receipt of the command. All further communication must then be performed at 9600 baud. Note: this rate is not written into EEPROM until the ***E command is issued to the module. The unit will power up at the last baud rate specified and then saved by the combination of SB96 and ***E. (Note: Unless otherwise specified all units **are shipped** at 9600 baud). FSI recommends that the unit be used in the 9600 or 19200 baud mode whenever possible by the host device.

Returns

No Return

Example

SB96	unit now communicates at 9600 baud
***E	stores current baud rate in EEPROM

Sc

Usage

SC

S

Mode

RUN or CAL

Description

The SC command sets the module into the continuous data mode. When continuous data is selected, new data is automatically transmitted as soon as it is available without any user request. The rate of new data availability depends upon the integration interval selected. Note the SC command is ignored in the OPEN mode.

The S command is used to stop the continuous data mode. **NOTE:** This is a special command. When the module is in the continuous mode, the S command is the **ONLY** command the module will recognize. This **MUST** be an **UPPER** case S and no terminator character is required.

Returns

Data as it is acquired, pressure if in the RUN mode. If in the CAL mode the data type selected; sensor output RR, reference zero output RO, reference half scale output R50, or, reference full scale output R100. Data is returned at the rate as determined by the ST command.

See Also

ST

Scop

Usage

SCOP

Mode

OPEN

Description

This command sets the module to send continuous data on power up. (Note. This command must be followed by the `***E` command prior to turning the power off or the unit will power up and run as per the setting currently stored in EEPROM.) The unit will send data at the baud rate and frequency as set by the current value found in EEPROM.

Returns

No Return

Example

SSOT

Usage

SSOT

Mode

OPEN

Description

This command sets the module to send scaled data while in the RUN mode. (Note. This command must be followed by the ***E command prior to turning the power off or the unit will power up and run as per the setting currently stored in EEPROM.) The unit will send data at the baud rate and frequency as set by the current value found in EEPROM. scaling is a 5 digit ASCII number between 0 - 65535. Pressure can be found based upon the current value found in calibration term AIOO (note: AIOO is normally close to the full scale pressure of the transducer. Exact scaling can be found from the following table to convert scaled units back to pressure in decibars.

Value A100	Conversion to dBAR
< 500	(OPM Reading/300) - 10
< 1500	(OPM Reading/60) - 10
< 2500	(OPM Reading/30) - 10
< 3500	(OPM Reading/20) - 10
>3500	(OPM Reading/10) - 10

Example: an OPM reading of "12345" with a AIOO 1324.4567

Pressure (dBAR) $(12345/60) - 2 = 203.75$ dBar
This would be an OPM with a IOOOM transducer.

Return

No Return

ST

Usage

ST=n

Mode

OPEN

Description

The ST command sets the current integration interval "Tau" which correlates to the integration time for each measurement made. The integration interval is used to measure both the sensor channel and the "calibration" channels used to compute pressure. As a result the maximum data transfer rate is dependent upon the length of integration interval "Tau" used. The single REQUIRED parameter specifies the integration interval to use. A longer integration interval improves the signal to noise ratio.

The form of entry is:

ST=n

Where n -> is a single numeric digit from 0 to 4. The table below provides the actual interval and maximum data transfer rate represented by each numeric value.

ST SETTING	INTEGRATION TIME	DATA RATE
0	105 ms	4 Hz
1	64 ms	10 Hz
2	50 ms	15 Hz
3	29 ms	25 Hz
4	24 ms	32 Hz

Note: The data transfer rate in the above Table are based upon the "SC" command (set continuous) data transfer mode.- Polled data rates will be lower due to character processing overhead by the OPM controller, See command "Carriage Return or Linefeed" for additional detail relative to polled data transfer.

ST CONTINUED NEXT PAGE

ST (Continued)

RESOLUTIONS FOR EACH TAU SETTING

FULL SCALE PRESSURE RANGE (dBAR)					
TAU	700DM	300DM	200DM	100DM	200M
0	0.02	.008	.006	.003	.0006
1	0.03	.014	.009	.005	.0009
2	0.04	.018	.012	.006	.0012
3	0.07	.031	.020	.010	.0020
4	0.09	.038	.025	.013	.0025

Returns

Carriage-Return & Linefeed.

