## *Biospherical Instruments Inc. (Proprietary)*

## *BIC Command Set: version 1.01*

The BIC supports RS-232 at 9600 baud, 8 data bits, 1 stop bit, and no parity. All commands are given as normal (printable) ASCII characters, and data is transmitted as either 8 bit binary, ASCII hexadecimal, or ASCII decimal. The instrument will run in either handshaking (polled) or free run modes. Free run modes will either report data at approximately a 5 Hz rate, or can be slowed to transmit data sets after a selectable 1 to 9 second delay. All high resolutions channels conduct their measurement simultaneously, as each sensor channel has its own analog to digital converter. When groups of BICs are deployed on the same RS-232 interface, with all inputs tied together and all outputs tied together, the polled mode will allow all conversions on all units to start simultaneously. Group operation requires the use of the polled mode, ruling out free run operation.

**Table 1. Command Set – in most commands, "a" refers to the unit identifying tag:**

| **Command** | **Code** | |
|---|---|---|
| Start Conversion | *Q0! | No response, commands all units |
| Get Data | *aD! | Requests data from unit a |
| Ask Presence | *aP! | **Responds WWW.Biospherical.com, BIC2104 sn:12345, v: 0.10B,1,5,0,D,5,1,a** |
| Set Mode | *aM | Sets the operational mode including the tag |
| Read Calibration | *aR! | Responds with detailed calibration file |
| Stop | ^X | Control-x or Cancel – stops data transmission in free run mode. |
| Write Calibration | *aW! | Records internally detailed calibration file |
| Help | ? | Responds with brief command summary |
| FreqRej | *aFX0! | X = 5 for 50hz rejection, 6 for 60hz rejection. Responds with confirmation |
| Set Serial # | *aI! | Password protected, for factory use only |

The RS-232 driver is tri-state, with the driver in the high-impedance mode while it is not transmitting data in order to conserve power, and allow party-line communications. The BIC is addressable, permitting several BIC devices to be on the same RS-232 line, wired in simple parallel, if they are operated in the polled mode (free run not allowed in party line operation). The user may set individual address for the BICs.

The BIC reports data in ADC (analog to digital converter) counts, and calibration information is stored in the BIC for retrieval by the host computer or data logger, but this calibration information is not applied by the BIC itself. Normal channels utilize 24-bit analog to digital converters and produce a 4-byte reading (the 4th byte contains sign and status information).

Four characters uniquely identify every data string transmitted from the BIC. The first is always "#", followed by the tag or address character, then two digits the first of which specifies how many active normal channels, and the second how many active low resolution channels. Data bytes follow, and, in the case of binary data transmission, a single byte checksum is the last character transmitted.

## Connection Information:

| Connector Pinout vs. Function | DB9 Serial Connector | External Connector (U/W or Surface) | Internal 16 pin PCA Connector |
|---|---|---|---|
| **Sensor Tx** | 2 | 1 | 1 |
| **Sensor Rx** | 3 | 2 | 2 |
| **DTR/PWR** | 4 | 3 | 3 |
| **RTS/PWR** | 7 | 4 | 4 |
| **GND** | 5 | 5 | 5 |

The instrument may be connected to and directly powered by a PC or Laptop serial port. If an external power supply is used, then 6-12V @ 10mA must be supplied to either of the two PWR pins. The type of wires used is not important for most testing applications, however small gauge wire may limit cable length. Please contact the factory for current production information on specific connector models and vendors.

## Command Details:

### Start Conversion:
### SEND: *Q0!
### GET: no response

This command does not have a unit tag, because it is meant to start all BIC devices that may be listening. The 0 is necessary, but not significant.

### Get Data (Decimal Mode):
### SEND: *aD!
### GET: #`a51,3614694,8387960,0000013,0400846,8384003,0816`

The BIC responds with the preamble "#a51" indicating that it is tag "a" with 5 high resolution and 1 low-resolution channels. The high-resolution channels are always transmitted first. In this case the first channel (3614694) reports 2.154 volts (0.5960microvolts per count), followed by the three additional high-resolution channels. The last number (0816) is the count for the low-resolution channel (5*816/1024 = 3.98v).

