Crystal
pressure

APM CPF Series Operation Manual

AMETEK ®
SENSORS, TEST & CALIBRATION

Contents

Overview

▍INTRODUCTION

The Crystal APM CPF series of pressure modules allow you to add pressure measurement capability to your JOFRA process calibrator. The APM uses the same reliable, high accuracy, digital temperature compensated technology found in the nVision, housed in a new rugged enclosure with an integrated cable to connect to your JOFRA calibrator. In addition, you can connect the APM to a hand-held pressure calibrator to increase the range of that calibrator.

Supported JOFRA Calibrators

The Crystal APM has been engineered to work seamlessly with many of the most popular JOFRA calibrators. Below is a list of compatible JOFRA calibrators.

- AMC910
- ASC300
- ASC301
- ASC321
- ASC-400
- ASC-400 BARO
- HPC500
- HPC502
- HPC600

Note: This manual includes information on the APM CPF modules only. For details on the operation of JOFRA calibrators, please refer to their <u>User Manuals.</u>

What's Included

Each unit includes an APM CPF pressure module, a fitting of your choice (NPT, BSP, or M20), NIST traceable calibration certificate, and AMETEK product CD. Crystal Engineering calibration facilities are A2LA accredited, (#2601.01) which is internationally recognized by ILAC.

Note: A CPF adaptor fitting is not included with 15 000 psi / 1000 bar / 100MPa APM models. The module connector is compatible with 1/4 medium pressure tube system, HIP LM4 and LF4 Series, Autoclave Engr SF250CX Male and Female Series. See our <u>CPF Data Sheet</u> for additional adapter fittings.

Operation

ADVANCED PRESSURE MODULE (APM) INSTRUCTIONS

Pressure Connection

Crystal CPF◆ System: Medium Pressure Female (MPF) (1/4" medium pressure tube system with 7/16-20 threads). See our CPF Brochure for further information.

◆U.S. Patent No. 8,794,677

CPF o-ring size and material: AS568A-012, Viton 80 durometer (P/N 3981).

For most applications CPF Fittings can be hand tightened for use up to 10 000 psi / 700 bar / 70 MPa (no tools required). Wrench tightening is recommended (to achieve a metal to metal cone seal) for applications where chemical compatibility of the process fluid and the o-ring are a concern, or for pressures above 10 000 psi / 700 bar / 70 MPa. We recommend a tightening torque of 120 in-lbs ±20 in-lbs. Please note this is only a fraction of the typical torque required to seal a 1/4" NPT fitting. If a torque wrench isn't practical to use, the fittings can be assembled as follows: Hand tighten fitting fully until the cone has bottomed out. Tighten an additional 20º using a wrench. Apply a small amount of media-compatible lubricant to the gland threads and male cone to increase fitting life, reduce the likelihood of galling, and promote sealing.

❗ **CAUTION:** **To achieve CPF maximum allowable working pressures no o-ring substitutions are allowed. See our CPF brochure and CES-003 CPF Safety Guide available from the website at ametekcalibration.com for further detail.**

❗ **WARNING:** **Pressurized hoses and associated equipment are potentially dangerous. Slowly bleed off pressure from the system being pressurized prior to connecting or disconnecting the Crystal APM.**

Measuring Vacuum

All ranges of the APM can be used to measure moderate vacuum. Ranges 300 psi / 30 bar / 3 MPa and below are calibrated for vacuum use.

When measuring pressure less than ambient barometric conditions, a minus sign (-) will appear.

❗ **CAUTION:** **The APM is not recommended for continuous use at high vacuum.**

Overpressure Conditions

The APM will read pressure up to approximately 110% of the rated pressure range. All JOFRA indicators will display overpressure warnings. For example, above 110% of the range, "OL" will display in red on an ASC-400, indicating an Overload Alarm. The zero function does not affect when the "OL" is displayed to indicate overpressure. So depending on the zero value, it is possible that the display will indicate "OL" without the maximum pressure being displayed.

