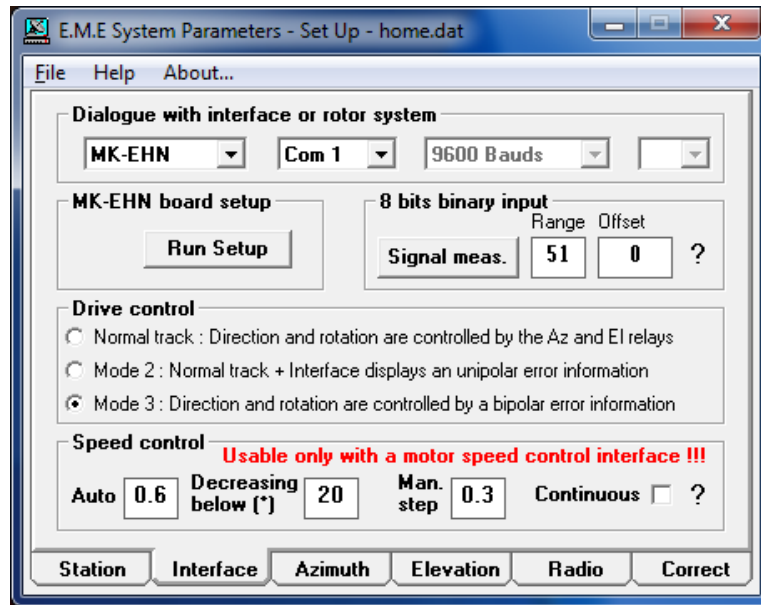


Antenna rotation – Modes

F1EHN – Jan 2018

The interface board includes 4 relays to manage the antenna rotation. With the SETUP module, the operator is able to select the running mode of the TRACKING module according to the antenna design. There are 3 different modes has described below. The figure below shows how you can set the wished mode in the setup module.

