

# AF2 Robot Engineering Data GUI

## 1 Introduction

This document describes an extension of the standard AF2's GUI with the parameters related to the robot mechanisms and the fixed probe.

## 2 Overview

The Engineering Data GUI can be run on any PC, capable of running xhost session. To start the standard AF2 GUI, first start a ssh session to the af2pc1 or af2pc2 (depending on which PC has the AF2 software running).

Example:     xhost +  
              ssh -X af2pc1.ing.iac.es -l af2  
              password: xxxxxxxx

Then start the AF2 Engineering Mimic by typing: '**af2 mimic**' , this will start the windows shown in fig 1. The green lines represent the positions of the science fibres, the yellow lines the positions of the fiducial fibre bundles, used for autoguiding, and the black lines are the fibres which have been disabled. The grey box in the top right corner, represents the moving part of the robot head.

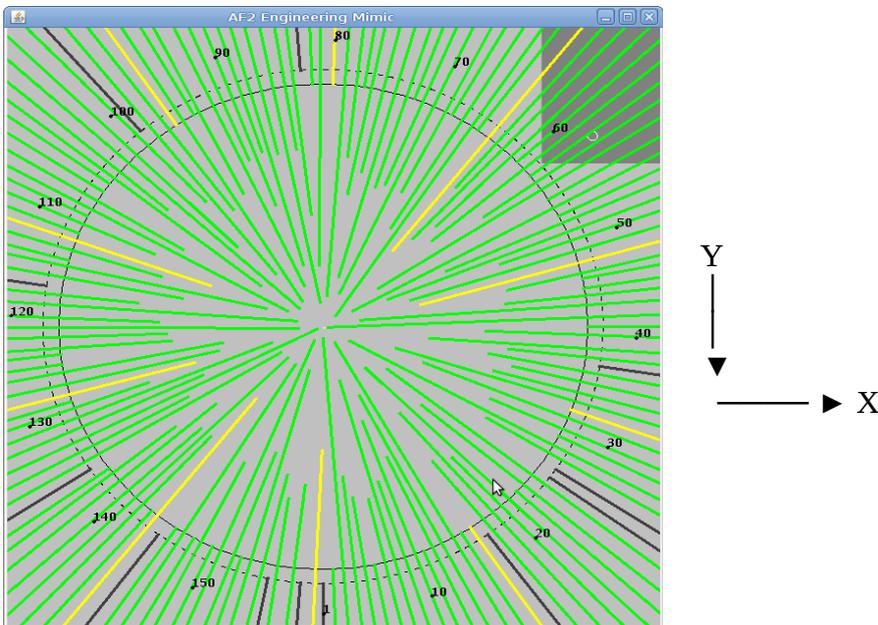


Fig 1: AF2 Engineering Mimic

The engineering data GUI can then be started by clicking the right mouse button in the AF2 Engineering Mimic. This will bring up a small menu, then left click on: **Show robot axis engineering status**

Fig 2 to 5 are examples of the Engineering Data after certain commands have completed.

Axis	Raw Encoder Va...	Hi Limit	Lo Limit	Home	Stop Codes (most recent first)
X	5	false	false	false	[101, 0, 101]
Y	0	false	false	false	[101, 0, 101]
Z	0	false	false	false	[1]
Theta	0	false	false	true	[101, 1, 0, 101]
Probe	1	false	false	false	[1]

Fig 2: After "af2 wake" command completed

'af2 wake' is always the first command to be executed. This will switch on the power to the robot, and then initialise the various axes. When you are near the robot, you can also hear the different steps in this sequence. First there is a click from the power relay. Then the Theta mechanism is initialised by rotating the mechanism until the Home switch is found. The next thing you hear is a pneumatic valve operating the gripper 3 times. Then the X and Y axes are moved to the centre of the field to detect the Home switches and then moved to X and Y = 0.

To be able to view a fibre on the TV monitor, first the command: 'af2 backillum on' has to be issued. This switches on an infrared LED source in WYFFOS, in order the fibres can be seen by the TV camera mounted in the gripper assembly. Then the command: 'af2 viewfibre x' can be issued, where 'x' is the fibre number to be viewed.

Axis	Raw Encoder Va...	Hi Limit	Lo Limit	Home	Stop Codes (most recent first)
X	5374	false	false	false	[101, 100, 101, 0, 101]
Y	134054	false	false	false	[101, 100, 101, 0, 101]
Z	0	false	false	false	[1]
Theta	458	false	false	true	[101, 100, 101, 1, 0, 101]
Probe	1	false	false	false	[1]

Fig 3: At position of Fibre 2, after execution of 'af2 viewfibre 2'

Axis	Raw Encoder Va...	Hi Limit	Lo Limit	Home	Stop Codes (most recent first)
X	134233	false	false	false	[101, 100, 101, 100, 101, 0, 101]
Y	5413	false	false	false	[101, 100, 101, 100, 101, 0, 101]
Z	0	false	false	false	[1]
Theta	18262	false	false	false	[101, 100, 101, 100, 101, 1, 0, 101]
Probe	1	false	false	false	[1]

