Monochromator Controller RB9603

M.J. Moene

1. INTRODUCTION

The RB9603 RULBUS module enables setting the wavelength of a Bausch&Lomb monochromator remotely by driving it's nonius with a stepping motor. Figure 1 shows the controller's front panel.

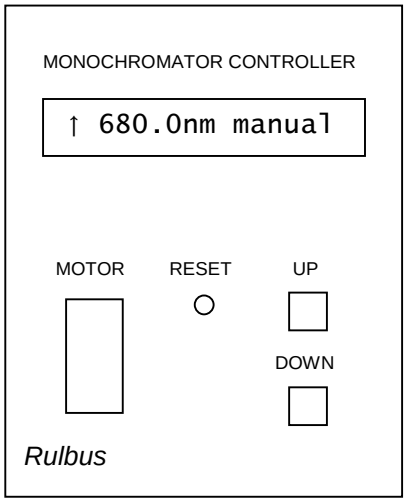

Figure 1 front panel.

The controller module itself sits in a RULBUS rack. A stepping motor–potentiometer assembly is located on the Bausch&Lomb monochromator to drive it. Via a cable the assembly is connected to the MOTOR connector on the controller.

The potentiometer in the assembly records the absolute position of the monochromator. It is used to calibrate the monochromator wavelength at 500nm initially and to check the position when a new wavelength has been reached.

The wavelength can be set manually with Up and Down keys and programmatically via the RULBUS computer interface. The display indicates the following:

```
[↑ 500.0nm calib.]    [  680.0nm manual]    [· 840.5nm remote]
```

up- or down arrow, or middot If the monochromator is adjusting it's wavelength, an up- or down arrow indicates the movement and it's direction. A middot in this position indicates that the wavelength displayed is the wavelength as represented by the potentiometer position.

wavelength The wavelength the monochromator is at or heading to in quarter nm.

calib. or manual or remote The monochromator is in it's calibration phase (calib.), the last wavelength was specified via the keys (manual), or via the computer interface (remote).

2. STARTUP

When the controller starts, it displays a message like `[MCC 1.0 20011105]` indicating the version of the controller's program. While this message is displayed, the Up and Down keys can be used to do the following.

Key	Function
Up	Display the wavelength range as selected with jumper CN4: 0..1000 nm, or 100..1100 nm.
Down	Show the wavelength as represented by the potentiometer position.
Up + Down	Start the procedure to calibrate the wavelength measurement (see section 5.).

3. WAVELENGTH CALIBRATION

After startup, the monochromator is moved to a wavelength of 500 nm. When the controller arrives at 500 nm, check that the monochromator also is at 500 nm. If it's not, bring the monochromator's physical position into accordance with the controller's position as follows:

1. Decouple the nonius from the motor temporarily.
2. Turn the nonius to 500 nm.
3. Couple motor to nonius again.

Apart from the wavelength calibration, there's also a wavelength measurement calibration. This is not a user level calibration, but you *can* check if this calibration is still accurate (See section 5.).

4. NORMAL OPERATION

After the wavelength calibration procedure, the monochromator wavelength can be changed both manually and remotely via the computer interface.

4.1 Manual operation

The following table describes the working of the Up and Down keys under manual operation.

Key	Function
Up	+1 nm (+10 nm repeating when held down).
Down	−1 nm (−10 nm repeating when held down).
Up + Down	Toggle between showing the wavelength setvalue and the wavelength as represented by the potentiometer position.

4.2 Remote operation

Remote operation will be normally done via driver software or an application program and a user need not know about the implementation details.

This section describes the communication protocol for those who do want to write a driver for the monochromator controller.

The messages exchanged between computer and monochromator controller consist of two-letter commands and an optional argument or response of six uppercase hexadecimal characters. The argument and response values are four times the wavelength in nm. The following table lists the commands that can be send to the monochromator controller via the computer interface.

Cmd	Arg	Resp	Remark
GW		WLact	Get current wavelength
GS		WLset	Get wavelength setvalue
GA		WLadc	Get measured wavelength (ADC)
GM		WLmean	Get 4-sample mean measured wavelength (ADC)
GN		WLmin	Get minimum wavelength
GX		WLmax	Get maximum wavelength
SW	WLset		Set wavelength setvalue
CW			Calibrate, move to 500 nm

The RULBUS processor – monochromator controller is a master–slave combination. The master controls the communication. It writes to the controller's command register and reads from the status register. These registers are both at the same RULBUS address, normally $CE.

