POX-OEM Serial Communication Protocol Revision 1.1

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1. Scope
The purpose of this document is to define the serial communication protocol between all Mediaid POX
OEM boards and OEM equipment.

2. Electrical/Timing
A three wire RS-232 style interface is all that is needed to communicate with the POX-OEM; RxD, TxD
and ground. The RxD carries serial data to the POX_OEM while the TxD carries serial data from the
POX_OEM. These two signals are TTL level signals. A TTL high is an RS-232 "mark" and a TTL low is an
RS-232 "space". The characters are transferred at a rate of 19200 baud.

3. Command/Response packet format
The character format is: one start bit, 8 data bits (lsbit first) one stop bit. Multiple characters make up a
command/response packet. The $N+2$ characters in the command/response packet are: "command"(or
"response"), "data1", "data2",..., "dataN", "checksum" N is determined by the command/response
and may be zero.

The timing between the "command/response" and "checksum" must not exceed two hundred fifty
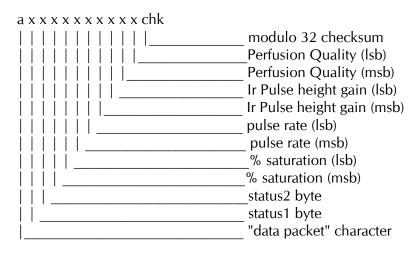milliseconds (250ms).

The command characters (information from the OEM product to the POX-OEM) are the ASCII characters
from "!" to "?". The response characters (information from the POX_OEM to the OEM product) are the
ASCII characters from "a" to "~". They are all defined in the following section.

All dataN used in the command packets are base 32 digits where the base 32 zero character is ASCII
"@", the base 32 thirty-one character is ASCII "_". This makes all characters displayable and contiguous.
If a number to be transmitted is greater than 31 then it is split into groups of 5 bits and sent most
significant first. Example: the number 263 is split as an 8 and 7 [(8*32) + 7 = 263], the 8 is sent first.

The checksum is the negative modulo 32 summation of all the previous characters in the packet
(including the command/response) plus the offset of 0x41. That is if all characters are modulo 32
summed in a packet their sum would be zero. (Hint: To create a checksum add all transmitted
characters, negate, AND that negated sum with 0x1f and add 0x41, makes all checksum characters "@"
through "_", same as the dataN characters.)
A graphical representation is:

Command Packet Format for "data packet":

```
a x x x x x x x x x x chk
| | | | | | | | | | | |_____ modulo 32 checksum
| | | | | | | | | | | |_____ Perfusion Quality (lsb)
| | | | | | | | | | |_____ Perfusion Quality (msb)
| | | | | | | | | |_____ Ir Pulse height gain (lsb)
| | | | | | | | |_____ Ir Pulse height gain (msb)
| | | | | | | |_____ pulse rate (lsb)
| | | | | | |_____ pulse rate (msb)
| | | | | |_____ % saturation (lsb)
| | | | |_____ % saturation (msb)
| | | |_____ status2 byte
| | |_____ status1 byte
| |_____ "data packet" character
```

If the two temperature bytes are E\ they decode as (("E" – "@")*32) + ("\" – "@"). ("E" – "@") is equal to 5, multiplied by 32 is 160. Then add ("\" – "@"), which is equal to 28, to get 188. This represents 18.8 degrees centigrade. An ACK is sent upon reception of a valid command packet. A NAK is sent when something is wrong with the packet or it's contents.

4. Available commands and responses

4.1. Commands to the POX-OEM

4.1.1. ASCII !   data request
             ! _

4.1.2. ASCII "   reset the POX-OEM
             "^

4.1.3. ASCII # data send mode
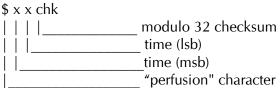   #@]   query mode
    #A\   auto send mode (1 second interval)
    #B[query time/date stamped
    #CZ   auto send mode (when new data is ready)
    #DY   auto send time/date mode (when new data is ready)

4.1.4. ASCII $ perfusion send interval (incomplete, x = data, chk = checksum)
    $ x x chk
    | | | |_____ modulo 32 checksum
    | | |_____ time (lsb)
    | |_____ time (msb)
    |_____ "perfusion" character
    The perfusion send interval can range from 1 to 255 (truncated if greater than 255). Each
    interval is 5 ms, minimum interval 30 ms (example: perfusion send interval = 1, time
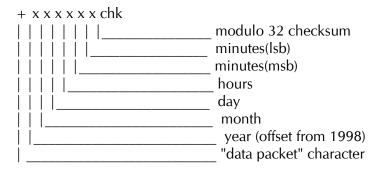   between transmissions is 35 ms).

