

Manual for the MIKE-PLC control (Revision B, for GUI)

Index.

I. Conceptual description.	Page 2
II. Parts / devices involved.	Page 2
III. Signals involved.	Page 3
IV. How it works (interaction between PLC and user interface devices).	Page 3
Safety measures.	Page 4
How readings may fail.	Page 4
V. Tables (Slit Table, Blue Focus Table, Red Focus Table).	Page 5
VI. User manual for Mike's local control panel.	Page 6
A. Remote control screen.	Page 6
B. Local control screens.	Page 7
B.1. Menu screen.	Page 7
B.2. Blue focus screen.	Page 8
B.3. Red focus screen.	Page 9
B.4. Slit screen.	Page 10
B.5. Quartz and Hollow Cathode Lamps screen.	Page 11
B.6. Flipper + Shutter screen.	Page 12

Manual versions:

Original (Man V1/V2, PLC replaced original control electronics)	Mar. 2007
Revision A (Man V3, Slit table modified)	Aug. 2010
Revision B (PLC program modified to make it GUI-suitable)	Sept. 2011

I. Conceptual description.

The purpose of the project was to come up with a control system based on a Programmable Logic Controller (PLC) for replacing the electro-mechanic original control system of the instrument (we did not touch the CCDs electronics).

None of the devices included in the original control system's electronics chassis were removed from it in order to be able to reinstall it to make the instrument work in case the new control system fails. This also means that the new chassis includes connectors that match the ones used for the original system.

We also added a linear potentiometer to enable slit-position measurement and control. This potentiometer had been installed on top of the slit mechanism's motor in August 2005, with the help of Oscar Duhalde.

II. Parts / devices involved.

Hardware (PLC + interface devices):

The controller is a DirectLogic DL205 series PLC. Its parts are a D2-260 CPU, two input modules (one 32 5~15Vdc discrete inputs, used for shutter signals from the saddlebags, and one 8 channel analog input module, used for measuring focus and slit positions and instrument internal temperature), two output modules (one 8 Relay output module and one 115Vac discrete output module) and an Ethernet module (H-ECOM-100), used for remote access/control (primarily from the GUI, but also from a PC running the PLC programming software). The complementary operator (user) device is: A C-More Micro touch panel, model EA1-S3ML, which is the 'Local' user interface (AKA local panel).

The electronics control box has an ON-OFF switch for turning ON/OFF the Local control panel. This was added to avoid light contamination in the instrument's area produced by the panel's display.

Communications:

The communication between the PLC and the GUI goes through the telescope Ethernet. The PLC's Ethernet module is connected to the network through one of the outlets in the NASE platform (VLAN 1), and accessed from the GUI using the Modbus TCP/IP protocol.

Serial communication between the PLC and the local panel goes through an RS485 cable (notice that both devices are in the same cabinet).

Other hardware:

Inside the electronics cabinet, there is one board where I gathered all the parts that couldn't be replaced (the R-C circuits for driving the Focus and Shutter motors and two voltage regulators, for 5Vdc and 9Vdc). The 5Vdc voltage regulator feeds the three Potentiometers used to measure Slit and Focus positions. Other non replaceable devices are the flipper controller, which is fed by 9Vdc (from the mentioned voltage regulator), and the EMCO high voltage power supply (which feeds the Th-Ar, hollow cathode lamp).

III. Signals involved.

There are very interesting issues related to input signals.

Shutter control signals coming from the DSP boards in the saddlebags (CCDs) are +5Vdc for 'open shutter' and -5Vdc for 'close shutter'. As the module we chose (it was actually the only option) has DIACs (two diodes in anti-parallel configuration) in its input circuits, either status of the signals (+5Vdc or -5Vdc) made the input to read 'ON'. This was solved installing diodes in series with the signals, so now the levels that reach the module are: Near +5Vdc for 'open' and 0Vdc for 'close'.

Focus and Slit position raw signals were a little too jumpy, so in the end I installed 25uF (25Vdc) capacitors in parallel with the incoming signals. The result is smooth control, with a tolerance of +/- 1 unit in the readings (actually 1mV). The process indicators used with the original system didn't show the mentioned jumps in their readings. I assume that they have internal stabilization or filtering circuits for solving this issue.

For being able to measure the temperature inside the instrument (currently in a temporary location), I used the last two free terminals in connector J2 (which takes / brings signals to / from the blue plate), U and T, for connecting an AD592 sensor.