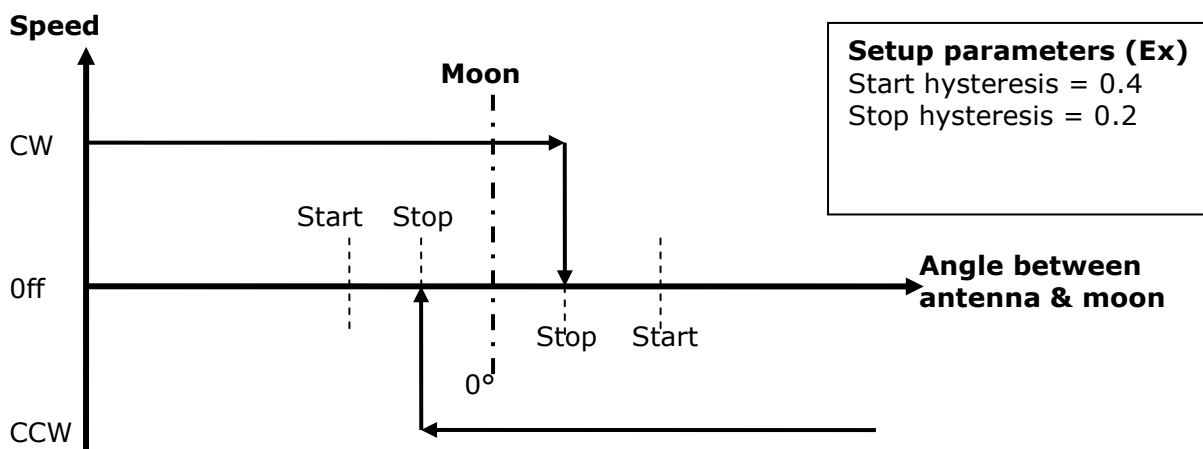


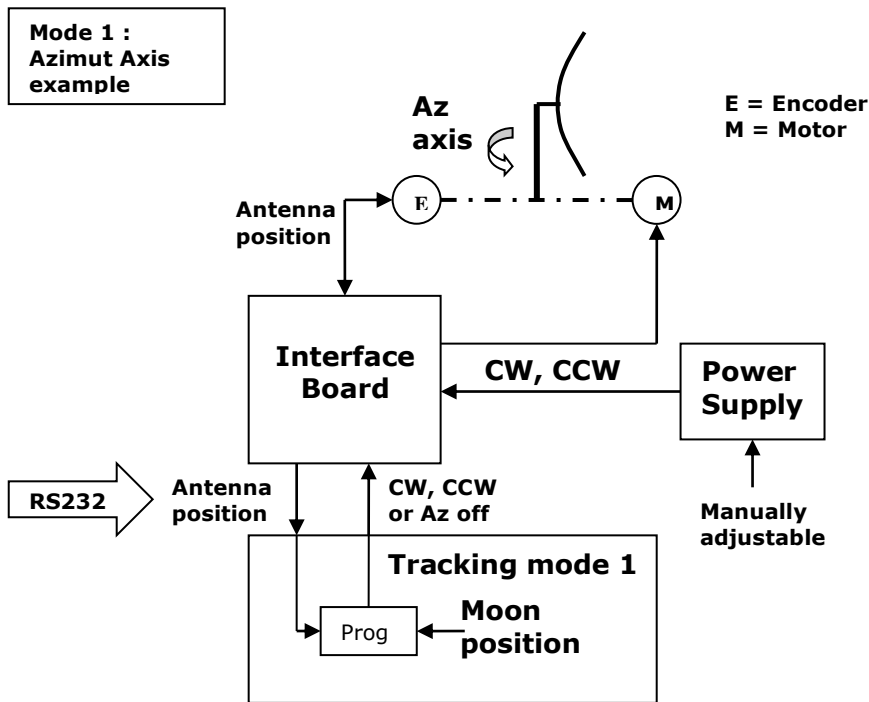
1 Mode 1 (Normal track)

The azimuth (cw, ccw) and elevation (up, down) relays control the rotation and the direction of the antenna. The speed (drive or motor supply) is fixed or manually adjusted.

The hysteresis allows reducing the time when the antenna is rotating to reach the source position with stopping the rotation after the source position.

The antenna rotates if the angle between antenna and moon (ex) is greater than “start” value. The antenna stops if the angle between antenna and moon (ex) is greater than “stop” value over the source position.



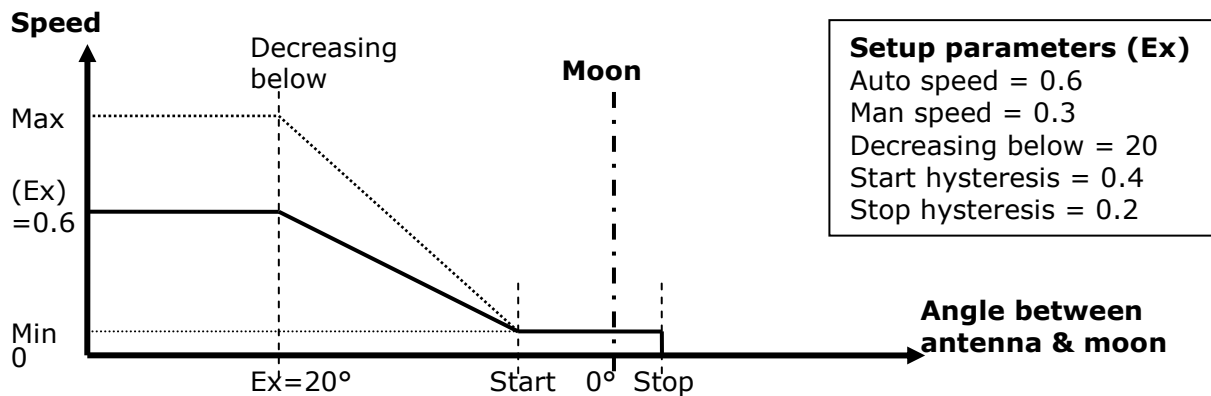


2 Mode 2 (normal track with rotation speed control)

Runs like the mode 1. Moreover the interface supplies an error word on 2 different formats :

- On the Rx Bus outputs, a 7 bits binary error corresponding to the offset between the antenna and the tracked source (ex : moon). The error is coded from 5 (min) to 127 (max).
- On an analog output, a voltage error corresponding to the offset between the antenna and the tracked source. The voltage is automatically set from 0.16 (min) to 4.096 V (maxi). The voltage range is adjustable with the setup parameters)