4.1.5. ASCII %   diagnostics mode
            %[

4.1.6. ASCII & error code request
            &Z

4.1.7. ASCII ' baud rate change request (this must be the first command received after the reset
      command is sent (b^), otherwise this command is regarded as an error.
      '@Y   9600 baud
      'AX   4800 baud

4.1.8. ASCII (parametric request
            (X

4.1.9. ASCII)   software version request
)W

4.1.10. ASCII + set date and time (incomplete, x = data, chk = checksum)

      + x x x x x x chk
      | | | | | | | |_____ modulo 32 checksum
      | | | | | | |_____ minutes(lsb)
      | | | | | |_____ minutes(msb)
      | | | | |_____ hours
      | | | |_____ day
      | | |_____ month
      | |_____ year (offset from 1998)
      | _____ "data packet" character

4.1.11. ASCII , model number request
            ,T

4.1.12. ASCII - POX on/off request-
      @S   POX off
      -AR   POX on

4.1.13. ASCII . sensor type request (used on models that have removable sensor modules)
            .R

4.1.14. ASCII / perfusion waveform inversion request
      /@Q   perfusion normal
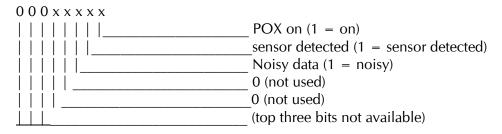   /AP   perfusion inverted

4.2. Responses from the POX-OEM

4.2.1. ASCII a POX-OEM Data (incomplete, x = data, chk = checksum)

```
a x x x x x x x x x x chk
  | | | | | | | | | | |_____ modulo 32 checksum
  | | | | | | | | | | |_____ Perfusion Quality (lsb)
  | | | | | | | | | | _____ Perfusion Quality (msb)
  | | | | | | | | | _____ Ir pulse height gain (lsb)
  | | | | | | | | _____ Ir pulse height gain (msb)
  | | | | | | | _____ pulse rate (lsb)
  | | | | | | _____ pulse rate (msb)
  | | | | | _____ % saturation (lsb)
  | | | | _____ % saturation (msb)
  | | | _____ status2 byte
  | | _____ status1 byte
  | _____ "data packet" character
```

The status bytes are defined as follows:
Status1 Byte format:

```
0 0 0 x x x x x
  | | | | | | | |_____ error flag (1 = error)
  | | | | | | | _____ no finger (1 = no finger)
  | | | | | | _____ pulse detected (1 = detected)
  | | | | | _____ new data (1 = new data available)
  | | | | _____ setting up (1 = setting up)
  |_|_|_____ (top three bits not available)
```

Status2 Byte format:

```
0 0 0 x x x x x
  | | | | | | | |_____ POX on (1 = on)
  | | | | | | | |_____ sensor detected (1 = sensor detected)
  | | | | | | |_____ Noisy data (1 = noisy)
  | | | | | _____ 0 (not used)
  | | | | _____ 0 (not used)
  |_|_|_____ (top three bits not available)
```

4.2.2. ASCII b POX-OEM power up OK response (complete)
b^

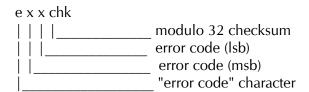4.2.3. ASCII c POX-OEM Data, Date and time stamped (incomplete, x = data, chk = checksum)

```
c x x x x x x x x x x x x x x x x chk
| | | | | | | | | | | | | | | | | |_____ modulo 32 checksum
| | | | | | | | | | | | | | | | |_____minutes(lsb)
| | | | | | | | | | | | | | | |_____ minutes(msb)
| | | | | | | | | | | | | | |_____ hours
| | | | | | | | | | | | | |_____ day
| | | | | | | | | | | | |_____ month
| | | | | | | | | | | |_____ year (offset from 1998)
| | | | | | | | | | |_____Perfusion Quality (lsb)
| | | | | | | | | |_____Perfusion Quality (msb)
| | | | | | | | |_____Ir pulse height gain (lsb)
| | | | | | | |_____Ir pulse height gain (msb)
| | | | | | |_____ pulse rate (lsb)
| | | | | |_____ pulse rate (msb)
| | | | |_____ % saturation (lsb)
| | | |_____% saturation (msb)
| | |_____ status2 byte
| |_____ status1 byte
|_____ "data packet" character
```

4.2.4. ASCII d Perfusion Data (incomplete, x = data, chk = checksum)

```
d x x chk
| | | |_____ modulo 32 checksum
| | |_____perfusion (lsb)
| |_____perfusion (msb)
|_____"perfusion" character
```

