NPM
USER 7500
SPECIFICATION

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1. Overview

This document describes the implementation of the 7500 protocol used in NPM Sensor.

2. Instrument Communication Modes

2.1. Overview

There are three modes of communication:

1. *User communication* – This is a user interactive mode using simple letter commands for ease of use.
2. *Computer communication* – This mode is used for computer-to-device communication. It includes a level of data integrity.
3. *Network communication* – This mode is used for computer-to-device communication with more than one device on a network.

2.2. User Communication

In the user communication mode (terminal mode), the user simply presses the Enter key, <cr>, three times to enter the mode. In this mode simple character commands can be issued with no <Esc> character required.

An asterisk character appears when entering terminal mode, and also after a command has completed. The asterisk indicates that the instrument is ready for a new command. Commands are echoed back from the instrument in this mode.

Pressing <Esc> or Q<cr> will exit terminal mode.

2.3. Computer Communication

In the computer communication mode the command format include a level of data integrity – checksum.

This mode is entered whenever an <Esc> character is sent to the instrument.

Character echo is suppressed in this mode.

2.3.1. **Computer Command Format**

The computer command has the following format:

```
<Esc>Cmd p1 p2*cs<cr>
```

Computer commands are prefaced with an `<Esc>` (0x1B) character followed directly by a command, `Cmd`, which is variable in length depending on the command. After the command characters there can be zero or more parameter fields, `p1 p2`. Each parameter field is delimited by one or more Space characters (0x20). The end of the message is signaled by the Checksum Delimiter character `*` (0x2A) followed by the checksum, `cs`, and finally terminated with a carriage return `<cr>` (0x0D) character.

A computer command example follows:

```
<Esc>RV 1*1234<cr>
```

All command responses are terminated with a checksum

```
RV 1, NPM, 82109-1, R1.0.0*01385<cr><lf>
```

2.3.2. **Checksum Computation**

Checksum is calculated as the 16 bit unsigned integer sum of all of the characters after the `<Esc>` character up to but not Including the Checksum Delimiter Character `*` (0x2A). It is printed out as an ASCII decimal number.

The result is always 5 characters in length with leading zeros.

The checksum may be bypassed in the following manner: `*//<cr>`.

2.4. Network Communication

Refer to the 7500 Network Protocol Specification.

3. Command Summary

3.1. Command List

Command	Description
#	Request MetRecord Revision
1	Request settings report
A	Network ID Prefix (Address)
E	Stop Sample
H	Help Menu
S	Start Sample
Q	Exit User Mode
X	Exit User Mode
CU	Get/Set Concentration Units
DS	Report channel descriptors
ID	Get/Set location ID or Network address
MA	Get/Set Modbus address
ME	Print Measurement (legacy command)
NW	Network Mode On/Off
OI	Get output interval
OP	Report Operation Mode
QH	Print Query Header
RL	List Record Types
RP	Reference Pressure
RQ	Report current readings without header
RS	Request settings report
RT	Record Type
RV	Report Model/Part/Revision
SK	Get/Set User K Factor
SS	Report Serial Number
ST	Get/Set Sample Time.
UN	Get/Set data log channel units
ZC	Zero Calibration
CAL	Calibration Mode Low flow

CAH	Calibration Mode High flow
CAX	Exit Calibration mode
PPM	Purge Pump PWM %
PWM	Sample Pump PWM %
SID	Set ID (Same as ID)
SPR	Set Point RH
DFLT	Default all of the Flow, AT, RH, BP calibrations
DSCRC	Get the data log channel descriptors CRC

4. NPM Sensor Commands

The command and responses shown below are for computer mode unless otherwise noted. User mode responses are more verbose and similar in nature.

4.1. # – Request MetRecord Revision

Command	Description
#	Request the MetRecord Revision.

Response	Description
# 7500 r	7500 – This document number r – The revision of this document implemented in firmware

Example
#<cr> # 7500 C<cr><lf>

4.2. 1 – Report Settings

Command	Description
1	Report the settings.

Response

```
Settings Report
Station ID, 01
NPM, 82109-1, R1.0.0
Serial Number,
Modbus Node, 1
Baud Rate, N/A
Sample Time, 0
Output Interval, 0
Record Type, MetRecord
Conc Units, ug/m3
RH SP, 50.0
Alarm Relay SP, 0.0
K Factor, 1.000
Pump PWM, 32.5%
```

4.3. E – Stop Sample

Command	Description
E	Stop Sample

Response:
None

4.4. H – Help Menu

Command	Description
H	Report the last data record.