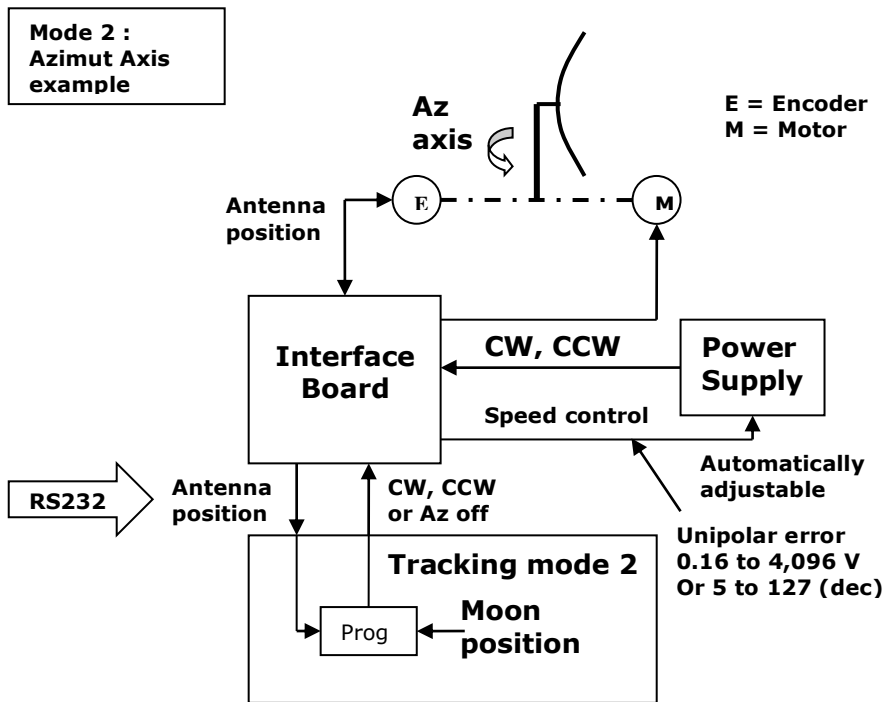
Then the speed (drive or motor supply) can be automatically adjusted.



Max = 127 (4.096V), Min = 5 (0.16V)

In automatic tracking, the speed is automatically adjustable according to the graphic above. In manual positioning (Kbd arrow key), the rotation speed is equal to :

Max speed * Man speed, that is to say : $127 * 0.3$ (Ex) = 38 (decimal) => 1.21 V (for a linear system as presented in chapter 2.2. For other system where the min value has to be higher to allow a minimum speed higher than min value, report to chapter 2.1).



From this typical use, the mode 2 allows 2 different setups regarding the use of a motor drive function. This function could be with an open loop for the speed control (any device to measure the speed rotation) or with a closed loop by using a speed rotation control.

2.1 Motor drive with an open speed control loop

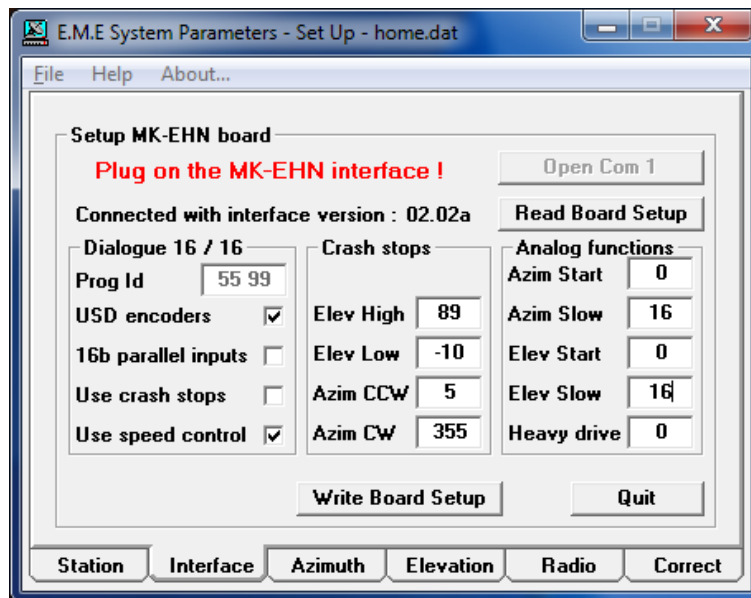
These systems haven't any device to measure the speed of rotation and are without speed control loop. So, in this case of use, it is very difficult to control the rotation for the very slow speed like to compensate the earth rotation to follow / track an object like the moon or the sun.

In this case it is possible to manage the slow speed by using the "Analog functions" available in the MK-EHN board setup. These functions are specific controls to manage the start of motors and the minimum voltage to have a slow speed. In a normal use (see next chapter 2.2) all these values are set to "0".