Note: One of the advantages of this new control system is that no induction appeared on the analog signals, like we had when first installed MIKE (remember we had to use ferrites for filtering, and still we had jumps on the control room indicators when the Quartz lamp or the Th-Ar lamp were turned on or off).

Output signals are simple. The focus motors need 120Vac applied to one of their two 'input' leads through appropriate R-C circuits to turn one way or the opposite way. The only restriction is that both 'input' leads MUST NOT be energized at the same time (the PLC program logic and hardware wiring take care of this restriction).

IV. How it works (interaction between PLC and user interface devices).

Although the control tasks are performed by the PLC, which receives the input signals and sends the output (actuation) signals to the motors, shutters, lamps and flipper controller, the local interface (also known as Local control panel) and the GUI 'tell' the PLC what to do.

The main user interface is Mike's GUI running on a computer located in the control room (remote controller, which replaced the touch panel in the control room). Control is also possible by using the Local interface (located on the electronics control box attached to the instrument) by pressing its F4 function pushbutton. While local control is enabled (a red LED above the pushbutton F1 will stay ON), control functions are shared by both the panel and the GUI (user should be aware whenever other person is using the local control panel).

All position measurements (Slit and the two Focus mechanisms) are 5V full scale. 2V full scale values are no longer available in the local control panel (due to the removal of the remote touch panel, which was able to scale internally, it was decided to use all position values in their native scaling, and make users aware of it).

On the GUI, Slit position values are showed in 5VFS, and Focus (Blue and Red) position values are showed in 2VFS (scale conversion from 5VFS made in the GUI's code). The data transfer between the GUI and the PLC uses 5VFS values.

The tables in page 5 show the position vales in both, the native 5V full scale, and the 2V full scale.

Safety measures.

- Initial conditions: Every time the PLC program starts (after a power cycle), the 'Initial stage' sets all the output lines to 'Zero'. This stage is executed only once after power-up or program restart. This means that all the devices and mechanisms (motors) are set to OFF or STOP state. This avoids any movement or device going ON after an unexpected power cycle.
- Software limits were included for Slit and Focus movement ranges. This means that the mechanisms can move up to these limit positions, but cannot move outside the range. The values for these limits are in the table on page 5 of this document.
- Time-Out flags were included for the three mentioned mechanisms on their respective 'Auto' mode. Maximum time with none or minimal reading variation for Slit was set to 2 seconds, and to 1 second for each Focus. If the movement 'times out', it will be stopped by the program and the message 'Slit Stuck' (or similar for focus) will blink on the screen of the local control panel.
If a mechanism times out (assuming it is not mechanically stuck), you can still retry moving it using either the 'Manual' or the 'Auto' mode to determine its actual condition.

How readings may fail.

- Motors getting stuck in one place or the signal wire getting disconnected from the corresponding PLC's analog input (this last case was tested). For these two cases, the situation from the PLC's point of view is the same; the reading stays stable even while commanding the motors to move (WATCH OUT, they can actually move). 'Slit stuck' or 'Focus stuck' message is displayed on the local panel accordingly. But, as written above, motors can still be commanded to move using 'Manual' or 'Auto' modes.
- No power on the measuring potentiometers: The readings go down to 0.0V. As readings don't change, the 'Slit stuck' or 'Focus stuck' messages are displayed on the local panel accordingly.

V. Tables.

The slit plate has 22 slits. The PLC is able to move the Slit mechanism to any position within its allowed range, and the GUI tells the PLC where to move it, according to the position of the target slit (or to any other position using ‘Options – Slit-Position’). For the two focus mechanisms, we created 20-position tables, with positions separated 4 units (using 2VFS values) from each other for making the focus sequence easier to carry out. If the optimum calculated focus is not a value in the table, there is always the chance of getting there by using the ‘Auto’ mode (in the local panel). The values (positions) contained in the mentioned tables are the following:

Slit Table		
Position	Physical Slit	Slit table 5VFS
1	0.35 x 0.35	3481
2	1.00 x 0.35	3370
3	1.00 x 0.50	3268
4	1.00 x 0.70	3171
5	1.00 x 1.00	3058
6	1.50 x 0.35	2956
7	1.50 x 0.50	2860
8	1.50 x 0.70	2767
9	1.50 x 1.00	2666
10	1.50 x 1.50	2547
11	2.00 x 0.35	2446
12	2.00 x 0.50	2360
13	2.00 x 0.70	2255
14	2.00 x 1.00	2158
15	2.00 x 1.50	2047
16	2.00 x 2.00	1910
17	0.35 x 5.00	1780
18	0.50 x 5.00	1681
19	0.70 x 5.00	1586
20	1.00 x 5.00	1485
21	1.50 x 5.00	1378
22	2.00 x 5.00	1248
Minimum Physical limit		1075
Minimum SW limit		1100
Maximum SW limit		3750

