

XP²ⁱ

Digital Test Gauge

Programming Instructions



CRYSTAL
engineering corporation

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Introduction

Thank you for choosing the XP2i Digital Test Gauge from Crystal Engineering Corporation.

Your **XP2i** is a combination of leading edge technology and rugged industrial design.

Your **XP2i** can be customized through the use of ConfigXP™ software available from Crystal Engineering. Your personal computer can disable, enable or modify a variety of features of your **XP2i**. Look for the **CONFIGXP PROGRAMMABLE** logo for programmable features, like:

- a user defined pressure scale, and/or disable unused pressure units
- password protection to prevent unauthorized changes
- disable keypad recalibration, peak button, and/or units button
- expand or decrease allowable Zero range
- set the gauge to a different density of water factor (4°C, 60°F or 68°F)
- store a 12 digit ID or tag number in non-volatile memory
- adjust calibration values

*We hope your **XP2i** meets your expectations, and we're interested in any comments or suggestions you may have. You can send us a note at: feedback@crystalengineering.net. Many features in this and our other products are a direct result of your comments!*

The **XP2i** can be connected to a personal computer via RS-232, using an ordinary DB9 extension cable (male DB9 for the **XP2i** connection, female DB9 for the PC side). The interface lets you record displayed readings and recorded peaks. The data string always includes the pressure units.

The **XP2i** can be operated remotely, as if you were pressing the buttons. You can use a simple terminal program to send the commands, or, you can incorporate them into your own software program.

A special command, Streaming Data, initiates data transmission of displayed pressure at the rate of approximately 3 times per second.

I/O Settings

The serial interface settings are:

BAUD RATE	PARITY	DATA BITS	STOP BITS	FLOW CONTROL
9600	NONE	8	1	NONE

Communication Format

Input is case-sensitive; all instructions should be sent in UPPERCASE. Instructions must be terminated with a single carriage return (CR) character followed by an optional linefeed (LF) character. Note that while the **XP2i** expects either CR or CR/LF as command termination on its input, it always appends a CR/LF pair to its output. For reference, CR is ASCII value 13 decimal, while LF is ASCII character 10 decimal.

You have 30 seconds to complete an instruction. After 30 seconds, the **XP2i** will evaluate whatever it has received and try to match it to its table of commands. Since the command is incomplete, it will fail to match and the **XP2i** will return: **N, Ø**. (Negative acknowledgment with no reception errors, so syntax is wrong.)

Query Instructions

All queries start with a question mark (?). Any pressure values returned are split across two lines; the first contains a floating-point value, and the second contains the name of the measurement unit. Each line is right-justified in a fixed width 10 character field. (Since each line is terminated with a **CR-LF** pair, this means the total length of the response to a measurement query is 24 bytes.) A decimal point will always be included with the pressure value (for clarity) even if it is not displayed on the **XP2i**. For example, a pressure query of a 300 PSI **XP2i** on the mbar scale could return a reading like this:

```
2478.  
mbar
```

If low batteries cause the low battery message to be displayed, then any pressure query will replace the pressure value with the letters **"BATT"**.

Message Store

?MSG Retrieve the data (usually tag# or ID) from the message store.

Model

?MOD Return the model name, up to 20 characters long. For example, a 100 PSI **XP2i** would return the following:

```
100PSIXP2I
```

Pressure

?P,U Pressure returns the pressure value, followed by the pressure unit on the second line.

Example:

```
-7.89  
mmH2O
```

Pressure (one line)

?PRE Returns data and units on one line, and separates the reading and units with a comma.

Example:

```
2.01, PSI
```

Pressure, High

?P,H Pressure, High returns the stored peak pressure value, in whatever pressure units are currently being displayed.

```
91.3  
mmH2O
```

Pressure, Low

?P,L Pressure, Low returns the peak low, or “valley” measurement, in the pressure units currently being displayed.

```
-10.7  
mmH2O
```

Range

?RNG Range, returns the pressure range of the gauge. It is returned in two, 10 character lines. The first line is the value, the second line is the pressure unit. For example, a 100 PSI **XP2i** would return.

```
100.00  
PSI
```

Return Average Pressure

?P,A Using the same format as the “?P,U” command, the average pressure is returned. If averaging is disabled, “X,0” is returned. Enable averaging through Config XP.

Return the Average Window Size

?AVS The average sample size is returned. If averaging is disabled, “X,0” is returned. Enable averaging through Config XP.

Serial Number

?SN# The serial number is returned in two strings. A typical example is shown below:

```
3  
12659
```

Version

?VER Version returns the **XP2i**'s firmware version as a 4 digit number preceded by the letter "R".

This number is for factory use only.

Example version number:

R0101

Water Density

?H2O Applies only to models that include inches of water. Water density returns the current density of water in terms of temperature with one of three values possible:

_4C

60F

68F

Zero Check

?Z,U Zero Check reveals how much was subtracted from the reading to zero the gauge in the pressure units currently being displayed. When batteries are installed or the **XP2i** is reset, the zero is cleared and equals zero.