The values for start and slow represent values that should be set into the speed control DACs. "Start" is the value that allows the motor to start moving and "Kickms" represents the number of milliseconds of maximum DAC voltage required to just start the motor moving. This is used if the motor wants higher voltage to start and then to have its slowest speed with a lower voltage. But it is risky because the running is non-linear and the starting phase is a stress for the system. Probably it is better to have a higher slower speed with a smooth starting. For that, if Start = 0 and Kickms = 0, this starting function is disabled.

"Slow" is the value that will just keep the motor moving at the slow speed once it has been started. There are separate values for start and slow on the two axes. The values must be set from 0 to 127 (corresponding to 0 to 4 V for the DAC output).

The figure below shows a typical setting for an open speed control loop.



With a slow value of “16” the minimum DAC output will be $4 / (128/16) \Rightarrow$ about 0.5 V. If your drive needs a higher voltage to start its moving then put Start = Slow and set “Kickms” to have enough time to start the drive (during this time the DAC output is set at maximum – 4V).

Be careful when you are using this function. It is careful to favorize a higher slow speed and doesn't use the “Heavy drive” function. This running is risky and under your own choice.

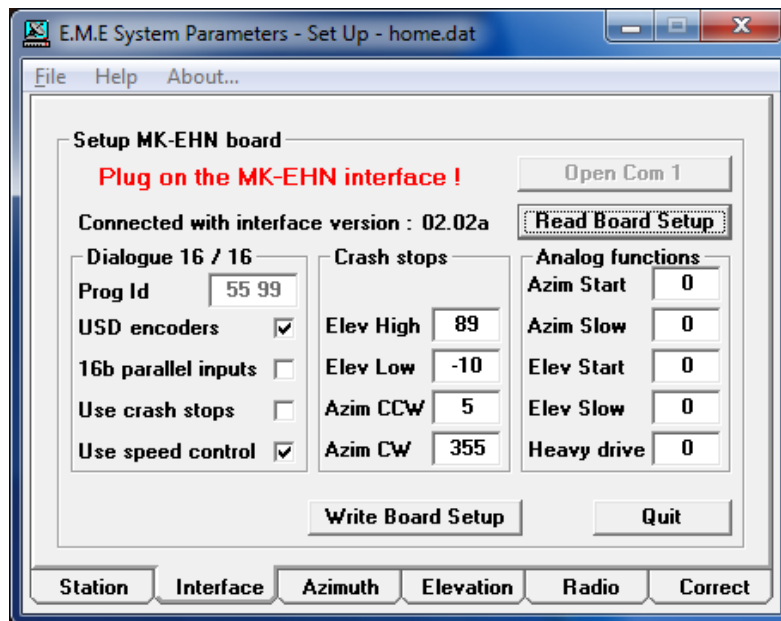
If you wish to limit the voltage range of the DAC output corresponding to the range between the maximal and minimal speed, you can set the “Auto speed control” to a lower value than 1. 1 set a full range of 4V. For example, If Auto = 0.5 and Slow = 32 (Start = 0, Kickms = 0), you will get 1V as minimal voltage and 3V as maximum one. The range is 2V ($0.5 \cdot 4V$). Of course, the DAC output voltage cannot exceed 4V and you have to set these functions into a good running range.

2.2 Motor drive with a closed speed control loop

These systems have device to allow to measure the speed of rotation of your antenna. So, the motor drive (PWM) verifies the voltage control at its input is corresponding to the speed rotation and then adjust the motor speed to be equal to the speed corresponding to the input voltage. For a zero voltage, the speed rotation will be null, for a maximum voltage the speed will be at maximum (example : $4^\circ/s$ for 4V). This running is linear and if the DAC output voltage is set, by example at 0.1V so the antenna will rotate at $0.1^\circ/s$. With this kind of motor drive, it is very easy to control the antenna rotation for the very slow speed like earth rotation. In this case, **the values of “Analog functions” must be set to “0”.**

If you wish to limit the voltage range of the DAC output corresponding to the range between the maximal and minimal speed, you can set the “Auto speed control” to a lower value than 1. 1 set a full range of 4V. For example, If Auto = 0.5, you will get 2V as maximal voltage for the maximum speed. The minimum speed is 1 LSB.