See Also

RT

Example

"If the integration value n=0 corresponds to a 105 ms integration interval and a 4 hertz data rate (4 samples/second).

**** *C**

Usage

*****C**

Mode

RUN or OPEN

Description

This command enters the unit into the CAL mode. This mode allows the user **to read reference** data, internal temperature data (electronics and transducer temperature) and the raw sensor data from the module. The actual parameter transmitted by the unit is determined by the transmission of the RR, RO, R50, R100 commands. The unit will transmit RO (zero reference data unscaled) upon entering the mode until changed by the user.

Returns

No Return

*****E**

Usage

*****E**

Mode

CAL or OPEN

Description

This command is valid in either CAL mode or the OPEN mode. Upon entry of the command all calibration constants and operational settings **ARE** written to EEPROM (saved). This is the only command that will update EEPROM data and must be used when data is to be saved. Note: You will overwrite any stored data so ensure your calibration constants are correct using the RCAL command prior to issuing this command.

Returns

No Return

*****O**

Usage

**** *0**

Mode

RUN or CAL

Description

This command enters the unit to the OPEN mode. Data collection is stopped. From the OPEN mode operational settings and calibration constants can be read and edited. The unit will return a value of -5.0000 if pressure is requested by either a CR or LF (the SC command is invalid in this mode). In this mode the following commands are valid: nnnnn, nnnnn=, ST=n, RT, VER, S/N, CDATE, CDATE=, MODE, RCAL, ROP, SB48, SB96, SB19, SCOP, CCOP, RCOP, SAOP, CAOP, RAOP, ADR, ADR=, SSOT, CSOT, RSOT, ***E, ***C, ***Q, and ***R.

Returns

No Return

***Q

Usage

***Q

Mode

RUN, CAL, or OPEN

Description

This command reads the EEPROM and begins operation based on the parameters found there. If the SCOP (send continuous on power up) has been set in EEPROM the unit will begin to send data on receipt of this command. If

the SAOP (address operation enabled) has been set in EEPROM₁ the unit will enter the un-addressed state and await for the appropriate address to be received (see address mode operations). Note: if calibration constants **have been** modified and the ***E command has NOT been issued, this command will over write these edited values with the data contained within the EEPROM.

Note: if the Baud Rate of operation has been changed via the "SBxx" command, and the new rate has not been stored to EEPROM via the use of the "***E" command, and the "***Q" command is issued, the unit will revert to baud rate operation at the rate stored in EEPROM.

Returns

No Return

*****R**

Usage

*** * *R**

Mode

CAL, or OPEN

Description

This command sets the unit into the RUN mode. It will only enter the run mode if valid calibration factors are found for the unit. Valid data consists of non zero values for A50 and AbO, and TB. Data rate is determined by the setting of ST.

Returns

No Return

?

Usage

?

Mode

OPEN

Description

This command returns a table of commands to assist the user in operation of the instrument. The table is as detailed below. Reference each command detail in this manual for exact usage.

Returns

Command Help List:

Carriage-Return or Linefeed; get 1 scan of data, any mode

```
***0 ***C ** ***E ***Q
SAOP ADR ADR= CAOP RAOP
SCOP CCOP RCOP
SSOT CSOT RSOT
SB48 SB96 SB19
SC S
RR RO R50 RiDO
RT ST=
RCAL ROP MODE
```

(Data, ***O C & R, MODE, RT & SC work in run mode, all others in open mode)

(All cal factors are read or written using the term references shown in RCAL)

ERROR MESSAGES:

For any invalid Command, the module will respond with "BAD COMMAND" with the "bell" character. Some error messages are followed by a short description to assist depicting the nature of the error. A command is invalid if it is not recognized or if it is incomplete or parts are incorrect. Also where noted, some commands are only valid when the module is in a specific mode and invalid in the other modes.