If the Q command has been previously been issued, then the reading will be immediately returned (it was taken just after the Q command was received). If no Q command was issued, then the sampling process will be started and approximately 200mS later that data will be transmitted. High-resolution readings always occupy 7 digits, and the most significant digit is replaced with a – sign in the case of negative numbers. Only very small (a few millivolts) negative readings may be reported. When in Hexadecimal or decimal mode, the data is followed by a carriage return and line feed.
After receiving the Q command, and the requested conversion is completed, no new conversion will begin until either a new Q command is received, or data is read with a D command, followed by a second D command to read new data..

## Get Data (Hexadecimal Mode):

**SEND: *aD!**

**GET:** `#a5126E4FE3A2FFFB9441FFFFE9C20C3637C2FFDA80C3003`

The BIC responds with the preamble "#a51" indicating that it is tag "a" with 5 high resolution and 1 low resolution channels. The data follow in fixed hexadecimal format. The high resolution channels are always transmitted first, and each channel occupies 8 characters. In this case the first channel (26E4FE3A) reports x volts If the Q command has been previously been issued, then the reading will be immediately returned (it was taken just after the Q command was received). If no Q command was issued, then the sampling process will be started and approximately 200mS later that data will be transmitted. When in Hexadecimal or decimal mode, the data is followed by a carriage return and line feed.

## Get Data (Binary Mode):

**SEND: *aD!**

**GET:** `#aQ&äþ8/ Á=  G Åé²/ýÛ¸0` **(unprintable string)**

The BIC responds with the preamble "#aQ" indicating that it is tag "a" with 5 high resolution and 1 low-resolution channels. The character Q is 51 in hexadecimal, which signifies the 5 high-resolution and 1 low-resolution channel. The following characters are in 8-bit binary. The high-resolution channels are always transmitted first, and each channel occupies 4 bytes. If the Q command has been previously been issued, then the reading will be immediately returned (it was taken just after the Q command was received). If no Q command was issued, then the sampling process will be started and approximately 200mS later that data will be transmitted. The last byte in the string (which does not print in this example) contains an 8-bit checksum. The response is NOT terminated by a carriage return or line feed.

## Get Presence:

**SEND: *aP!**

**GET: WWW.Biospherical.com, MUV-2104-21102dp, v: 1.00,3,0F,0,D,5,1,a, 60hz**

The first of the comma separated fields is our company internet address, followed by the model identification and serial number, the version of the firmware, the binary configuration of low resolution channels, the binary configuration of high resolution channels (expressed as a two digit hexadecimal number, 0 for polled operation, D for decimal,  a turn-on delay of 5 seconds to allow the instrument to stabilize, and a 1 second delay between readings (ignored in this case of polled).  The tag is reported.  Finally, the optimal noise rejection frequency is sent.

## Set Configuration:
## SEND: *aMABCDEFGH!
## GET: OK, Mode accepted for tag H

The parameters A-G are as follows:

**A:** bit position of active picAD channels.  Valid values are 0-7.  The binary representation of this number shows the channels that are enabled.  For example, most instruments have A=3, which has a binary representation of 00000011.  This enables PIC analog to digital channels 0 and 1 (2 channels).

**BC:** bit positions of active high-resolution (delta-sigma converter) channels.  This two hexadecimal value specifies the bit positions of the active channels. A four optical channel sensor would have a value of "0F" (00001111).  A four optical channel device with temperature and depth would have a value of "CF" (11001111), as temperature and depth occupy channels 6 and 7 (counting from 0).

**D:** specifies the method of operation where 0=polled, 1=free run.  *This must be 0 for operation with LoggerLight.*:

**E:** specifies the format for data transmission where B=binary, H=hex, and D=decimal. *This must be B for operation with LoggerLight.*:

**F:** specifies the number of seconds of  warm-up after power is applied to the sensor.  This ranges from 0 to 9 and only applies to free-run mode. Timing is approximate.