The perfusion data can range from 0 to 1023

4.2.5. ASCII e Error (incomplete, x = data, chk = checksum)

```
e x x chk
| | | |_____ modulo 32 checksum
| | |_____ error code (lsb)
| |_____ error code (msb)
|_____ "error code" character
```
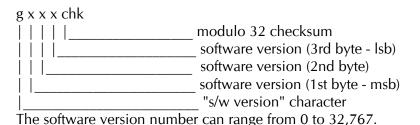
Error data can range from 0 to 1023. There may be multiple errors in a response.
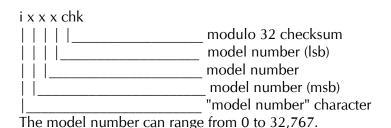
4.2.5.1. Error codes

4.2.5.1.1. No error, 0

4.2.5.1.2. ROM checksum error, 1(0x001)

4.2.5.1.3. Low power supply, 2(0x002)

4.2.5.1.4. EEPROM error, 4(0x004)

4.2.5.1.5. No red LED, 8(0x008)

4.2.5.1.6. No Ir LED, 16(0x010)

4.2.5.1.7. Thin tissue, 32(0x020)

4.2.5.1.8. Thick tissue, 64(0x040)

4.2.5.1.9. Maximum perfusion, 128(0x080)

4.2.5.1.10. System failure error, 256(0x100)

4.2.5.1.11. No module attached, 512(0x200)

4.2.5.1.12. Analog output calibration failure, 1024(0x400)

4.2.6. ASCII f Parametric (incomplete, x = data, chk = checksum)

```
f x x x x x x chk
| | | | | | | | |_____ modulo 32 checksum
| | | | | | | |_____ red pulse height gain
| | | | | | |_____red perfusion gain
| | | | |_____red LED drive
| | | |_____ IR pulse height gain
| | |_____ IR perfusion gain
| |_____ IR LED drive
|_____ "parametric" character
```

4.2.7. ASCII g Version (incomplete, x = data, chk = checksum)

```
g x x x chk
| | | | |_____ modulo 32 checksum
| | | |_____ software version (3rd byte - lsb)
| | |_____ software version (2nd byte)
| |_____ software version (1st byte - msb)
|_____ "s/w version" character
```
The software version number can range from 0 to 32,767.

4.2.8. ASCII i Model number (incomplete, x = data, chk = checksum)

```
i x x x chk
| | | | |_____ modulo 32 checksum
| | | |_____ model number (lsb)
| | |_____ model number
| |_____ model number (msb)
|_____ "model number" character
```
The model number can range from 0 to 32,767.

4.2.9. ASCII j NAK (complete)
      j@V   NAK because of bad command
      jAU   NAK because of check sum
      jBT   NAK because of internal error
      jCS   NAK because of time out
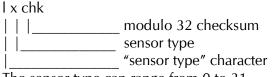   jDR   NAK because of bad parameter
These NAK commands (Not Acknowledge) are transmitted upon there being an error in the last OEM data packet, or, an internal POX error.

4.2.10. ASCII k ACK (complete)
      kU
This ACK command (Acknowledge) is transmitted upon acceptance of the last transmitted command.

4.2.11. ASCII l Sensor type (incomplete, x = data, chk = checksum)
```
l x chk
| | |_____ modulo 32 checksum
| |_____ sensor type
|_____ "sensor type" character
```
The sensor type can range from 0 to 31.
1 = M120 finger sensor module
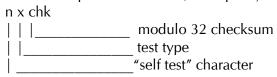2 = M120 cable adaptor module
3 = RS-232 interface
The sensor type response is a 0 for a request to an M15

4.2.12. ASCII m Request for OEM version number (complete)

      mS

      This command is used for Mediaid testing, not for general use.

4.2.13. ASCII n Request for selt test (incomplete, x = data, chk = checksum)

      n x chk

      | | |_____ modulo 32 checksum
      | |_____ test type
      | _____"self test" character

      The test types available from 0 to 31.
      0 = Lo Batt cal
      1 = Display test
      2 = EEPROM test
      3 = Initialization of EEPROM

Revision History

      Rev 0.6 Added baud rate modifier
      Rev 0.7 Added command "m" for requesting OEM connected rev
            Added command "n" for requesting self testes, cannot be used by OEM
      Rev 0.8 Added System Failure and No module Attached to error codes
      Rev 0.9 Added error code for analog output calibration failure, used on M15As
            Added note in sign-off sheet for electronic copy
      Rev 1.0 Removed Temperature and Spare output, changed the checksum offset.
            Added the perfusion send interval time from 1 to 255.
            Removed request of serial number.
            Incorporated Perfusion Quality values range, 1-10.

Table 1: Perfusion Quality values

Pulse Amplitude	Perfusion Quality
0.0% -0.9%	0-6
1.0%-2.0%	7
3.0%-4.0%	8
5.0%-10.0%	9
10%-20%	10