ERROR	REASON
BAD COMMAND	Unrecognized command, generic in all operational modes. Re-enter command after checking validity of command in the present operational mode of the instrument. Note, most commands are only functional while the instrument is in the OPEN mode.
NOT OPEN	command requires the unit to be in the OPEN mode. Place unit in the OPEN mode by issuing the ***O command. Re-enter initial command.
BAD DATE	During entry of calibration date using the "CDATE=" command, improper format was used. Re-enter the calibration date using as an example the format "CDATE=01JAN91".
ERROR, NOT RUNNING	The "SC" Set-Continuous command was issued while the unit is in the OPEN mode. Place the unit in the RUN mode using the ***R command. Re-issue the SC command.
ERROR, CAL TERMS MISSING	Upon the issue of the ***R, enter RUN mode from either the CAL or OPEN modes a complete set of calibration constants was not available for the processor to compute pressure. Enter the OPEN mode using the ***O command and check the status of the calibration constants using the RCAL command. Constants A50 and A100 MUST be non-zero, and TB MUST be non-Zero.
ERROR, ADDRESSING PRESENT	While in the OPEN mode, attempt has been made to enter address mode operations using the SAOP command while continuous data send on power up has been set using the SCOP command. Clear the continuous on power up using the CCOP command and then re-enter the SAOP command. Remember all operational changes MUST be stored in EEPROM using the ***E command upon setting to insure that unit will power-up in the correct operational modes. All operational modes not saved using the ***E command will revert to previous settings upon the next power-up of the instrument.
ERROR, ADDRESS RANGE 0 – 7	While in the OPEN mode, attempt has been made to

enter address which is out of range. Address must be an integer between 0 and 7.

ERROR, TAU RANGE 0 – 4

While in the OPEN mode attempt has been made to enter an invalid sampling rate. The sampling rate is set by setting TAU equal to an integer from 0 – 4. Sampling rates are as follows:

0 = 4 samples/sec
1 = 10 samples/sec
2 = 15 samples/sec
3 = 25 samples/sec
4 = 32 samples/sec

ERROR, CONTINUOUS ON POWER-UP ACTIVE

This error message is the inverse of the last error message. While in the OPEN mode, attempt has been made to enter the set continuous on power-up command function using the SCOP command while address mode operations are set by previous entry of the SAOP command. Clear the address mode operations using the CAOP command and then re-enter the SCOP command. Remember all operational changes must be stored in EEPROM using the ***E command upon setting to insure that unit will power-up in the correct operational modes. All operational modes not saved using the ***E command will revert to previous settings upon the next power-up.

ERROR, FACTORY ONLY

While in the OPEN mode the serial number using the S/N= command or the version using the VER= command have been entered. These values are only modifiable by the factory and allow FSI to keep complete history on each unit delivered and its current version and revision level. For complete details pertaining to your instrument and its current level please consult factory.

ERROR, ADDRESS RANGE = 0 – 7

While in the OPEN mode the user has attempted to enter an invalid address numeral for the instrument using the ADR= command. Re-enter a valid address between 0 – 7 using the ADR= command with the following format as an example ADR=5.

BAD EEPROM CHECKSUM

Upon power up or ***Q command processor found bad check sum in EEPROM. Go to OPEN mode and re-enter calibration constants complete with ***E command. If the unit continues to transmit this error consult factory for repair.

EEPROM READ ERROR

Unit detected EEPROM read error during initialization. Reset power and continue. If error message persists re-enter calibration data and terminate with the ***E command. If the unit continues to transmit this error consult factory for repair.

EEPROM WRITE ERROR

Unit detected EEPROM read error during completion of ***E command, Reset power and continue. If error message persists re-enter calibration data and terminate with the ***E command. If the unit continues to transmit this error consult factory for repair.

SECTION 2.0

CALIBRATION INSTRUCTIONS

Calibration of the OPM requires the use of high quality primary standards and established Calibration techniques. FSI offers a Calibration service for users who do not have access to a primary standards calibration facility. FSI recommends that the unit be returned to the factory for re-calibration if possible.

Equipment Required:

- a) Standard Air Precision Dead weight Tester located at a calibrated gravity station. Total residual errors of corrected dead weight must be less than 0.001% of full scale for proper calibration of the OPM.
- b) **WELL STIRRED** temperature controlled bath with a minimum 5 gallon capacity. Short term stability in excess of +/- .01 Celsius. Range of operation 0.5 to 29 Celsius,
- d) IBM/PC XT/AT Computer with 1 serial port.
- e) +12VDC Power supply, and the test cable provided with your OPM.
- f) The executable versions of DASTDOPM.EXE, CALOPM.EXE, DAFINOPM.EXE, CALOPMF.EXE, and a graphing program which accepts Lotus 123 format data files, example "GRAPHER". All programs are provided the diskette supplied with your OPM. EXECUTABLE PROGRAMS MUST BE LOADED INTO THE "C:\OPM\" DIRECTORY AND a "C:\OPM\DATA\" directory established for the program working files.