Blue Focus Table		
Position	Blue focus table 5VFS	Old table 2VFS
1	2810	1.124
2	2820	1.128
3	2830	1.132
4	2840	1.136
5	2850	1.140
6	2860	1.144
7	2870	1.148
8	2880	1.152
9	2890	1.156
10	2900	1.160
11	2910	1.164
12	2920	1.168
13	2930	1.172
14	2940	1.176
15	2950	1.180
16	2960	1.184
17	2970	1.188
18	2980	1.192
19	2990	1.196
20	3000	1.200
Min SW limit	2250	0.900
Max SW limit	3625	1.450

Red Focus Table		
Position	Red focus table 5VFS	Old table 2VFS
1	2560	1.024
2	2570	1.028
3	2580	1.032
4	2590	1.036
5	2600	1.040
6	2610	1.044
7	2620	1.048
8	2630	1.052
9	2640	1.056
10	2650	1.060
11	2660	1.064
12	2670	1.068
13	2680	1.072
14	2690	1.076
15	2700	1.080
16	2710	1.084
17	2720	1.088
18	2730	1.092
19	2740	1.096
20	2750	1.100
Min SW limit	2000	0.800
Max SW limit	3375	1.350

NOTE: The table for the Slit positions was modified on July 2010, and it was updated on this manual on August 9th, 2010.

Patricio Jones (August 9^h, 2010).

VI. User manual for Mike's local control panel.

The local control panel for Mike is a C-More device, which has a touch-sensitive screen and 5 function buttons.



Picture #1. C-More local control touch-panel and its bezel

The panel gives the user total control of (at least) the same functions the PLC carries out for the GUI. Its control capabilities are separated on different 'screens', that the user can access by pressing the 'Menu' button on any screen of the panel (excepting on the 'Remote control' screen). The screens are listed and described below:

A. Remote control screen.

Is the power-up default screen, and it shows the status of the most important variables of the instrument: Blue and Red Focus current positions (milivolts), Slit current position (milivolts), current status of the Blue and Red shutters, current status of the Flip Mirror, and the internal temperature of the instrument.

Remote control (from GUI)			
Press F4 for Local control			
Status	Shutter	Focus	
Blue	Open	1234	Blue focu
Red	Open	1234	Red focus
Slit	1234		Slit mech
Flipper	In		12.3 oC

Picture #2. Remote control screen

Press the 'F4' pushbutton (its red LED will be on, like on the picture on previous page) to access the 'Local' control screens. Notice that while in 'Local' control, you may go back to the 'Remote Control' screen (exit from Local control) by pressing the 'F1' pushbutton (its red LED will be on to indicate you that).

B. Local control screens.

Below there is a description of every local control screen.

Please notice that for the Slit mechanism and for the Blue and Red mechanisms, their screens are 'dynamic'. This means that these screens change their layout depending on the status of the 'Mode' button on each one, so there is one layout for 'Manual' control, and a slightly different layout for 'Automatic' mode. This feature allows better room usage, to have tidier screens.

Safety: As a preventive measure, all the mechanisms or devices are disabled and/or turned off when their corresponding local screen is not active. This avoids leaving a moving mechanism or an on lamp unattended, and it does not interfere with the commands coming from the GUI.

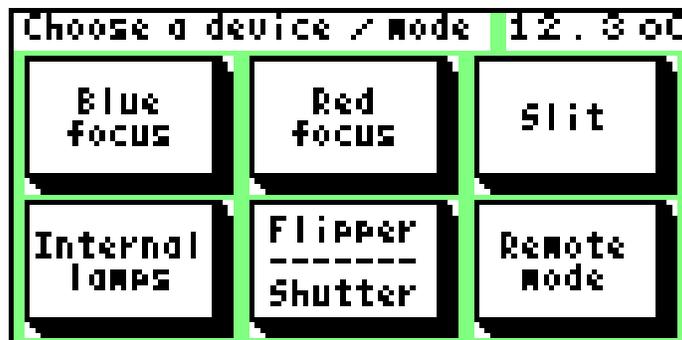
B.1. Menu screen.

