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Title: Standard Protocol FX (enhanced)	
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REVISION HISTORY:

DATE:	**REV:**	**DESCRIPTION OF CHANGE:**
03/15/00	A	Original Release (was SOFT-110) Mis-named Applies to Engineering not Software. No change to body of text.

1.0 SCOPE:

1.1 The following is an outline of the serial communication protocol used by Pacific Scientific Instruments particle counters that utilize *enhanced* Standard Protocol (FX).

2.0 OVERVIEW:

2.1 This document describes the structure of the data record, the command characters used, and the basic requirements for firmware development for Pacific Scientific Instruments particle counters that utilize the Pacific Scientific Instruments FX Protocol. This document should also be considered a guide for software development when the intended purpose is to interface with Pacific Scientific Instruments products that utilize the Pacific Scientific Instruments FX Protocol. FX Protocol is a super set of Standard FIX Protocol and is backward compatible.

2.2 Pacific Scientific Instruments products that deviate from the protocol parameters as describe in this document, although practicable, are incongruous. Refer to the operating manual.

2.3 Pacific Scientific Instruments products that pre-date this synopsis may not utilize this protocol, or may only support a limited portion. (Refer to the operating manual.)

3.0 COMMUNICATION, COMMAND, & TIMING PARAMETERS:

3.1 The length of the data record will vary depending on the data size such as count data, and will very with environmental inputs present such as relative humidity and temperature. However, the end of a complete data record is always terminated with a carriage return and line feed.

3.2 The data record's count data is represented as totalize cumulative counts. Count data should always appear before environmental data.

3.3 Default configuration; Eight (8) data bits, One (1) stop bit, No parity, 9600 Baud.

3.4 A device will be de-selected if it has an overrun, noise, or framing error.

3.5 While selected, if a device does not understand a command, it should echo a '?'.

3.6 A device will be de-selected if it receives a '?'.

3.7 When a device is first powered up, it is de-selected. Once selected, a device is de-selected by selecting another device, or an unused select code. Refer to section 5.0.

3.8 A valid device select should precede each command sent to a device.

3.9 While selected, a device will echo all valid commands sent back to the sender, unless otherwise noted.

3.10 When a device detects a valid device select code in the range of ASCII 128-191, its universal "device select" command "U" becomes disabled.

3.11 A device shall default it's device select code to 32, or alternatively may be set to any higher value except device select code 63.

3.12 Devices shall operate with a minimum" Hold Time of ZERO, and provide exactly 60 records per hour if the Sample period is set for one minute.

3.13 The data record of the most recent sample period shall be constructed into a serially formatted record at the end of the sample period, and NOT upon receipt of the "A" or "B" command; this will reduce unnecessary processing delays**.** See section 8.0.

3.14 There must be a **10-millisecond** minimum delay before communication redirection.

3.15 There can only be a maximum of **25-milliseconds** of time removed out of a Sample period while in Auto sample mode and Hold time is set for zero time.

3.16 Devices shall echo all FX commands within **50-milliseconds** of receiving the command, with the exception of the "e" stop counting command which has up to **500-milliseconds** because of time needed to buffer and build the data record.

3.17 For commands that return a data string, the string must begin transmitting within **50-milliseconds** from the request, and can take up to **500-milliseconds** to complete.

4.0 REQUEST FOR DATA (Command Set):

Returned format example = **(echoed command, data, data, data...n+, cr, lf)**

Note: The braces, spaces, and commas are not part of the returned data, but are merely shown and used for clarity. All Commands and Data characters are ASCII or extended ASCII Characters.

crlf = **c**arriage **r**eturn and **l**ine **f**eed.

4.1 (A) Send Buffered Records

Returned Format = (echoed command (A), (See section 8.0))

Example: A# (equals no buffered data records available)

The next data record in the rotating buffer will be sent. When the rotating buffer is empty, a "#" character will be sent. Each record is erased from the buffer as it is sent. If no sample periods have been completed since the device was turned on and the rotating buffer is empty, then a "#" character will be sent. If the device does not have a rotating buffer, a record of the most recent sample period will be sent. See Section 8.0.