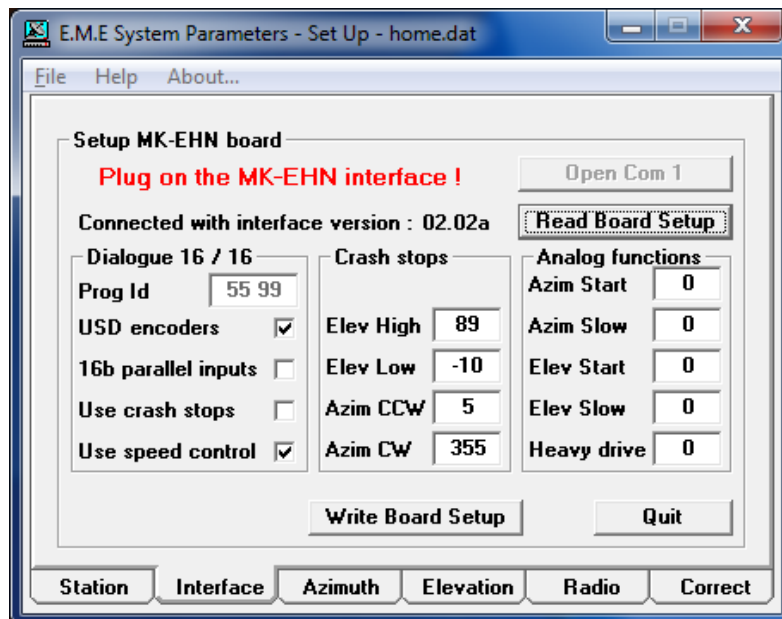
The figure below shows a typical setting for an closed speed control loop.



3 Mode 3 (automatic speed control)

This mode 3 is only usable with a linear system having a closed speed control loop.

In this case, the values of “Analog functions” must be set to “0”. The figure below shows a typical setting for a closed speed control loop.