It is a simple screen that allows the user to access and control any of the instrument's mechanisms or devices.

At its lower-right, it has a button that takes the panel back to the 'Remote mode' screen. The use of this button is equivalent to using pushbutton F1 on the panel.

The internal instrument's temperature is displayed at the upper-right of this screen.

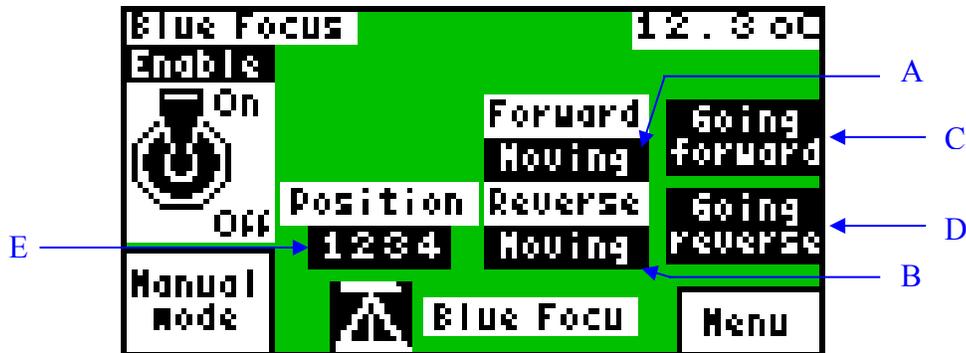
This screen is displayed after pressing the panel's F4 pushbutton while on the 'Remote mode' screen, and also by pressing the 'Menu' button on the lower row of each local control screen.



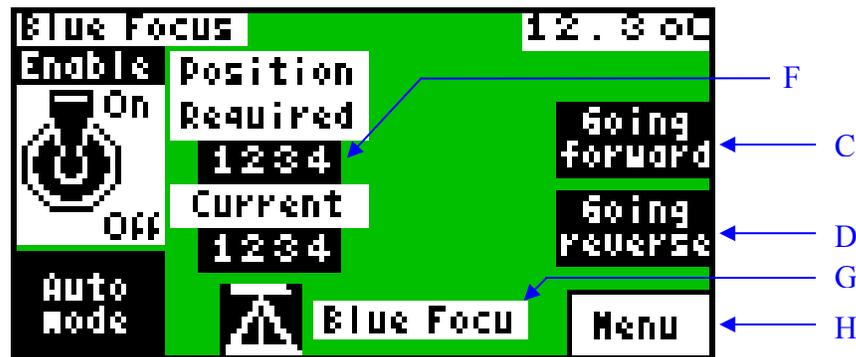
Picture #3. Menu screen

B.2. Blue focus screen.

Here you can control the Blue focus mechanism in either 'Auto' or 'Manual' mode, which you choose pressing the 'Mode' button located on the lower-left. The 'Enable' selector must be set ON in order to make it work.



Picture #4. Blue focus screen (Manual mode).



Picture #5. Blue focus screen (Automatic mode).

Manual mode: Press below the 'Forward' (A) or the 'Reverse' (B) labels to make the motor move the mechanism in either way. The movement will be executed while the button is pressed (temporary buttons), or until the mechanism reaches the related soft limit. Momentary 'Going forward' (C) or 'Going reverse' (D) flags will show up according to the movement being executed. These flags reflect the status of the actual PLC outputs. You will see the position value (E) changing according to the movement of the mechanism.

Automatic mode: Press the value below 'Required Position' (F) to make a number entry window pop up. Type in the value you want the mechanism to move to (and press Enter). The motor will move the mechanism until it reaches the entered position, within a range of +/-2 counts, or until it reaches the related soft limit. Momentary 'Going forward' (C) or 'Going reverse' (D) flags will show up according to the movement being executed. You will see the current position value changing according to the movement of the mechanism.