Command communication The commands sent are two-letter strings optionally followed by a space and an argument. The command–argument string is terminated by the end-of-text character COMEOT (see table on the next page). If a result is returned, the master must collect it's characters. Arguments and results consist of six uppercase hexadecimal characters. Like command–argument strings, results are terminated with the COMEOT character.

write a command–argument string

```
for each character in string do
    write character
write COMEOT
```

read a response

```
read character
while character ≠ COMEOT
    string = string + character
    read character
```

Character communication Exchanging characters with the monochromator controller is done as follows.

write a character

```
write COMRDY

read tempchar
until tempchar = COMRDY

write character

read tempchar
until tempchar = character

write COMRDY
```

read a character

```
write COMRDY

read tempchar
until tempchar = COMRDY

write COMGET

read character
until character ≠ COMRDY

write COMRDY
```

The table below lists the codes used for communication with the monochromator controller.

Code	Value	Remark
COMRDY	0	Character accepted / ready to accept a character.
COMGET	1	Request from master for a character of a response.
COMEOT	2	End of command-argument or response string.
other	-	Command, argument, or response character. When accepted, the controller echoes it to the status-port

4.3 Error messages

The monochromator controller may display the messages as summarised in the next table.

Message	Remarks
[Calibrate: RESET]	The wavelength represented by the potentiometer position differs from the selected wavelength by more than 2 nm; reset the controller to recalibrate the wavelength.
[Hstack overflow!]	Hardware stack overflow program flow lead to an unrecoverable error; it may be due to too many nested subroutine calls; reset the controller to continue.
[Stack overflow!]	Software stack overflow program flow lead to an unrecoverable error; this may be caused by a programming error, please inform the person responsible for the control program; reset the controller to continue.
[Stack underflow!]	Software stack underflow the program contains a programming error; please inform the person responsible for the control program.

5. WAVELENGTH MEASUREMENT CALIBRATION

The procedure to calibrate the electronics for the wavelength measurement is started by pressing both the Up and Down key during startup. The calibration comprises the following steps.

1. Calibrating the 5.00V voltage reference.
2. Calibrating the full scale (1000nm).

The calibration procedure is as follows.

Step	Screen	Remarks
0.		Decouple the nonius from the motor.
1.	[MCC 1.0 20011105]	Reset the monochromator controller and press the Up and Down keys simultaneously until the screen under 2. appears.
2.	[Calibrate ADC]	Calibration procedure starts.
3.	[P2: CN13,pin1 5V]	With P2 (10 kOhm), calibrate Upin1, CN13 to 5.00V; press a key when ready.
4.	[↓ please wait...]	Doing 4400 steps reverse; motor and potentiometer are slip-coupled.
5.	[↑ please wait...]	Measuring U0, stepping forward until Uadc > U0.
6.	[↑ please wait...]	Stepping forward to position 4000 (1000 nm).
7.	[P3: 4321 <- 4000]	With P3 (500 Ohm), calibrate first reading to 4000.
8.	[MCC 1.0 20011105]	Reset the monochromator controller; wait until it arrives at 500 nm.
9.	[500.0nm calib.]	Move the monochromator to 500 nm manually; couple the nonius to the motor again.

A. BAUSCH & LOMB MONOCHROMATORS

Setup	Room	l/mm	λ [nm]	Blaze [nm]	nr.
Δϵ2	1111	1200	400–1000	500	6
	1107		400–1000 400–1200	750	5
	1023	1200	300–1000	630	15
HADOFLO	1105		0–700 ?	300	3
Δϵ3	1001	1200	200–600	300	2
SNAFA2	1103		200–600	300 (500)	1
LD/ADMR	1028	1200	300–1000	750	13
	1028		300–1000	600	9
	1028	1200	300–1000	500	7
	1028	1200	300–1000	500	11
HEFA	1011	1200	300–1000	750	4
	1011	1200	300–1000	600	10
	1026	600	200–1400	1000	14

A very old list of Monochromators at Biophysics (C.Francke)