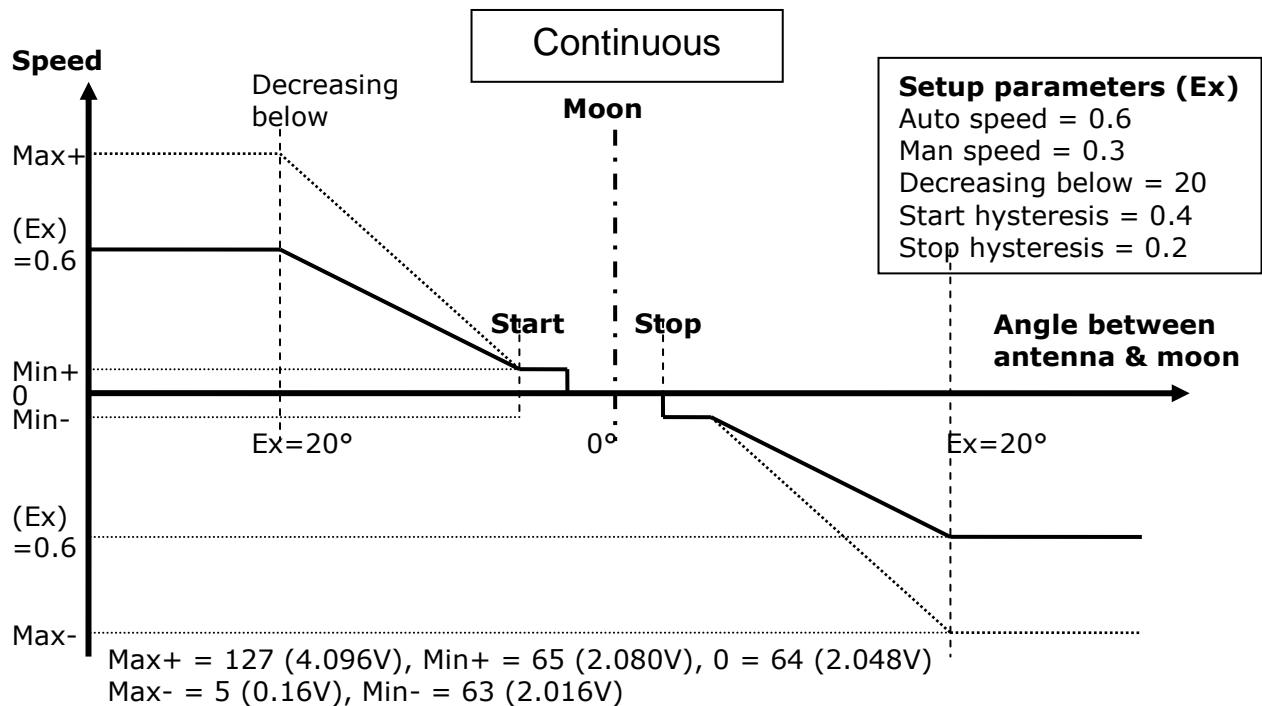
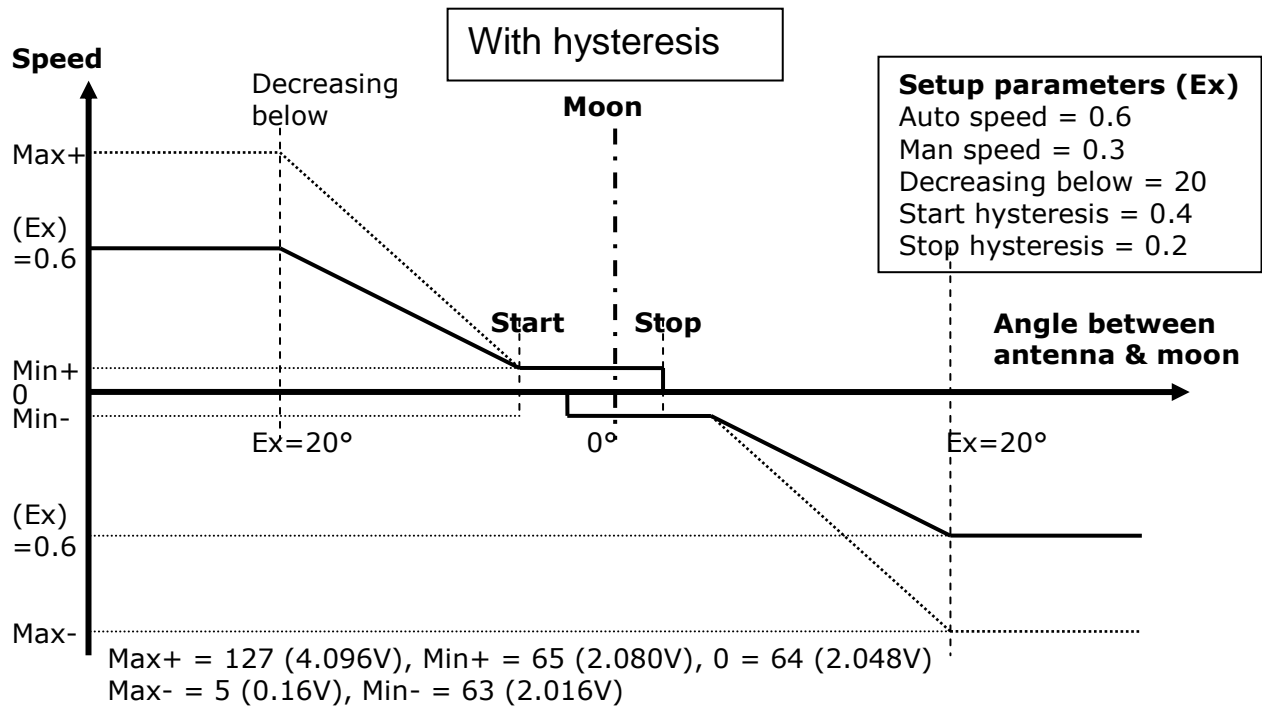
In the mode 3, the rotation, direction and speed of the antenna can be automatically adjusted.

The interface supplies a bipolar error word on 2 different formats :

- On the Rx bus outputs, a 7 bits bipolar binary error corresponding to the offset between the antenna and the tracked source (ex : moon). The error is coded from 5 (max negative error) to 127 (max positive error). For a null error, the interface displays the “64” decimal value.
- On an analog output, a voltage error corresponding to the offset between the antenna and the tracked source. The supplied voltage is centered on 2.048 v and varies of +/-

2.048 V from that (0 to 4.096V). With an external operational amplifier, the voltage can be easily shifted so that +2.048V error value gives 0V and the output is now bipolar +/-2.048V (or more) to pilot a servo-control of position.

In this mode 3, the relays of the board are used by the Tracking module to switch on or off the servo-control. The direction of rotation of the antenna is only controlled by the voltage or error word of control speed. 2 running are available with hysteresis and continuous (selectable with EME Setup into the mode 3).