For instance, if a 100 psi APM is zeroed when 30 psi is being applied, it will indicate that the overpressure condition has been reached at 80 psi.
(i.e., 110% x 100 psi – 30 psi = 80 psi).

Overpressure can affect accuracy, but the effect is only temporary unless the sensor has been damaged. See Specifications for maximum allowable overpressure ratings.

Specifications

Modules

Module Range	0 - 30% Gauge Full Scale	30 - 110% Gauge Full Scale
psi	± (% Full Scale)	± (% of Reading)
30	0.0075%	0.025%
100	0.0075%	0.025%
300	0.0075%	0.025%
1000	0.015%	0.05%
3000	0.015%	0.05%
10000	0.015%	0.05%
15000	0.015%	0.05%

bar	± (% Full Scale)	± (% of Reading)
3	0.0075%	0.025%
10	0.0075%	0.025%
30	0.0075%	0.025%
100	0.015%	0.05%
300	0.015%	0.05%
700	0.015%	0.05%
1000	0.015%	0.05%

kPa / MPa	± (% Full Scale)	± (% of Reading)
300 kPa	0.0075%	0.025%
1	0.0075%	0.025%
3	0.0075%	0.025%
10	0.015%	0.05%
30	0.015%	0.05%
70	0.015%	0.05%
100	0.015%	0.05%

Accuracy (Gauge)

0 to 30% of Full Scale . . . .± (0.0075% of Full Scale) or ± (0.015% of Full Scale)

30 to 110% of Full Scale . . . .± (0.025% of Reading) or ± (0.05% of Reading)

Vacuum . . . . .For 100 psi / 10 bar / 1 MPa and lower:

± (0.06% of Full Scale*)

For 300 psi / 30 bar / 3 MPa:
± (0.06% of Full Scale*) ±1 LSD

*Full Scale = -14.5 psi / -1.0 bar / -100.0 kPa.

Accuracy specifications include all effects of linearity, hysteresis, repeatability, temperature, and stability for one year.

Note: Exposure to environmental extremes of temperature, shock, and/or vibration may warrant a more frequent recertification period.

APM modules must be exercised and re-zeroed whenever exposed to significant changes in environmental conditions to achieve these specifications. To exercise a module, cycle the module between zero (ambient barometric pressure) and the pressure of interest. A properly exercised module will return to a zero reading (or return to the same ambient barometric reading).

! CAUTION: Advanced Pressure Modules (APM) are not recommended for continuous use at high vacuum.
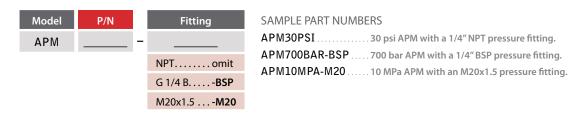
Operating and Storage Temperature

Operating Temperature Range . . .-20 to 50° C (-4 to 122° F)
Storage Temperature Range. . . . . .-40 to 75° C (-40 to 167° F)

Accuracies, Ranges, and Resolutions

psi	bar	kPa/MPa	Overpressure	psi	kg/cm2	inHg	inH20	mmHg	mmH20	kPa	bar	mbar	MPa
30PSI			3.0 x	0.001	0.0001	0.001	0.01	0.01	1	0.01	0.0001	0.1	
	3BAR		3.0 x	0.001	0.0001	0.001	0.01	0.01	1	0.01	0.0001	0.1	
		300KPA	3.0 x							0.01	0.0001	0.1	
100PSI			2.0 x	0.001	0.0001	0.01	0.1	0.1	1	0.01	0.0001	0.1	0.00001
	10BAR		2.0 x	0.001	0.0001	0.01	0.1	0.1	1	0.01	0.0001	0.1	0.00001
		1MPA	2.0 x							0.01	0.0001	0.1	0.00001
300PSI			2.0 x	0.01	0.001	0.01	0.1	0.1		0.1	0.001	1	0.0001
	30BAR		2.0 x	0.01	0.001	0.01	0.1	0.1		0.1	0.001	1	0.0001
		3MPA	2.0 x							0.1	0.001	1	0.0001
1KPSI			2.0 x	0.1	0.001	0.1				0.1	0.001		0.0001
	100BAR		2.0 x	0.1	0.001	0.1				0.1	0.001		0.0001
		10MPA	2.0 x							0.1	0.001		0.0001
3KPSI			1.5 x	0.1	0.01	0.1				1	0.01		0.001
	300BAR		1.5 x	0.1	0.01	0.1				1	0.01		0.001
		30MPA	1.5 x							1	0.01		0.001
10KPSI			1.5 x	1	0.01					1	0.01		0.001
	700BAR		1.5 x	1	0.01					1	0.01		0.001
		70MPA	1.5 x							1	0.01		0.001
15KPSI*			1.3 x	1	0.01					1	0.01		0.001
	1000BAR*		1.3 x	1	0.01					1	0.01		0.001
		100MPA*	1.3 x							1	0.01		0.001