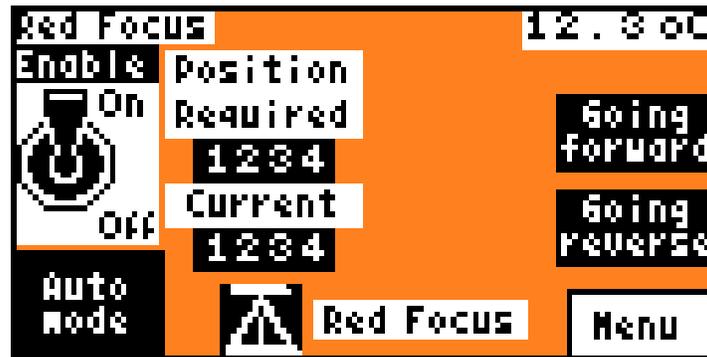
In automatic mode, if the mechanism gets slower than usual, the PLC program will assume that it is 'stuck' and will trigger a 'timeout' flag. The mechanism can still be

commanded to move using the manual mode, in order to troubleshoot or diagnose it. A scroll message saying ‘Blue mechanism stuck’ (G) will appear on the center-bottom of the screen while this ‘timeout’ flag is active.

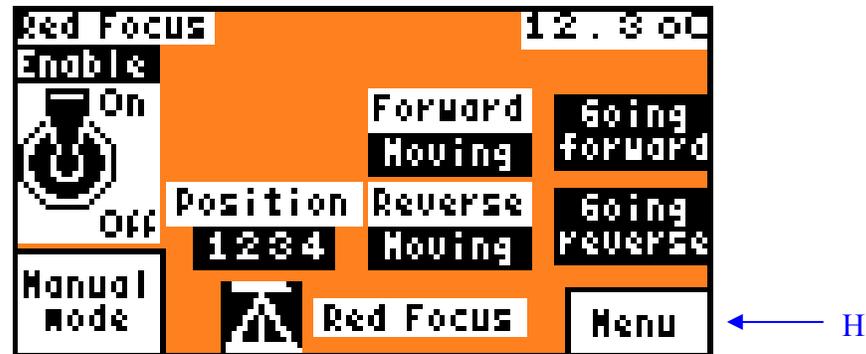
By pressing the ‘Menu’ button (H), you access to the ‘menu’ screen that allows you to select any of the other available screens, or to go back to the one you are coming out of.

B.3. Red focus screen.

The control for the red focus mechanism works exactly the same way it is described above for the blue focus mechanism. The two versions of the red focus control screen (for manual and for automatic modes) are shown below.



Picture #6. Red focus screen (Manual mode).

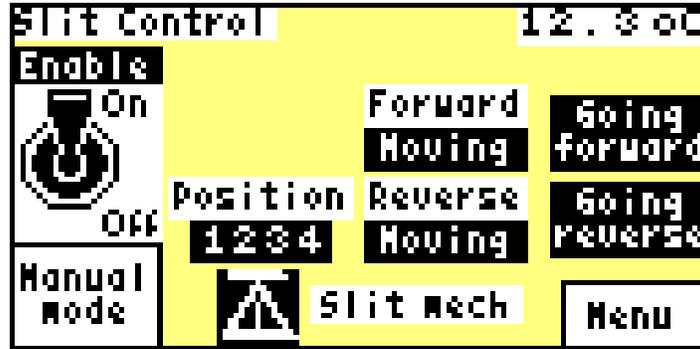


Picture #7. Red focus screen (Automatic mode).

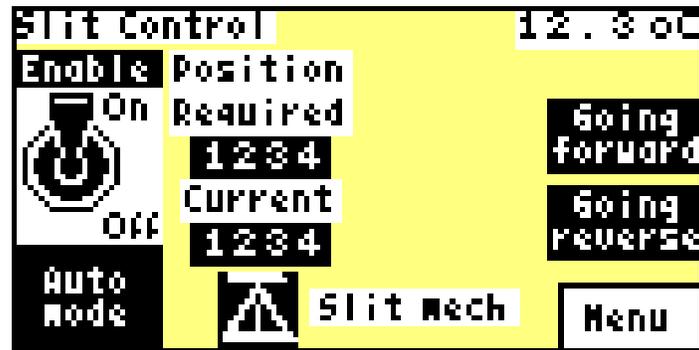
By pressing the ‘Menu’ button (H), you access to the ‘menu’ screen that allows you to select any of the other available screens, or to go back to the one you are coming out of.

B.4. Slit screen.

The Slit control screen works basically the same way the focus control screens do. The mechanism can be controlled in either 'Auto' or 'Manual' mode, which you choose pressing the 'Mode' button located on the lower-left. The 'Enable' selector must be set ON in order to make it work.