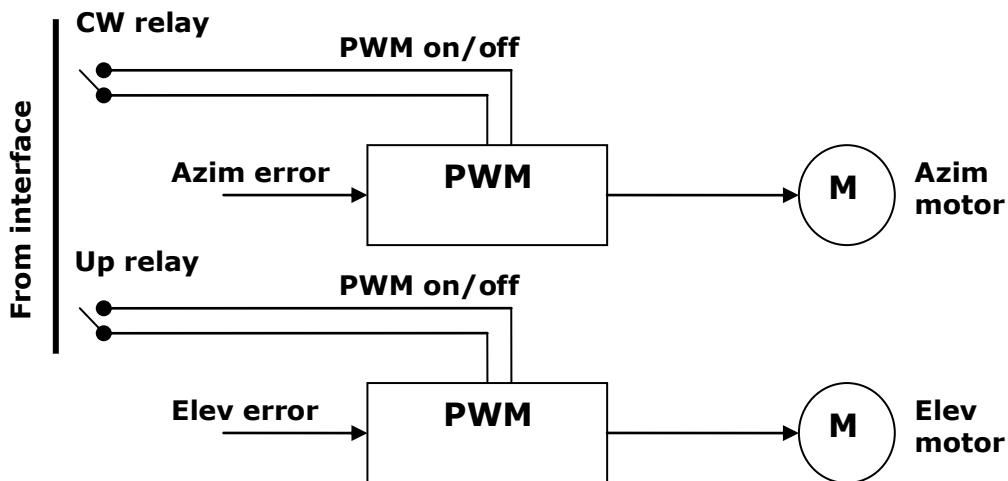
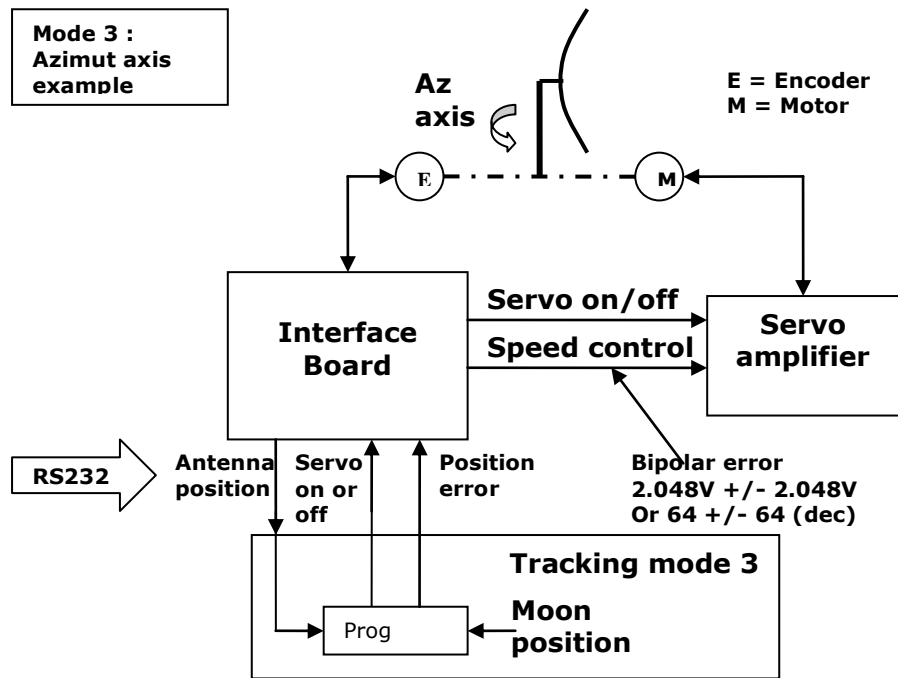


In automatic tracking, the speed is automatically adjustable according to the graphics above.

Compared to mode 2, Mode 3 in manual positioning (direction key), is a continuous mode. The drive is on. The error word is set to 64 because the antenna position is equal to the designation position. When the operator press an arrow key, tracking increases (or decreases, depends on the key) the error word and the antenna rotates to the next antenna position equal to previous position + angular increment set with the emesetup. If the operator maintains the key pressed the antenna rotates continuously. When the operator releases the key, the antenna stops. The angular increment is equal to :

$$\text{Start HysteresisValue} * 10 * \text{Man Speed}, \text{ that is to say } 0.4^\circ * 10 * 0.3 = 1.2^\circ.$$