**G:** specifies the number of seconds of  delay after each free run sample. Valid values are 0 (as fast as possible) to 9.  Timing is approximate.

**H:** represents the tag character (normally lower case a - z) for the sensor.  This will be identical with the second parameter (a) unless the tag is to be changed, when it is the new value.

## Get Calibration File:
## SEND: *aR!
## GET:

```
Serial Number,12345,,,,,
Model ID,BIC2104,,,,,
ActiveHighResChannels,5,,,,,
ActivePICchannels,1,,,,,
CalibrationDate,1/3/2003,,,,,
Reserved,,,,,,
Label,PotA,PotB,SmPot,Temp,Par,POT
Address,1,2,3,4,5,1
Offset,0,0,0,0,0,0
Scale,1.293,3.221,9.0221,0.01,1,10
Immersion,0.87,1,0.75,1,0.87,1
Units,uW/cm^2/nm,deg C,uW/cm^2/nm,deg C,uW/cm^2/nm,deg C
Equation,1,1,1,1,1,1
Reserved,,,,,,
Comment,"this is a test file, built to test the software.",,,,,
Checksum OK
```

It is important to note that the information in the calibration file IS NOT USED by the sensor, but by host software when it decodes the voltage data.  This calibration data is loaded into the sensor at the factory during calibration or recalibration. If you need details on how to load this information into the sensor, please contact us directly.

**Help:**
**SEND:???**
**GET:**

```
MUV-2104-21102dp, v: 1.01
*Q0! start conversion
*xD! ask for data
*xP! to have unit report presence
 To Set Mode of operation use *xMABCDEFGH! where
 A: bits picAD chans (0-F): 00000011 (2 chans)
 BC: bits HiRes AD chans (0-FF): 00111111 (6 chans)
 D: 0=polled, 1=free run: 0
 E: FORMAT (B=binary, H=hex, D=decimal): B
 F: secs warmup on power up: 0
 G: secs delay after free run sample: 0
 H: TAG character (lower case a - z): x
Free running starts after reset, send control-X to cancel
```

When sending the help reminder, the current values are also displayed, at the end of each line.

**Set optimum noise rejection frequency**
**SEND: *aFX0!**
**GET: Set to X0hz**

Where a is the tag and X is either “6” or “5” to set the optimal rejection to either 50Hz or 60Hz.. Normally, the setting of this is not significant. If you are operating the sensor in a region of strong electrical interference – under power lines, for example, it should be set accordingly.

**Set instrument Serial #**
**SEND: *aI!**
**GET: Send Password and string**
**SEND: Jenny**
**GET: Perfect! Send 16 chars:**
**SEND: 1234567890123456**

Where a is the tag and 1234567890123456 are the 16 characters of your choice to for the instrument serial #. Spaces count as characters. Normally this is a factory set value and should not be modified by the end user.

## Decoding the binary and hexadecimal data strings

The high-resolution sensor channels present data as 4 bytes. The hexadecimal output doubles each byte into two hexadecimal digits. These bytes are the raw data from the analog to digital converters used in the BIC. The most significant bytes are transmitted first, and assuming that they are put into an array (b(1 to 4)), the following equations produce the sensor voltage

```
V = ((b(4) + (b(3) * 16) + (b(2) * 4096) + ((b(1) And 15) * 1048576)) / 3355443)
If (b(1) AND 32) = 0 THEN V = 5 – V
```

The two most significant bits (bits 6 and 7 counting from 0) of the most significant byte should always be zero. Bit 5 is the sign bit, and bit 4 is a flag indicating that the ADC is in the extended portion of its range.

## Application of Calibration Equation

$$E = \frac{voltage - offset}{(Scale * WetCoefficient)}$$

where *E* = Engineering units (like microwatts/cm2/nm), voltage is the reported voltage, *offset* is the sensor reading when dark if it is an optical channel, *Scale* is the scale factor in (volts/Engineering Units) and “*WetCoefficient*” is also known as the Immersion coefficient, and modifies the scale factor if the sensor is used underwater. This modification compensates for changes in refractive index between air and water.