Fig 4: At position of Fibre 40, after execution of 'af2 viewfibre 40'

Axis	Raw Encoder Va...	Hi Limit	Lo Limit	Home	Stop Codes (most recent first)
X	190616	false	false	false	[101, 100, 101, 0, 101]
Y	-180606	false	false	true	[101, 100, 101, 0, 101]
Z	300	false	false	false	[1, 0, 1]
Theta	74877	false	false	true	[101, 100, 101, 1, 0, 101]
Probe	1	false	false	false	[1]

Fig 5: After "af2 park" command completed

### 3 Description of the fields in the table

The table of the Engineering GUI provides raw information of the robot axes head. The status of motion for each axis can be determined by checking the stop code. This can be useful when motion on an axis has stopped unexpectedly. The update period for the GUI is 1 second, so it can take up to 2 seconds for the data in the table to be updated.

The Axis column contain the 4 axis of the moving part of the robot:

- X – horizontal movement
- Y – vertical movement
- Z – gripper jaws movement up and down with respect to the focal plane
- Theta – rotation of the gripper jaws
- The fifth row represents the so called fixed Probe mechanism, which moves a coherent fibre bundle in and out of the field. This mechanism hasn't been used, and is recently disabled due to a fault.

The next column contains the raw encoder values of the different axis:

- X and Y are shown as an integer number representing microns (um) relative to the AF2 field centre.
- The Z axis of the gripper jaws are arbitrary units encoder values, were the button height is 5000 and the lift height is 300, and value 0 when the gripper is retracted.
- The Theta axis is also represented in arbitrary units encoder values between -150000 and 150000. The arbitrary units correspond approximately to 200 unit / degree. Zero units corresponding to the gripper being vertical.

Note: the raw encoder values of X and Y in this table are different than the values shown in the AF2 Robot Parameters window due to corrections applied for thermal expansion, axis non-orthogonality and straightness corrections. The value of Theta also differs, as in the AF2 Robot Parameters it's expressed in minutes of arc.

The next 3 columns show the status of the various switches, 'true' representing switch activated.

The next column contain the stop codes, which are explained in the table below. The stop code is a number representing the motion status. The 10 most recent axis stop codes are displayed with the most recent stop codes on the left of the column.

Stop Code Meanings:

- 0 – Motors are running, independent mode
- 1 – Motors stopped at commanded independent mode
- 2 – Decelerating or stopped by FWD limit switches
- 3 – Decelerating or stopped by REV limit switches
- 4 – Decelerating or stopped by Stop Command (ST) (See Ref [\[1\]](#) page 165)
- 6 – Stopped by Abort input
- 7 – Stopped by Abort command (AB) page 20
- 8 – Decelerating or stopped by Off on Error (OE1) (See Ref [\[1\]](#) page 138)
- 9 – Stopped after finding Edge (FE) (See Ref [\[1\]](#) page 91)
- 10 – Stopped after homing (HM) (See Ref [\[1\]](#) page 98)
- 11 – Stopped by selective abort input
- 50 – Contour running
- 51 – Contour stop
- 99 – MC time out
- 100 – Motors are running, vector sequence

101 – Motors stopped at command vector

See the SC Stop Code section of the command reference for further information in the [Galil 1800 Command Reference](#) the pages mentioned after the command codes, refer to this manual.