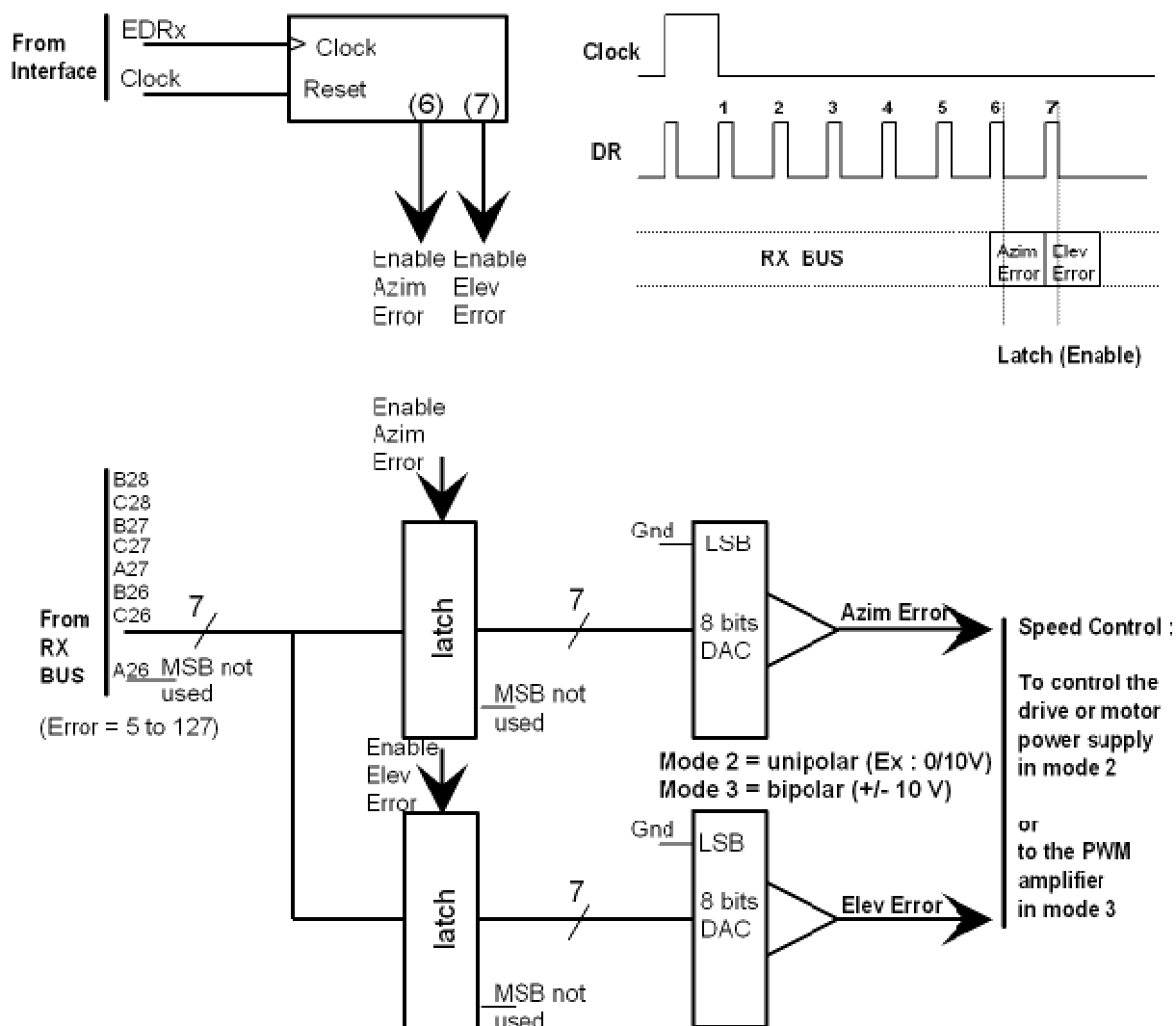
The increment is depending of the start value defined in the hysteresis setup.



4 Example to use the digital Rx bus interface

The RX bus is available on both, the previous F1EHN board and the new MK-EHN board.

TRACKING SPEED CONTROL Mode 2 or 3



5 Control of the tracking running

The tracking module includes a dedicated tab to help the operator in the control of the tracking system. The figure below shows this tab.

For both axes, the antenna position is the sum of the following values :

Antenna position = Encoder position + Offset value + Op adjustment + Angular correction

Speed is the error value between the antenna position and the source position in tracking mode (Tracking must be active and the value is depending on the mode of tracking (1 to 3). In mode 3, 64 means “no rotation”.

The filter value is not available at this moment, probably on a next coming version.