Response:
Command Menu RV<cr> - Reports Firmware Revision ID<cr> - Set Unit ID ST<cr> - Set Sample Time S x<cr> - Start/Stop Sample RQ<cr> - Display Measurement OP<cr> - Operation Status SPR<cr> - RH Set Point Q,X<cr> - Exit User Mode H,?<cr> - Help

4.5. S – Start Sample

Command	Description
S	Start sampling

Response:
None

4.6. Q,X – Exit User Mode

Command	Description
Q	Exit User mode and enter Computer mode.
X	Exit User mode and enter Computer mode.

Response	Description
Exit Terminal Mode	The command was successful.

Example
Q<cr> Exit Terminal Mode<cr><lf> X<cr> Exit Terminal Mode<cr><lf>

4.7. CU – Concentration Units

Command	Description
`CU`	Request the concentration units.
`CU e`	Set the concentration units. Where ‘e’ is the enumerator 0=ug/m3, 1=mg/m3

Response	Description
`CU e-units`	`e` – Concentration Units enumerator. `units` – Units name string.

Example

`CU<cr>`
`CU 0-ug/m3<cr><lf>`
 	
`CU 1<cr>`
`CU 1-mg/m3<cr><lf>`

4.8. Field Descriptors

Retrieval commands are used to query the instrument for Descriptor Information Table. These commands can be accessed by any serial device such as a data logger or software.

Information can be retrieved in either in single line responses or in bulk. Single line responses are needed for devices with limited serial input buffer sizes.

4.8.1. **DS 0 – Query Abbreviated Descriptor Information**

Command	Description
`DS 0`	This command returns the general header information.

Response	Description
`DS n,id,r`	The response will indicate the general descriptor information. `n` – Number of field descriptor lines available. `id` – Location ID `r` – Reserved for future use. 0 is the default.

Example
`DS 0<cr>` `DS 1,01,0<cr><lf>`

4.8.2. **DS c – Specific Descriptor Information**

Command	Description
`DS c`	This command returns the specific channel header information in the Descriptor Information Table. `c` – Channel number.

Response
`DS c,FieldName,MeasureType,units,prec,math,max,min`

Parameter	Description
`c`	Field number – 1 based.
`FieldName`	Field name string in printable ASCII. This is the user selected name for the measurement. Example: AT1 for air temp, FT1 for flow temp, etc.
`MeasureType`	Measurement type string in printable ASCII See the definitions in Appendix A of the 7500 Protocol document
`units`	Engineering units string in printable ASCII. See the definitions in Appendix B of the 7500 Protocol document.
`prec`	Display value precision.
`math`	Math type field. Vector (V), Scalar (S), Total (T), Minimum (MIN), Maximum (MAX), Standard Deviation (STD), Bitwise OR (OR), No Math (NO).
`max`	Maximum measurement value.
`min`	Minimum measurement value.

Example
`DS 1<cr>` `DS 1,Conc,CONC,mg/m3,3,S,100.000,0.000<cr><lf>`

4.8.3. **DS – Request All Descriptor Information**

Command	Description
DS	This command returns all of the general and header information. The command can be used for devices that have a large serial input buffer size.

Example
DS<cr> DS 1,Conc,CONC,mg/m3,3,S,100.000,0.000

4.8.4. **DSCRC – Descriptor table CRC**

Command	Description
DSCRC	This command returns the instrument descriptor table CRC. The intent is for the system or software to query and save this CRC. The value is then compared on subsequent reads to check for any instrument configuration changes. If the CRC does not match the previous CRC then check for a change in the field configuration parameters.

Response	Description
DSCRC hhhh	hhhh – The CRC value in hexadecimal.

Example
DSCRC<cr> DSCRC A9C5<cr><lf>

4.9. ID – Request or Set the Location ID

Command	Description
`ID`	Request the Location ID.
`ID id`	Set the Location ID. This is an 8 character string. The first part must evaluate as non-zero numeric.

Response	Description
`ID id`	`id` – The location ID.

Example

`ID<cr>`
`ID 01<cr><lf>`
 	
`ID 03<cr>`
`ID 03<cr><lf>`

4.10. MA – Request or Set the Modbus Address

Command	Description
`MA`	Request the Modbus address.
`MA a`	Set the Modbus address. The range is 1 to 247.

Response	Description
`MA a`	`a` – The Modbus address.

Example

`MA<cr>`
`MA 1<cr><lf>`
 	
`MA 2<cr>`
`MA 2<cr><lf>`

4.11. NW – Set Network Mode

Command	Description
NW	Request the measurement concentration setting.
NW m	Set the network mode where m is 0-Off, 1-On.