32.7

kPa

Commands

The following are commands. All commands start with an exclamation mark (!).

Clear Peaks

!CLR Clear high and peak low values by setting them to the current live reading (which might not be zero). For instance, if the current live reading were 253 PSI, then both high and low peak registers would contain 253.

Disable/Enable Peak Display **CONFIGXP PROGRAMMABLE**

Prevent peak pressure readings from being displayed and disables peak button operation.

!NPK Prevents peaks from being displayed.

!PKS Enables peak button operation (default).

Message Store **CONFIGXP PROGRAMMABLE**

!MSGx Up to 12 characters (usually tag# or ID) can be stored in EEPROM. Set the message with "!"MSGx" where "x" is the message.

Next Pressure Unit

!I,P This command is acknowledged with a simple "**A,Ø**". To check which units were selected, send the command "**?P,U**" to return the pressure value and the current pressure units.

No Auto Off

!NAO Prevents automatic shutdown. The default setting of the XP2i allows the product to automatically shut down 20 minutes after the last button push or the last RS-232 command. This command will return:

NO
AUTO
OFF

To re-enable automatic shutdown, send the reset **!YAO** (Yes Auto Off) command. This command will return: Auto Off 20 denoting the ability to turn off the product after 20 minutes of inactivity. The **!NAO** and **!YAO** settings are retained when the product is powered down or when a reset ("**!RST**") command is used.

Reset

!RST This command schedules a reset. There will be a three second pause before the **XP2i** resets; during this time, no commands or queries should be sent to the unit. When the unit resets, a product identification string, called the Boot Signature, is sent. (See the **Programming Tips** section for more information.) Some communication noise, including a serial framing error, is possible on reset. Resetting the **XP2i** clears the zero value, clears the **peak high** and **peak low** values, enables automatic shutdown after 20 minutes of inactivity (resetting that timer to 20 minutes on reset), and selects the first pressure unit on the **XP2i** (which can vary with product type, but will be consistent for each reset operation). After a reset, you should query and/or select appropriate measurement units using the "**?P,U**" and "**!I,P**" commands. If the reset command fails to operate properly, or appears to "lock up" the device, contact technical support.

Set the Average Window Size **CONFIGXP PROGRAMMABLE**

!AVS x Sets the number of pressure reading to be averaged. The valid range is from 1 through 10, i.e. **!AVS 5<CR>** or **!AVS 10<CR>**. If an invalid size is entered, or averaging is disabled, "**x,0**" is returned. Averaging is enabled with ConfigXP, only.

Streaming Data On/Off

!ISP1 Displayed pressure is sent out of the serial port after each new reading at a rate of approximately 3 readings per second, and returns data in the same format as the **?PRE** query.

!SPO Cancels streaming data output.

Water Density **CONFIGXP PROGRAMMABLE**

!_4C Set the density of water to 4°C (39.2°F)

!60F Set the density of water to 15.6°C (60°F)

!68F Set the density of water to 20°C (68°F)

Zero

!ZER Zeroes the pressure readings by setting a zero value equal to the current applied pressure. The zero cannot be cancelled, but it can be reloaded by calling this command again. To check the zero value, send the Zero Check command ("**?Z,U**"). If you want to disable the zero after enabling it, send the reset ("**!RST**") command. (Read the Reset section first to be sure you understand all effects of performing a reset.)

Acknowledgment of a Command

The **XP2i** always returns some indication to let you know a command or query was received and acted on. For queries, the return of the measurement data is the acknowledgment. For commands, possible acknowledgments are "**A**", "**N**" or "**X**", followed by a comma then a single digit. The digit indicates whether there were any reception errors. The combination is left justified.

A The **XP2i** understood the command and acted on it.

N The **XP2i** did not understand the command, due to either syntax or reception errors.

X The command was understood, but is not implemented or supported at this time.

Following an "**A**", "**N**" or "**X**", the single digits mean the following:

Ø There were no reception errors.

2 Buffer overflow.

4 Framing error.

6 There were both buffer overflow and framing errors.

Example acknowledgment:

A,Ø Understood the command and acted on it. No reception errors.

N,4 Could not understand the command because there was a framing error.

N,Ø Could not understand the command, even though it was received without errors, so syntax must have been wrong.

Troubleshooting the Digital Interface

The following section gives possible reasons for various error codes.

N,0 The “0” indicates there were no overrun or framing errors, so the command was properly received. However, the “N” means the **XP2i** could not match it to any allowed command. This means the syntax must have been wrong. The command is rejected and nothing is done.

Possible reasons:

Instruction sent without a comma between “P” and “U” of the “?P,U” query.

More than 30 seconds passed to finish a command.

Line termination is incorrect; send carriage returns (**CR**) only, do not send line feeds (**LF**).

