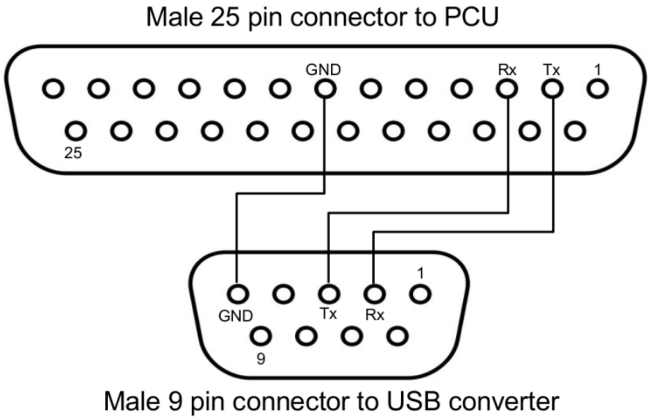
Open Source Software to Control Bioflo Bioreactors

David A Burdge and Igor GL Libourel

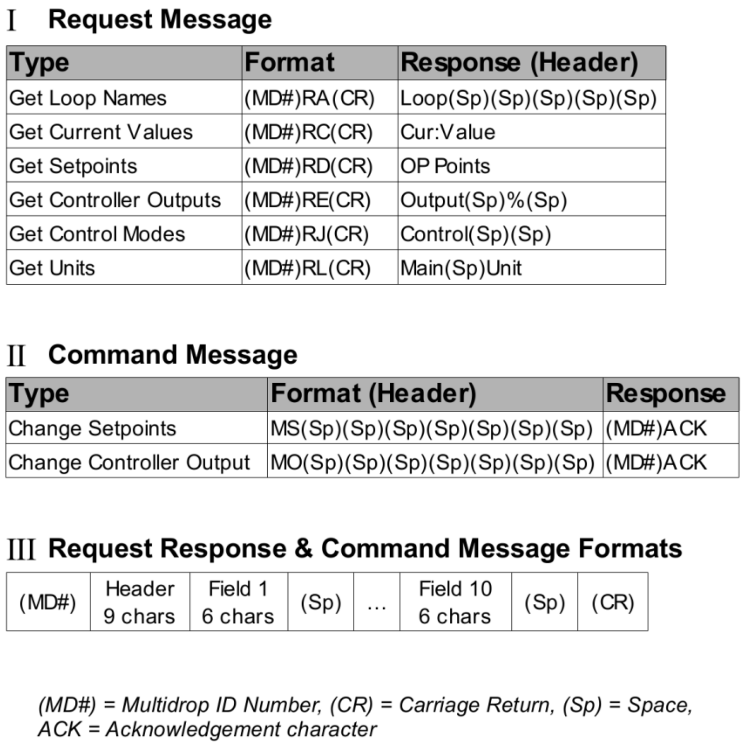
SUPPLEMENT

Figure 1: Patch cable to connect a Bioflo machine to a serial port


Male 25 pin connector to PCU
GND
Rx
Tx
1
25
1
GND
Tx
Rx
9
Male 9 pin connector to USB converter

The Bioflo110 primary control unit (PCU) is equipped with a 25 pin connector used for communicating with a personal computer. The connector was configured for RS-232 communication standard. The 25 pin connector was converted to a 9 pin connector: the Tx, Rx and GND pins of the 25 pin connector were soldered to the Rx, Tx and GND pins of the 9 pin connector.

Figure 2: Communication command structure



I **Request Message**

Type	Format	Response (Header)
Get Loop Names	(MD#)RA(CR)	Loop(Sp)(Sp)(Sp)(Sp)(Sp)
Get Current Values	(MD#)RC(CR)	Cur:Value
Get Setpoints	(MD#)RD(CR)	OP Points
Get Controller Outputs	(MD#)RE(CR)	Output(Sp)%(Sp)
Get Control Modes	(MD#)RJ(CR)	Control(Sp)(Sp)
Get Units	(MD#)RL(CR)	Main(Sp)Unit

II **Command Message**

Type	Format (Header)	Response
Change Setpoints	MS(Sp)(Sp)(Sp)(Sp)(Sp)(Sp)(Sp)	(MD#)ACK
Change Controller Output	MO(Sp)(Sp)(Sp)(Sp)(Sp)(Sp)(Sp)	(MD#)ACK

III **Request Response & Command Message Formats**

(MD#)	Header 9 chars	Field 1 6 chars	(Sp)	…	Field 10 6 chars	(Sp)	(CR)

(MD#) = Multidrop ID Number, (CR) = Carriage Return, (Sp) = Space,
ACK = Acknowledgement character

The AFS communications protocol uses a master-slave model where the PC is the master and the PCU is the slave. All communications are initiated by the PC, requesting a response from the PCU. Messages to/from the PCU are preceded by a multidrop number that specifics the vessel control system. The PC sends two types of messages: requests and commands. The request messages prompt the PCU to respond with specific information. A list of request types are shown in the first column of table I. Request message formats are shown in the second column of table I. The PCU responds to request messages with character strings formatted according to table III with response headers shown in third column of table I. The command messages prompt the PCU to change a setpoint or controller output value. The massages are formatted according to table III with format headers shown in the second column of table II.

Protocol execution:

Detail of an example script for the **Time Protocol VI** (full executable script is included as an additional supplement).

```
Temp 1    37.13084      60
Temp 1    37.26132     120
Temp 1    37.39109     180
Temp 1    37.51978     240
Temp 1    37.64705     300
Temp 1    37.77254     360
Temp 1    37.89592     420
Temp 1    38.01684     480
Temp 1    38.13498     540
Temp 1       38.25     600
Temp 1     38.3616     660
Temp 1    38.46946     720
Temp 1     38.5733     780
Temp 1    38.67283     840
Temp 1    38.76777     900
Temp 1    38.85786     960
Temp 1    38.94286    1020
Temp 1    39.02254    1080
Temp 1    39.09668    1140
Temp 1    39.16506    1200
Temp 1    39.22752    1260
Temp 1    39.28386    1320
Temp 1    39.33395    1380
Temp 1    39.37764    1440
Temp 1    39.41481    1500
```

Each line contains: 1) the controlled parameter; 2) the parameter setpoint, and; 3) the execution time relative to the start of protocol execution. All parameters, including from dynamically loaded plugins can be programmed in this fashion.

Example script for the **Python Protocol VI** (full executable script is included as an additional supplement).

```
import math
TempSetpoint=37.0+2.5*math.sin(2.0*math.pi*(CurrentTime-StartTime)*(1.0/7200.0))
```

The python protocol VI uses an open source library called LabPython to interface with the Python scripting language. By utilizing the Python language conditional logic can be implemented in protocols.