

NPM USER 7500 SPECIFICATION



Met One Instruments, Inc
1600 Washington Blvd.
Grants Pass, Oregon 97526
Telephone 541-471-7111
Facsimile 541-471-7116

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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 |
| PEM | 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: |
| <p>Command Menu</p> <p>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</p> |

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 |
|---|
| <pre>Q<cr> Exit Terminal Mode<cr><lf> X<cr> Exit Terminal Mode<cr><lf></pre> |

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 | <p>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.</p> <p>If the CRC does not match the previous CRC then check for a change in the field configuration parameters.</p> |

| 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 |
|--|
| <pre>NW<cr> NW 0 <cr><lf> <Esc>A NW 0*cs<cr> NW 0<cr><lf></pre> |

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 |
|---|
| <pre>OI<cr> OI 1<cr><lf> OI 0<cr> OI 0<cr><lf></pre> |

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

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

| Example |
|--|
| <pre>UN 1 1<cr> UN 1 1-ug/m3<cr><lf></pre> |

4.24. ZC – Zero Calibration

| Command | Description |
|---------|--|
| ZC s | <p>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.</p> <p>For dual fan versions, the Zero Calibration is automatic and the rate is determined by the Sample Time (ST command).</p> |

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

| Example |
|---|
| <pre>ZC 1<cr> ZC 1,10<cr><lf></pre> |

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 |
|--|
| <pre>SPR<cr> SPR 40.0<cr><lf> SPR 50.0<cr> SPR 50.0<cr><lf></pre> |

4.31. DSCRC – Channel Descriptor table CRC

| Command | Description |
|---------|---|
| DSCRC | <p>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.</p> <p>If the CRC does not match the previous CRC then check for a change in the field configuration parameters.</p> |

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

| Example |
|---|
| <pre>DSCRC<cr> DSCRC F69F<cr><lf></pre> |

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 Multplier |
| | | | | | |