N,2 **XP2i** buffer overflow, no action. In an overrun, bytes are lost, consequently the **XP2i** will not be able to match the command string. If it can't find a match, it returns “N”.

Possible reasons:

Not enough time allowed between commands. Check the communication parameters.

N,4 Framing error: Bytes were lost. Therefore, the command could not be matched. A framing error can sometimes occur after power-on, after reset, or when the batteries are changed; see the **Programming Tips** section for suggestions on handling this.

Possible reasons:

Noise on the line either created a false start bit or obscured the stop bit.

Multiple, but infrequent, framing errors are probably due to noise on the connection.

Frequent framing errors likely mean the **XP2i** or the PC is not operating at precisely 9600 Baud.

Occasionally, plugging the RS-232 connection into the **XP2i** will create a single framing error.

N,6 Both buffer overrun (**N, 2**) and framing errors (**N, 2**) occurred during this command. The “6” represents the binary OR masking of the two bits used to indicate a buffer overrun (bit 1) and a framing error (bit 2).

Possible reasons:

Look at “Possible reasons” for troubleshooting the **N, 2** and **N, 4** error codes, above.

Effects of Password Protection on Commands

If the **XP2i** is password protected, the following commands will have no effect and return “X,0”:
!_4C, !60F, !68F, !NPK, !PKS, !MSG, !RAS, and !AVS.

Programming Tips

The **XP2i** is a very straightforward device to communicate with, provided you follow these tips. This advice is derived from our own experiences automating systems based on the **XP2i**, as well as the experiences of our users; following these tips will help save you some time.

Anytime you establish (or re-establish) communications with the unit, you should use the following initialization sequence, which will help you deal with possible noise due to reset, etc.:

- 1** Reset the unit (unless you must preserve zero, peak values, etc.) by sending the "**!RST**" command.
- 2** Wait 15 seconds.
- 3** Read the Bootloader Signature, even if you ignore it, to clear it from the PC's input buffer; see below for more details.
- 4** Send a carriage return to clear any noise in the **XP2i**'s input buffer.
- 5** An error code, either "**N, 0**" or "**N, 4**" will be returned; this is normal (you have sent an empty command); read it to clear it. The buffers are now reset.
- 6** Use the "**?P, U**" and "**!I, P**" commands to select the pressure unit you want to use.
- 7** IF APPROPRIATE, zero the **XP2i** by sending the "**!ZER**" command, since the zero value will be clear.
- 8** IF APPROPRIATE, clear the high and low peak values to the current pressure (zero, if you followed step 6) by sending the "**!CLR**" command.
- 9** If you are logging data, you should log the serial number of the unit for traceability purposes by using the "**?SN#**" command. You should also log the product code, hardware revision and firmware version with the "**?VER**" command.
- 10** Disable automatic shutdown with the "**!NAO**" command.

A quick note about the Bootloader Signature: This string contains a 19 character, product-specific string (whose contents may vary with product revision), followed by a carriage return (**CR**), making the total string length 20 bytes. However, a reset turns the RS-232 interface on and off, so it may be subject to noise; a **NULL** may be received before the signature is sent, and the first character or so of the Bootloader Signature may be corrupted. A framing error is also possible. The procedure above will deal with this situation properly. Should you want to parse the bootloader signature, it has the following format: "**=XXXXXXXXXXXXXXXXXXXXX=**" where **x** will vary with product revision. The bootloader signature is used by the firmware upgrade tool, but should NOT be used to identify the firmware version; use the "**?VER**" command for that purpose. If you have a system that may have Crystal DTG or **XP2i** units attached, you can use this signature to determine which device is in use.

NOTE: Any time you detect the Bootloader Signature, the unit has been reset, or disconnected from and reconnected to power; turning the unit on and off with the button will not send the Bootloader Signature. You can use this behavior to detect a battery change, or a problem with the **XP2i**.

Some commands may take up to 500 milliseconds to return a reply. You should always wait at least 50 milliseconds after each reply is received before sending the next command. After a reset command it may take up to 15 seconds before the gauge resumes normal operation.

Data transmitted from the **XP2i** will always be 7-bit ASCII. Any high-ASCII characters indicate a line-noise problem, or a problem with the **XP2i** or PC.

The **XP2i** has very thorough integrity checks to catch corruption of program or calibration data memory. Should the data memory integrity check fail, the unit displays "ERR 1" on the display as the value line of the serial output. It is important to check for this, or you may mis-parse that line as "1 PSI", depending on your program. Should the program memory integrity check fail, the unit will continuously reset, blinking the LCD on and off, and the serial output will alternate between the bootloader signature and a line reading "**CRC FAIL**". This condition can be recovered from in the field by reloading the unit's firmware; contact technical support for details.

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708 Fiero Lane, Suite 9, San Luis Obispo, California 93401-8701



PN: 3984 — Rev B