Response	Description
NW 0	.

Example
NW<cr> NW 0 <cr><lf> <Esc>A NW 0*cs<cr> NW 0<cr><lf>

4.12. OI – Request or Set the Output Interval

Command	Description
OI i	Set Output Interval in seconds.. Where i is the Interval. 0=No volunteered output, n=Output every n seconds. No averaging.

Response	Description
OI n	Output Interval in seconds

Example
OI<cr> OI 1<cr><lf> OI 0<cr> OI 0<cr><lf>

4.13. OP – Report Operation mode

Command	Description
OP	Print report where f is the file number. 0 – Settings 1 – Data

Response	Description
OP, n, mode	n – Mode number mode – Name 0, STOPPED 1, ZEROING 3, SAMPLING 4, PURGING

4.14. QH – Report Data Record Header

Command	Description
QH	Report data record header.

Response
Conc(ug/m3),Status

4.15. RP – Reference Pressure

Command	Description
`RP p`	This command is used in conjunction with CAL and CAH commands. Once the unit settles the flow control, the Reference Flow value is entered and the calibration changes.

Response	Description
`BP Cal f`	`f` – Reference Pressure in mbar.

Example
`RP 970.3<cr>` `BP Cal 970.3<cr><lf>`

4.16. RQ – Request Last Record

Command	Description
RQ	Request the instantaneous measurement record.

Response:
The response is the same as the 4-command.

Example:
RQ<cr> 0000004,00,*00524

4.17. RS – Report Settings

Command	Description
RS	Report the settings.

Response:
The response is the same as the 1-command.

4.18. RV – Report Model, Firmware, Revision

Command	Description
RV	Request the model number, firmware part number, and revision string. Instruments with more than one processor or programmable devices will include more than one part number and revision on the next subsequent lines.

Response	Description
m, p, r	m – Device model name. p – Firmware part number. r – Firmware revision.

Example
RV<cr> NPM, 82109-1, R1.0.0<cr><lf>

4.18.1. RV 0 – Request the number of processor/devices supported

Command	Description
RV 0	Request the number of processor or programmable devices.

Response	Description
RV n	n – Number processor or programmable devices.

Example
RV 0<cr> RV 1<cr><lf>

4.18.2. **RV n – Request individual processor/device information**

Command	Description
`RV n`	Request the model number, firmware part number, and revision for a specified processor or programmable device `n`.

Response	Description
`RV e m, p, r`	`e` – Device enumerator. `m` – Device model name. `p` – Firmware part number. `r` – Firmware revision.

Example
`RV 1<cr>` `RV 1, NPM, 82109-1, R1.0.0`

4.19. SK – Get/Set K Factor

Command	Description
`SK`	Request the K factor gain.
`SK k`	Set the K factor gain.

Response	Description
`SK x.xxx`	`x.xxx` – K Factor gain.

Example

`SK<cr>`
`SK 1.000<cr><lf>`
 	
`SK 1.25<cr>`
`SK 1.25<cr><lf>`

4.20. SS – Get the Serial Number

Command	Description
SS	Get the serial number.

Response	Description
SS A99999	

Example
SS<cr> SS A99999<cr><lf>

4.21. ST – Request or Set the Sample Time

Command	Description
ST	Request the Sample Time.
ST s	Set the Sample Time in seconds. s – Sample time in seconds. Set to 0 for continuous operation. With the Dual Fan version this time determines the rate that a Zero cycle occurs.

Response	Description
ST s	s – Sample Time in seconds.

Example
ST<cr> ST 0<cr><lf> ST 3600<cr> ST 3600<cr><lf>

4.22. UN c – Request Specific Channel Available Field Units

Command	Description
`UN c`	Request the list of available channel/field units. `c` – Desired channel/field

Response	Description
`UN 1-a,...`	Returns the available units for the channel/field units. See Appendix C for a list of the approved unit codes. `1-a` – The enumerator and name `...` – More enumerators and names If a field has no units associated with it, a single response with an enumerator of 0 is returned with a unit name of N/A

Example
`UN 1<cr>` `UN 1 1-ug/m3,2-mg/m3<cr><lf>`

4.23. UN c u – Set Specific Channel Field Units

Command	Description
`UN c u`	Set the channel/field units. `c` – Desired channel/field `u` – Enumerated unit (1, 2, 3 etc.) Enumerators are 1 based. Sending a 0 enumerator to this command will echo back the current setting with no changes.