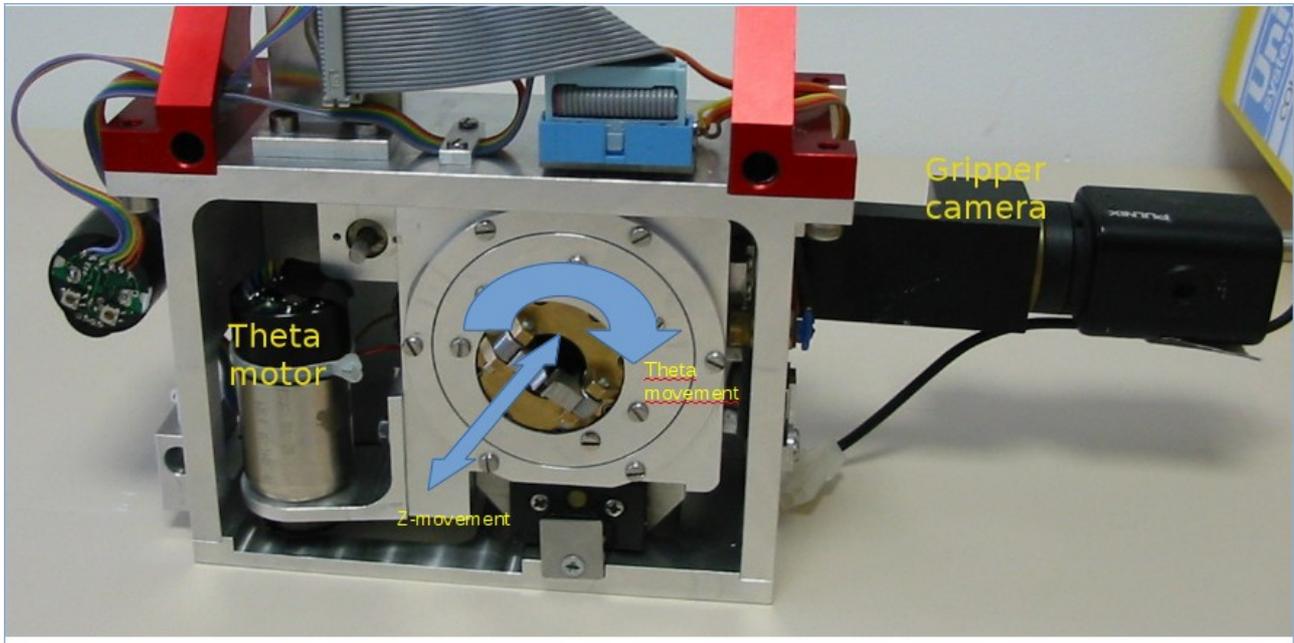


fig 6: Gripper unit with Theta- and Z-movement shown.

## 4 Troubleshooting

### Fault during wake

If a fault occurs during the '**af2 wake**' command, there will be a message returned to the user indicating which axis has failed to initialise correctly.

#### Theta Axis

A message such as “Failed to initialise the theta axis in -ve direction because the home switch could not be found” will be generated. If the theta axis is failing to initialise, then it is likely that the axis is sticking and is failing to find its home switch correctly during homing. This should be indicated in the AF2 axis engineering data table by a stop code that is not 0, 1, 9, 100 or 101. A stop code of 99 is likely as the theta axis motion would probably time out during the homing procedure.

#### XY Axes [Galil 1800 Command Reference](#)

If either the X or Y axis fails to initialise during wake, check the stop codes for the X and Y axes. These stop codes should always be 0, 1, 9, 100 or 101. Any stop code other than this indicates a fault with the axis. Also check that the encoder values are changing during the axis movements.

A message “Cannot offset by more than 2000” appears during wake. This is probably due to a failure of the XY absolute encoders (possibly due to a connection problem). The XY axes move

correctly to find the home switches, but when the motor and absolute encoders go out of sync by more than 2000 microns, the robot control system will indicate this as an error.

## Z Axis

If the Z axis fails to initialise during wake, check the stop codes for the Z axis. This stop code should always be 0, 1 or 9. Any stop code other than this indicates a fault with the axis. Also check that the encoder values are changing during the axis movement.

## Axis in Limit

In normal use, it is highly unlikely that an axis will ever hit its limit switches as software limits are applied to prevent this. In the event that an axis does activate its limit switch, further motion in the direction of the limit switch will not be possible until the logic state of the switch returns back to an inactive state. Stop codes of 2 or 3 will indicate that an axis has hit a limit.

To extract the robot from its limit switches:

1. If the robot is awake, use the engineering command '**af2 extract**' to extract the robot from its limits. The '**af2 wake**' command can also be used and will also extract the robot from its limits. To be able to use the so called [engineering commands](#) have to be enabled by typing: '**af2 eng**' these are password protected.
2. If the robot is not awake, use the command '**af2 wake**'. This will move the robot out of its limit switches and home all of the robot axes.

## 5 Tests

### X Y Home Switches

A test to check the Home sensors of the X and Y probe can done by performing the following command:

```
'af2 moverobot -50 -3600'
```

At these values the home sensors are true.

### Theta Home Switch

The Theta home switch can be tested by the command:

```
'af2 tmove 0'
```

However, for this last command to work you first need to enable the extended mode, by typing the command: '**af2 extended**' ,which again, is password protected.

### Z Home Switch

The Z axis uses the low limit switch for homing. It is not possible to drive the Z axis into its home switch during normal usage, as software limits are applied to prevent this. Any tests of the Z home/limit switch would need to be done with the motors off and the Z axis manually moved into

the switch.

## 6 Limit Switches

It is not possible to drive the robot into the limit switches during normal use, as software limits are applied. Any tests of the XY or Z limit switches would need to be done with the motor power off and the axes moved into their limit switches manually.

## 7 Robot Axis Positions

As explained in the Overview the AF2 Engineering GUI shows the actual encoder values of each of the axes. For the XY axes, the table shows the actual values of the absolute (linear) encoders. These XY encoder values will differ slightly from the robot position indicated in the AF2 Robot Parameters window due to corrections applied for thermal expansion, axis non-orthogonality and straightness corrections.

For the theta axis, the table shows the actual encoder value of the axis. This differs from the position indicated in the AF2 Robot Parameters window, as the AF2 Robot Parameters window shows the axis value in arc minutes between 0 and 21600.

For the Z axis, the table shows the actual encoder value of the axis. This is the same as the value shown in the AF2 Robot Parameters window.

## 8 References

- [1] [Galil 1800 Command Reference](#)
- [2] [Autofib2 Home page](#)
- [3] [Autofib2 command reference](#)

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