4.2 (B) Send Current Record

Returned Format = (echoed command (B), (See Section 8.0))

Example: B# (equals no current data record available)

The data record of the most recent sample period will be sent. Thereafter, if no new sample period has been completed, a "#" character will be sent. The rotating buffer is unaffected. See Section 8.0.

4.3 (C) Clear Buffer

Returned Format = echoed command (C)

If the device contains a rotating buffer, the buffer will be erased. If the device does not contain a rotating buffer, the last count cycle will be erased.

4.4 (D) Number of Records

Returned Format = (echoed command (D), # of records, cr, lf)

Example: D23crlf (23 records available)

The device will send the number of records in the rotating buffer terminated by a carriage return and line feed. The number of records returned is varying length, no leading zeros, and has no limit. If no data records are available, a "0" will be returned (D0crlf).

4.5 (E) EPROM Number

Returned Format = (echoed command (E), base#, -, dash#, -, revision, cr, lf)

Example: E2081234-1-Acrlf

The device will send the EPROM number in the format of (Base#-Dash#-Rev.).
The format field lengths can vary, and is terminated by a carriage return and line feed.

4.6 (H) View/Program Hold Time

Viewing

Entered Format = (command(H),cr, lf)
Returned Format = (echoed command (H),(echoed (cr, lf), HHMMSS, cr, lf)
View Example: Enter Hcrlf ; returned value = 15crlf (15 Sec. Hold Time)

When an upper case "H" followed by a carriage return and line feed are sent, the device will display the current Hold Time terminated by a carriage return line feed. Hold time will be in a format of HHMMSS (hours, min., sec.) Only relevant time information is returned.

Programming

Entered Format = (command (H), HHMMSS,cr,lf)
Returned Format = (echoed command (H), echoed (HHMMSS, cr, lf))
Programming Example: H100crlf (1 min. Hold Time programmed)

When programming, enter upper case "H" followed by only relevant time information in the format HHMMSS (Hours, Min., Sec.), followed by carriage return line feed. Do not enter leading zeros. Some devices may not have Hours field programming capability; refer to device's operating manual.

4.7 (L) View/Program Sample Period

Viewing

Entered Format = (command (L), cr, lf)

Returned Format = (echoed command (L), echoed (cr, lf), HHMMSS, cr, lf)

View Example: Enter Lcrlf; 100crlf is returned (1 min. Sample Per.)

When an upper case "L" followed by a carriage return and line feed are sent, the device will display the current Sample Period terminated by a carriage return line feed. Sample period will be in a format of HHMMSS (hours, min., sec.) Only relevant time information is returned.

Programming

Entered Format = (command (L), HHMMSS, cr, lf)

Returned Format = (echoed command (L), echoed (HHMMSS, cr, lf))

Programming Example: L1200crlf (12 min. Sample Per. programmed)

When programming, enter upper case "L" followed by only relevant time information in the format HHMMSS (Hours, Min., Sec.), followed by carriage return line feed. Do not enter leading zeros. Some devices may not have Hours field programming capability; refer to device's operating manual.

4.8 (M) Mode Request

Returned Format = (echoed command (M), (C, H, or S)

Example: MS (Mode equals Stopped)

The device will send its present mode. If counting, a "C" will be sent. If holding, an "H" will be sent. If stopped, an "S" will be sent.

4.9 (R) Re-transmit Record

Returned Format = (echoed command (R), (See section 8.0))

Example: R# (equals no data record to resend)

The last record sent will be re-transmitted. The buffer will not be cleared. If there is no record to re-transmit, a # following the echoed command will be sent. See Section 8.0.

4.10 (T) Identify Type

Returned Format = (echoed command (T), Name Label, cr, lf)

Example: T2408crlf

The device will send an alphanumeric data string name label terminated by a carriage return and line feed. The “Name Label” field can vary in length.

The string data will contain an “M” suffix for devices that have a manifold scanner attached.