CALIBRATION:

The calibration process for the OPM occurs through three steps. The user only is required to perform all three steps to fully calibrate the OPM.

The calibration process is as follows:

PRIOR TO CALIBRATION EXISTING CALIBRATION CONSTANTS
SHOULD BE SET TO THE FOLLOWING VALUES:

AO	= X	'Don' t Care
ASO	= X	'Don' t Care
AIOO	= X	'Don' t Care
BO	= X	'Don' t Care
B50	= X	'Don' t Care
BIOO	= X	'Don' t Care
CO	= X	'Don' t Care
C50	= X	'Don' t Care
CIOO	= X	'Don' t Care
TA	= 0	
TB	= 1	
TC	= 0	
TD	= 0	

1) Using a precision pressure dead weight tester the calibration values of the internal references and the sensor while operating at three fixed temperatures (preferable 0, 15, and 30 Celsius) are obtained. Using program DASTDOPM.EXE. Data output from this program is stored in the "C:\OPM\DATA\" directory with a file name "#####-S.DAT" where ##### is the serial number of the OPM. Data must be collected at 0, 50, and 100 percent of scale, for both increasing and decreasing pressures at each temperature.

2) A set of calibration coefficients for A0, A50, A100, B0, B50, B100, C0, C50, and C100 are determined using the CALOPM.EXE program, and are downloaded to the OPN via the program.

3) A second set of standard versus pressure values are determined with the OPM at the center temperature (preferably 15 Celsius), using the DAFINOPM.EXE program. Data output from this program is stored in the "C:\OPM\DATA\" directory with a file name "#####-F.DAT" where ##### is the serial number of the OPM. Data can be collected for any number of increasing and decreasing points dependent upon specific user requirements.

4) From the second set of data collected the calibration coefficients TA, TB, TC AND TD determined. These values are found and downloaded to the OPM using the CALOPMF.EXE program.

2.1 DISCUSSION OF CALIBRATION CONSTANTS:

Each of the calibration constants used in the FSI OPM are detailed below. This discussion is intended to familiarize the user with the function of each constant. As some of these constants interact with others a detailed knowledge of strain gauge pressure transducer calibration techniques is required prior to any constant adjustment. Please consult the calibration section of the manual prior to changing any constant. Note: any changed value can be tried prior to commitment to memory with the use of the ***E command. To return the unit to operating with presently stored values issue the ***Q command.

A) A0, A50, A100

These three constants are the values for the each of the reference network outputs at a internal temperature of the pressure transducer where ADO=0 counts. The reference temperature is near 15 Celsius but due to small variations in the transducer temperature measurement circuitry may be slightly below or above this temperature. Note, as the internal temperature is used only correct the pressure transducer it is never converted to an absolute temperature reading. The user could take measurements of ADI versus temperature to obtain a relationship from which the user could compute a temperature to within 0.5 Celsius.

B) B0, B50, B100

These 3 constants provide the equivalent of how the pressure transducer reference change as a function of internal temperature counts ADI. The value of the reference is calculated from the equation:

$$\text{Ref0} = A0 + B0 * AD1$$

This is performed for all three references during each calibration interval (each Second).

C) C0, C50, C100

These 3 constants provide the equivalent of how the pressure transducer reference change in a non-linear function of internal temperature counts ADi. The value of the reference is calculated from the equation:

$$\text{Ref0} = A0 + B0 * AD1 + C0 * AD^2$$

This is performed for all three references during each Calibration interval (each second).

C) TA, TB, TC, TD

These 3 correct any residual errors of the calculated pressure output. The equation has the form:

$$\text{Press} = TA + TB * \text{Press}' + TC * \text{Press}'^2 + TD * \text{Press}'^3$$

This allows the user to re-calibrate the unit by setting these terms back to 0, 1, 0, 0 and refitting OPM output to calculated dead weight tester values using a polynomial regression. The TA term also serves as an offset term, which can be adjusted to, correct for on-deck pressure offset readings prior to deployment.