Picture #8. Slit (manual mode) screen

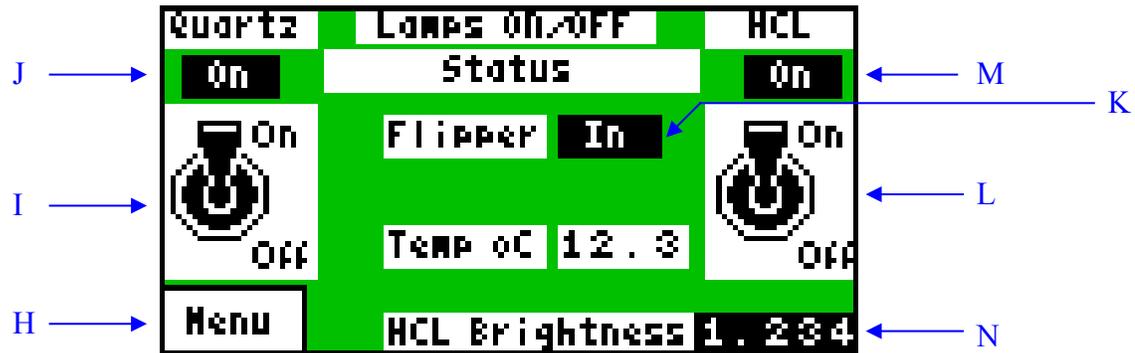


Picture #9. Slit (automatic mode) screen

By pressing the 'Menu' button (H), you access to the 'menu' screen that allows you to select any of the other available screens, or to go back to the one you are coming out of.

B.5. Quartz and Hollow Cathode Lamps screen.

Here you can control the Quartz lamp or the Hollow Cathode (Th-Ar) lamp.



Picture #10. Quartz and Hollow Cathode lamps screen

Turn the Quartz lamp ON/OFF by pressing the left switch (I). The status of the Quartz lamp (J) is displayed above the on/off switch.

The Flip Mirror goes automatically IN when the lamp is turned ON, and stays that way until the lamp is turned OFF (when it goes OUT). Its status (K) is displayed on the center of the screen.

Turn the Hollow Cathode lamp (HCL) ON/OFF by pressing the right switch (L). The status of the Quartz lamp (M) is displayed above the on/off switch.

The Flip Mirror goes automatically IN when the lamp is turned ON, and stays that way until the lamp is turned OFF (when it goes OUT). Its status is displayed on the center of the screen (K).

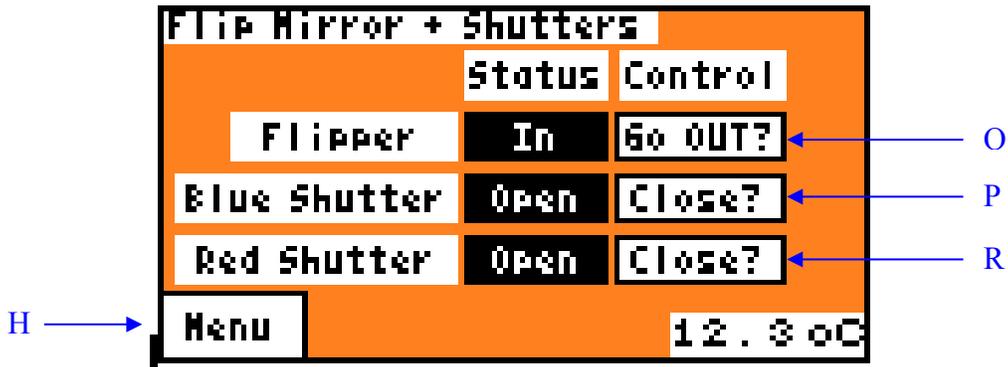
As the HCL has priority, the Quartz lamp will be forced off (by the PLC program) if it is on when the HCL is turned on.

At the bottom of the screen, there is a reading of the 'brightness' voltage set for the HCL (N). This voltage has been pre-adjusted in the electronics box, and must be between 4 and 5 Volts for the lamp to work properly.

By pressing the 'Menu' button (H), you access to the 'menu' screen that allows you to select any of the other available screens, or to go back to the one you are coming out of.

B.6. Flipper + Shutter screen.

Here you can control the Flip Mirror (IN/OUT) and the Shutters (Open/Close).



Picture #11. Flipper and Shutter screen

The center row shows you the current status of the Flipper / Shutters. On the right row (labeled 'Control') you find the buttons to turn the Flipper IN/OUT (O) and to Open/Close the blue shutter (P) or the red shutter (R).

By pressing the 'Menu' button (H), you access to the 'menu' screen that allows you to select any of the other available screens, or to go back to the one you are coming out of.