4.11 (U) Universal Device Select

Returned Format = echoed command (U)

The device will be placed in "Remote" mode, and will respond to all subsequent commands, regardless of the programmed device select code. However, this command will be automatically disabled if a device detects valid "device select codes" transmitted over a network. In this case, a '?' will be returned. This command should not attempt to be used when more that one device is attached to a serial port (e.g. RS485 networking).

4.12 (V) Protocol Version

Returned Format = (echoed command (V), Protocol Version, cr, lf)

Example: VFXAcrlf (Protocol = FX revision A)

The device will send an alpha data string terminated by a carriage return and line feed. The "Protocol Version" field will contain FX (enhanced Standard FIX Protocol).

5.0 ACTION Command Set:

Returned format example = **echoed command (x)**

note: The braces are not part of the returned command, but are merely shown and used for clarity. All echoed commands are ASCII or extended ASCII Characters.

crlf = **c**arriage **r**eturn and **l**ine **f**eed.

5.1 (128 - 191) Device select

Returned Format = echoed command (device select)

Example: Ç (symbol for device code 128 = device #1)

A device is selected when the ASCII character for the decimal range of 128 to 191 is sent. The device will be placed in “Remote” mode, and will respond to all subsequent commands after a character is sent that matches it’s device select code.

5.2 (192 - 255) Sub-Device select

Returned Format = echoed command (sub-device select)

Example: (symbol for sub-device code 192 = sub-device 1, or port 0)

A sub-device on a device is selected when the ASCII character for the decimal range of 192 to 255 is sent. When a device is sent a character that matches its sub-device select code, that device’s sub-device will be selected. Refer to the operating manual.

5.3 (a) Auto Sample Mode

Returned Format = echoed command (a)

Puts the device in the "Auto" count mode. When the "d" command is used, the device will count in the auto mode. Auto mode causes the device to continuously cycle through its Sample and Hold period settings.

5.4 (b) Manual Sample Mode

Returned Format = echoed command (b)

Places the device in the "Manual" count mode. When the "d" command is used, the device will count in the manual mode. Manual mode causes the device to cycle through its Sample period once.

5.5 (c) Start Counting (computer controlled)

Returned Format = echoed command (c)

The device will start counting without waiting for an even second boundary (quick start). Counting will continue until stopped by the computer. The count cycle is computer controlled.

5.6 (d) Start Counting

Returned Format = echoed command (d)

The device will begin counting and control the sample cycle based on the setting for counting mode (Auto/Manual) and sample period. This command will also turn on the air pump and sensor, if applicable.

5.7 (e) Stop Counting

Returned Format = echoed command (e)

The device will immediately stop counting without waiting for an even second boundary, and will build a data records (See Section 8.0).

5.8 (g) Active Mode

Returned Format = echoed command (g)

The device will enter a mode that prepares it for counting. For example, the air pump will turn on to purge the air path, and sensor's laser will turn on.

5.9 (h) Standby Mode

Returned Format = echoed command (h)

The device will enter a mode that will turn off air pumps and shut down laser sensors to conserve power or reduce equipment wear, if applicable. Only this command can turn off the pump and laser.

6.0 UNIVERSAL ACTION Command Set:

These are universal commands that act on all devices at the same time when connected in a network (e.g. RS485 networking).

6.1 (ua) Universal Auto Sample Mode

Entered Format = (command (ua), cr, lf) example: uacrlf

Returned Format = (None)

Puts the device(s) in the "Auto" count mode. When the "ud" command is used, the device(s) will count in the auto mode. Auto mode causes the device(s) to continuously cycle through their own Sample and Hold period settings. This command is not echoed.

6.2 (ub) Universal Manual Sample Mode

Entered Format = (command (ub), cr, lf) example: ubcrlf

Returned Format = (None)

Places the device(s) in the "Manual" count mode. When the "ud" command is used, the device(s) will count in the manual mode. Manual mode causes the device(s) to cycle through their own Sample period once. This command is not echoed..

6.3 (uC) Universal Clear Buffer

Entered Format = (command (uC), cr, lf) example: uCcrlf

Returned Format = (None)

If the device(s) contains a rotating buffer, the buffer will be erased. If the device(s) does not contain a rotating buffer, the last count cycle will be erased. This command is not echoed.