Response	Description
`UN c 1-a`	Returns the enumerator and unit name after the change. `c` – channel/field `1-a` – The enumerator and unit name

Example
`UN 1 1<cr>` `UN 1 1-ug/m3<cr><lf>`

4.24. ZC – Zero Calibration

Command	Description
`ZC s`	Starts (s=1) or stops (s=0) the Zero Calibration cycle. For single fan units, a Zero filter must be placed on the inlet prior to starting this calibration. For dual fan versions, the Zero Calibration is automatic and the rate is determined by the Sample Time (ST command).

Response	Description
`ZC s,t`	Returns the Zero Calibration status. s-status, t is time remaining.

Example
`ZC 1<cr>` `ZC 1,10<cr><lf>`

4.25. CAL – Calibration mode

Command	Description
CAL	Enters calibration mode and displays parameters

4.26. CAH – Calibration mode High Flow

Command	Description
CAH	Changes the flow rate to the high point

4.27. CAX – Exit Calibration Mode

Command	Description
CAX	Exit Calibration mode and stop the instrument.

4.28. PPM – Purge Fan PWM setting

Command	Description
PPM	Get/Set Purge Fan PWM percentage

Response	Description
PPM pct	Pct = PWM percentage

Example
PPM<cr> PPM 21.7<cr><lf> PPM 25.1<cr> PPM 25.1<cr><lf>

4.29. PWM – Sample Fan PWM setting

Command	Description
PWM	Get/Set Sample Fan PWM percentage

Response	Description
PWM pct	Pct = PWM percentage

Example
PWM<cr> PWM 32.5<cr><lf> PWM 25.1<cr> PWM 25.1<cr><lf>

4.30. SPR – RH heater control set point

Command	Description
SPR	Get RH set point
SPR sp	Set RH set point. 0 or 100 turns off heater control

Response	Description
SPR pct	Pct = RH Set point in %

Example
SPR<cr> SPR 40.0<cr><lf> SPR 50.0<cr> SPR 50.0<cr><lf>

4.31. DSCRC – Channel Descriptor table CRC

Command	Description
DSCRC	This command returns the channel descriptor table CRC. The intent is for the system or software to query and save this CRC. The value is then compared on subsequent reads to check for any instrument configuration changes. If the CRC does not match the previous CRC then check for a change in the field configuration parameters.

Response	Description
DSCRC hhhh	hhhh – The CRC value in hexadecimal.

Example
DSCRC<cr> DSCRC F69F<cr><lf>

5. Modbus Map

This section will cover the NPM Modbus Map.

5.1. 3x Modbus Map

MODBUS Name		Addr	Type	Points	
MB_123456	=	0	float	2	Known value for easier Byte Order configuration
MB_Op_State	=	2	Int	1	Purge, Sample, Zero etc
MB_Time_Remain	=	3	Int	1	When used with modes above which have set times in each state
MB_Revision	=	4	char	16	31 Char + Zero Terminator word aligned to 32 bytes
MB_Conc	=	100	float	2	
MB_AT	=	102	float	2	
MB_RH	=	104	float	2	
MB_BP	=	106	float	2	
MB_IOP	=	110	float	2	
MB_Flow	=	112	float	2	
MB_Alarm_Flags	=	200	word	1	16 Bit Alarm Flags
MB_Alarm_Code	=	201	word	1	Alarm Code of first alarm in the queue, 0 if none left to read in
MB_Alarm_P1	=	202	dword	2	Long Parameter for reason (Alarm Dependant)
MB_Alarm_P2	=	204	float	2	Float Parameter for reason (Alarm Dependant)

5.2. 4x Modbus Map

MODBUS Name		Addr	Type	Points	
MB_Byte_Order	=	0	Int	1	1 thru 4
MB_OP_Mode	=	1	Int	1	
MB_Out_Mode	=	2	int	1	Settings Based
MB_Cmd	=	3	Int	1	1=Run, 2=Stop, 3=Zero, 4=Span, 5=Sample, 6=Purge, 7=Cal Low, 8=Cal High, 9=Cal Exit
MB_ModBus_Addr	=	4	Int	1	1 to 247
MB_Baud	=	5	int	1	Baud Rate Enumerator value
MB_Unit_ID	=	10	char[10]	5	8 Char + Zero Terminator (word aligned to 10 bytes)
MB_Name	=	15	char[18]	9	16 Char + Zero Terminator (word aligned to 18 bytes)
MB_Nxt_Alarm	=	50	Int	1	Any value written here pops the next alarm message off the queue and puts it in the Alarm 3X read area
MB_Sample_Time	=	202	dword	2	Sampling Time in Seconds
MB_RH_Setpoint	=	209	float	2	
MB_K_Factor	=	218	float	2	K-Factor Mulitpier