0.025% of Reading modules (30PSI through 3MPA)

0.05% of Reading modules (1KPSI through 100MPA*)

Resolutions shown are the maximum resolutions available. The resolution of your JOFRA device may be different.

* CPF adaptor fitting is not included. CPF female connection is compatible with 1/4" medium pressure tube system, HIP LM4 and LF4 Series, Autoclave Engr SF250CX Male and Female Series. See our CPF data sheet for additional adapter fittings.

▶ **Ordering Information**

Model	P/N	Fitting
APM	_____	– _____
		NPT . . . . omit
		G 1/4 B. . . . . -BSP
		M20x1.5 . . . -M20

SAMPLE PART NUMBERS

APM30PSI . . . . 30 psi APM with a 1/4" NPT pressure fitting.
APM700BAR-BSP . . . . . 700 bar APM with a 1/4" BSP pressure fitting.
APM10MPA-M20 . . . . . . 10 MPa APM with an M20x1.5 pressure fitting.

Pressure Conversions

Pressure conversion factors will vary, and be dependent on the JOFRA device connected to the APM. Refer to the documentation for your particular JOFRA device for its specifications.

Media Compatibility

Liquids and gases compatible with sensor and CPF fitting system.

Wrench-tight . . . . 316 Stainless Steel

Finger-tight. . . . . 316 Stainless Steel and Viton (internal CPF o-ring)

CE Statement

CE   We declare that the APM is in accordance with the Electromagnetic Compatibility Directive, and the Pressure Equipment Directive per our declaration(s).

Communications

The APM interface uses a command – query – response protocol. Using this protocol the user can access the pressure measured by the module, as well as control and monitor the status of all the essential functions of the module.

INTERFACE DESCRIPTION

The APM can be remotely controlled using a PC terminal or computer program running the module in an automated system. A USB-based serial port connection is required for remote operation. The serial port connection also powers the module. Once connected, a user can write programs with Windows-based languages like Visual Basic.

SETTING UP THE SERIAL PORT FOR REMOTE CONTROL

A USB to serial cable (available with part number APMCAL KIT) is used for serial communications from the APM to a computer. To connect the module to a computer, attach it to a USB-to-serial cable, connected and installed on a PC. Connecting the module to the cable will automatically power it on.

Note: Be sure to set the appropriate COM port in your communications software: 9600 Baud; No parity; 8 Data bits; 1 Stop bit; No hardware flow control; Software flow control (XON/XOFF) recommended.

To verify the module has connected successfully, enter *IDN? within the communications program. This command will return information from the module.

USING COMMANDS

Command Types

The APM may be controlled using commands and queries. All commands may be entered using upper or lower case. Refer to Remote Commands and Error Codes for all available commands.

The commands are divided into the following types:

▶ **Module Commands**
Module Commands are used only by the module. For example, VAL? asks for the values displayed on the module display.

▶ **Common Commands**
Common Commands are standard commands used by most devices. These commands always begin with "*". For example, *IDN? tells the module to return its identification.

▶ **Query Commands**
Query Commands ask for Information, and always end with "?". For example, VAL? returns the current pressure reading of the module.