6.4 (uc) Universal Start Count (computer controlled)

Entered Format = (command (uc), cr, lf) example: uccrlf

Returned Format = (None)

The device(s) will start counting in either pre-selected counting mode (Auto, Manual). This command is not echoed. The device will start counting without waiting for an even second boundary (quick start). Counting will continue until stopped by the computer. The count cycle the computer will control time.

6.5 (ud) Universal Start Count

Entered Format = (command (ud), cr, lf) example: udcrlf

Returned Format = (None)

The device(s) will start counting in either pre-selected counting mode (Auto, Manual). This command is not echoed.

6.6 (ue) Universal Stop Count

Entered Format = (command (ue), cr, lf) example: uecrlf

Returned Format = (None)

The device(s) will stop counting and will build a data record. This command is not echoed.

6.7 (ug) Universal Active Mode

Entered Format = (command (ug), cr, lf) example: ugcrlf

Returned Format = (None)

The device(s) will enter a mode that prepares it for counting. For example, the air pump will turn on to purge the air path, and sensor's laser will turn on. This command is not echoed.

6.8 (uh) Universal Standby Mode

Entered Format = (command (uh), cr, lf) example: uhcrlf

Returned Format = (None)

The device(s) will enter a mode that will turn off air pumps and shut down laser sensors to conserve power or reduce equipment wear, if applicable. Only this command can turn off the pump and laser. This command is not echoed.

7.0 DEVICE SPECIFIC Command Set:

These are unique commands, and are not supported by all instruments. Refer to the user manual.

7.1 (S) View Active Sub-Device Codes

Returned Format = (echoed command (S), sub-device, sub-device, cr, lf)

Example: S192-207crlf (16 sub-devices available)

Example: S193,207,223crlf (3 sub-devices available)

Example: **S#** **(No sub-devices available)**

The device will send a string of currently selected or available sub-device codes terminated by a carriage return and line feed. A "#" will be returned if there are no sub-devices available.

7.2 (l) Local Mode

Returned Format = echoed command (l)

The selected device will be de-selected from Remote mode and placed in Local mode.

8.0 DATA RECORD FORMAT:

8.1 Data Record Format: (2 data channels shown for clarity)

A**S_DDDDDD_TTTTTT_PPPP_LLL_XXXXXX_LLL_XXXXXX_**C/S_VVVV VVcrlf

Figure 1

8.2 **A** = Echoed Command, **S** = Status Byte, **D** = Date, **T** = Time, **P** = Period,

L = Label, **X** = Data, **_** = Blank Space, **C/S** = Check-sum,

V = Check-sum value, **cr** = Carriage Return, **lf** = Line feed.

(A) Echoed command. Since the upper case 'B' is the command to send the most recent record, or 'A' to send the next record in the buffer, it will always appear before the record. It is NOT part of the record.

(S) Status byte. This is the first character of the record, it reports the status of the particle counter such as Cal fail, count alarm, etc. See "Status Byte Indicator Map" in Appendix B for more detail.

(D) Date. This is 6 characters wide and appears in the following format: MMDDYY (Month, Day, Year). Refer to operating manual.

(T) Time. This is up to 6 characters wide and appears in the following format: HHMMSS (Hour, Min., Sec.), and in the 24 Hour time format. If the device does not support a real time clock, refer to operating manual.

(P) Period. This represents the programmed sample period. The sample period can be up to 4 characters wide and appears in the following format: MMSS (Min., Sec.). If the data record is constructed from the "e" command, "0000" will be in this field location.

(L) Label. These are typically channel I.D. labels for either "Size" or "Type" and are generally 3 characters wide.

Example: Size: (0.5, 1.0, 10.). Type: (TMP, R/H, A/V).

(X) Data. This is count data in totalized cumulative counts, and/or environmental data in millivolts. The data field is 6 characters wide.

(_) Blank space. These are blank spaces in the data record.