Command Processing

The data entered into the module is processed as follows:

- Data is taken as 7-bit ASCII.

- Characters are discarded if their decimal equivalent is less than 32 (space), except 10 (LF) and 13 (CR).

- The most significant data bit is ignored.

- Upper or lower case is acceptable.

- More than one command (Compound Commands) may be entered on one line. Commands are separated by semi-colons. For example,
  PRES_UNIT KPA;FAULT?

Response Data Types

The data returned by the module can be divided into four types:

▶ **Integer**
For most computers and controllers, integers are decimal numbers ranging from -32768 to 32768. For example, FAULT? could return an integer of 117. Refer to the **Error Codes table** for more information on error codes.

▶ **Floating**
Floating numbers have up to 5 significant figures and exponents. For example, VAL? might return 25.345 PSI.

▶ **Character Response Data (CRD)**
Character Response Data is data returned as keywords. For example, PRES_UNIT? might return PSI.

▶ **Indefinite ASCII (IAD)**
Indefinite ASCII are any characters followed by a terminator. For example, *IDN might return CRYSTAL, APM003C, 678123, R130000.31/R08009.13.

Module Status

▶ **Error Queue**
If an error occurs due to invalid input or buffer overflow, its error code is sent to a 15 entry error queue. An error code is read from the queue with the FAULT? command. When the error queue is empty, FAULT? returns 0. The error queue is cleared when power is reset or when the clear command *CLS is entered.

▶ **Input Buffer**
The module stores all received data in a 128 character input buffer, which accommodates varying character input speeds.. If the input command/symbol stream is too fast, the module will send the XOFF command when the input buffer is full. When the module is able to continue to receive commands, it will generate the XON command. The module can receive up to eight more characters after the XOFF command has been sent. If more characters are received, it will stop receiving, clear the input buffers, interrupt command execution, and flag the error 120 (Input Buffer overflow).

In order to avoid interruptions in the command execution process:

- Turn on software (XON / XOFF) flow control on the PC side.

- Avoid long command lines (lines more than 96 characters).

- Send the *CLR command before starting the communication procedure.

- Check the error buffer sending the FAULT? command after the communication procedure is finished.

REMOTE COMMANDS AND ERROR CODES

The following tables list all the commands, and their descriptions, accepted by the APM.

Common Commands

Command	Description
*CLS	(Clear Status) Clears the error queue.
*IDN?	(Identification Query) Returns the manufacturer, model number, and firmware revision of the module.
*RST	Resets the module to the power up state.

Module Commands

Command	Description
DAMP	Turns Damp on or off.
DAMP?	Returns if Damp is on or off.
FAULT?	Returns the most recent error code.
PRES_UNIT	Sets the pressure unit for the indicated display.
PRES_UNIT?	Returns the pressure unit from the indicated display.
VAL?	Returns the measured values.
ZERO_MEAS	Zeros the pressure module.
ZERO_MEAS?	Returns the zero offset of the pressure module.
CAL_STORE	This command must be sent anytime a parameter has changed.

Parameter Units

Units	Meaning
PSI	Pressure in pounds per square inch.
KG/CM2 or KGCM2	Pressure in kilograms per square centimeter.
INHG	Pressure in inches of mercury at 0°C.
INH2O4C	Pressure in inches of water at 4°C.
INH2O20C	Pressure in inches of water at 20°C.
INH2O60F	Pressure in inches of water at 60°F.
INH2O68F	Pressure in inches of water at 68°F.
MMHG	Pressure in millimeters of mercury at 0°C.
MMH2O4C	Pressure in millimeters of water at 4°C.
MMH2O20C	Pressure in millimeters of water at 20°C.
CMH2O4C	Pressure in centimeters of water at 4°C.
CMH2O20C	Pressure in centimeters of water at 20°C.
MH2O4C	Pressure in meters of water at 4°C.
MH2O20C	Pressure in meters of water at 20°C.
MSW	Pressure in meters of sea water.
FTH2O4C	Pressure in feet of water at 4°C.
FTH2O20C	Pressure in feet of water at 20°C.
FTH2O60F	Pressure in feet of water at 60°F.
FTSW	Pressure in feet of sea water.
BAR	Pressure in bar.
MBAR	Pressure in millibar.
KPA or KPAL	Pressure in kiloPascal.
MPA or MPAL	Pressure in MegaPascal.
TORR	Pressure in Torr.

Error Codes

Error Number	Error Description
117	Unknown command.
118	Bad parameter value.
120	Input Buffer overflow.
122	Output Buffer overflow.
200	Invalid index.

ENTERING COMMANDS

Commands for the APM may be entered in upper or lower case. At least one space must be entered between the command and parameter. All other spaces are optional. Almost all commands for the APM are sequential, and any overlapped commands will be indicated as such. This section will briefly explain each of the commands and describe their general use. The descriptions will include any parameters that may be entered with the command, as well as the output of the command.

Common Commands

▶ ***CLS**

Clears the error queue. Also terminates all pending operations. When writing programs, use before each procedure to avoid buffer overflow.

▶ ***IDN?**

Returns the manufacturer, model number, and firmware revision of the APM. For example, *IDN? will return AMETEK, APM 0, 1.00.

Module Commands

▶ **DAMP**

Enables a damping filter on the readings returned by the VAL? command. The filter is a first-order smoothing filter with 90% damping percentage. For example, DAMP ON, will turn the damping function on.

▶ **DAMP?**

Returns the current state of the damping function. For example, DAMP? will return ON if the damping function is on.

▶ **FAULT?**

Returns the error code number of an error that has occurred. The command may be entered when a previous command did not do what it was intended to do. Refer to the **Error Codes table** for more information on error code numbers.

▶ **PRES_UNIT**

Used to set the pressure unit for the indicated display. For example, PRES_UNIT PSI will set the pressure unit to psi. Send CAL_STORE to save the new parameters. Refer to the **Parameter Units table** for a complete list of available pressure units.

▶ **PRES_UNIT?**

Returns the current pressure unit being used.

▶ **VAL?**

Returns the value of the current measurement on the upper and lower display. For example, if the APM is measuring 5 psi, then VAL? will return 5.000000E+00, PSI.

▶ **ZERO_MEAS**

Zeros the APM. Send CAL_STORE to save the new parameters.

▶ **ZERO_MEAS?**

Returns the zero offset of the APM.

APMCAL

CALIBRATION SOFTWARE

APMCAL provides an easy way to calibrate your APM CPF Series Pressure Module. With a USB to serial cable, a computer running Windows, an APM module, and the APMCAL software program, you can:

- Calibrate the APM with an easy-to-use Userspan Wizard.

- View and change the calibration date.

- View module details including model number, serial number, and firmware version.

- Update the firmware version of the APM.

Order part number **APMCAL KIT** to receive the program on CD, plus a USB to serial cable.

Support

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*ISO 17025 accredited calibration lab, (A2LA #2601.01).

If calling, have ready the model number, serial number, date of purchase, and reason for return. You will receive instructions for returning the device to us.

WARRANTY

Crystal Engineering Corporation warrants the APM (Advanced Pressure Module) to be free from defects in material and workmanship under normal use and service for one (1) year from date of purchase to the original purchaser. It does not apply to batteries or when the product has been misused, altered or damaged by accident or abnormal conditions of operation.

Crystal Engineering will, at our option, repair or replace the defective device free of charge and the device will be returned, transportation prepaid. However, if we determine the failure was caused by misuse, alteration, accident or abnormal condition of operation, you will be billed for the repair.

CRYSTAL ENGINEERING CORPORATION MAKES NO WARRANTY OTHER THAN THE LIMITED WARRANTY STATED ABOVE. ALL WARRANTIES, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, ARE LIMITED TO A PERIOD OF ONE (1) YEAR FROM THE DATE OF PURCHASE. CRYSTAL ENGINEERING SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT OR OTHERWISE.

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