(C/S) Check-sum label. The check-sum is always displayed in the last portion of the data record. See Appendix A, figure 1.

(V) Check-sum value. The check-sum value is the ASCII character summation of the data record, including blank spaces, beginning with the status byte to the last character up to, but NOT including, the blank space preceding 'C/S' in the data record, and is encoded hexadecimal. This field can is 6 characters wide. 4 bytes of hexadecimal with 2 leading zeros. See Appendix A,Figure 1.

9.0 REFERENCES/STANDARDS:

ISO 9001 4.12

ISO 9002 4.11

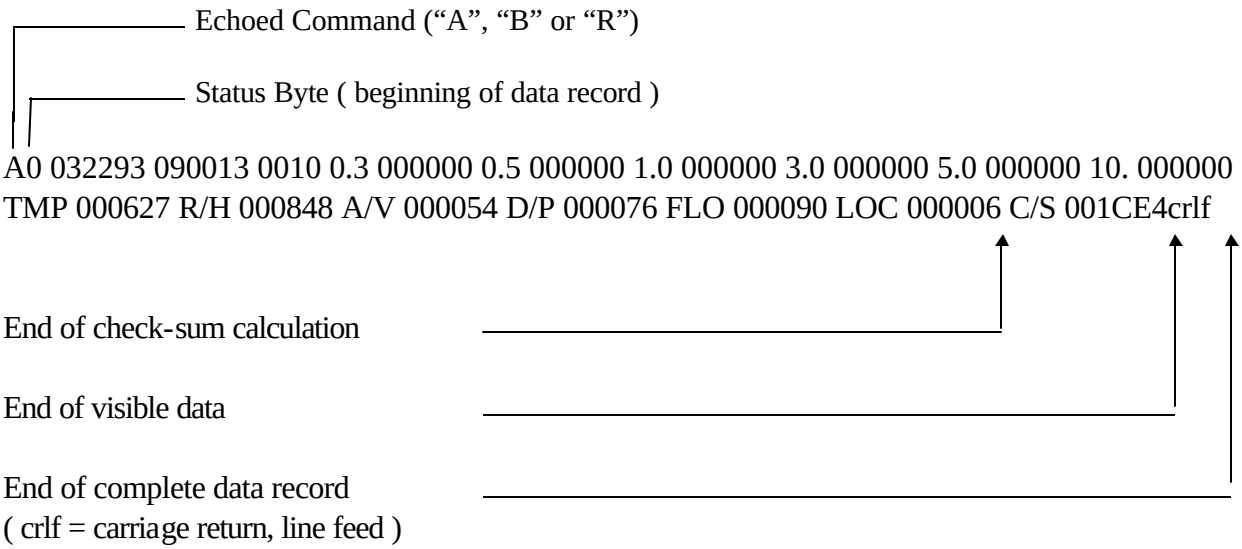
ISO 9003 4.7

ISO 9004 11.7

APPENDIX A

FIGURE 1

EXAMPLE DATA RECORD:



APPENDIX B

STATUS BYTE INDICATOR MAP

DATA BITS

MODEL (MSB)	8 D7	4 D6	2 D5	1 D4	8 D3	4 D2	2 D1	1 D0 (LSB)
237/237D	0	Z	1	E	Z	C	B	A
A2408/Manifold	0	G	1	E	D	C	Z	A
R4800	0	Z	1	Z	Z	C	Z	A
HF CNC	0	G	1	E	D	C	F	A

DATA BIT 5 ALWAYS 1, DATA BIT 7 ALWAYS 0

ACTIVE CONDITION =1; INACTIVE CONDITION = 0

CODE LEGEND:

A = CAL / SENSOR FAIL
B = LOW BATTERY
C = COUNT ALARM
D = HOME ERROR
E = ANALOG ALARMS
F = WAIT / FILL ALARM
G = AIR FLOW ALARM
Z = UNASSIGNED = 0

STATUS BYTE SYMBOL:

(**!**)
(**“**)
(**$**)
(**(**)
(**0**)
(**“**)
(**`**)

note: Combinations of ASCII characters will be created when more than one condition exists.