A Beginner's Guide to Homing with the XPS

Introduction

Getting the XPS motion controller up and running can be a little overwhelming for the first time user. After learning how to communicate with it and getting acquainted with the web-based interface, you may find that a change from the default homing method better matches your application. This short tech note is written for those users who are new to the XPS and may need some help deciding what homing method to use, how to change it, and how it may affect subsequent motion.

Encoders

Before discussing homing methods, however, let's briefly look at encoders. Encoders provide the position feedback to the controller and fulfill two purposes. First, they are integral to maintaining the correct motion profile during the move. Second, an encoder tells the controller when the stage has arrived at the correct position so the motion can be stopped and the position held. It is important to realize that the encoder and controller don't stop working just because the stage has arrived at the target position. The feedback loop is still active in maintaining that position long after the motion has stopped.

The controller keeps track of a stage's relative position by incrementing or decrementing a counter based on information received from the encoder. This means that after a power-down sequence the controller loses all information about the location of the positioner. When the power is restored the controller usually resets the position counter to 0 for each positioner (not always, however. See section on Homing Methods below.). If a motion sequence is then initiated without homing first (not possible with the XPS controller), serious damage could occur if the positioner hits an obstruction set by the application. This is an important point and one we will return to later. To determine an absolute position, the controller must make reference to some physical mark, or "switch", located on the stage. This switch, called a "home" switch or "origin" switch, must be unique to the entire travel of the positioner. Sometimes the home process is aided by the presence of an index pulse, usually on the encoder itself. The home switch can be located at the middle of travel, or at one of the two ends of travel. Once the controller has found this home switch (with or without the index pulse), all subsequent motions can then be made by referencing to this home position. Thus, finding this home switch accurately is extremely important for absolute positioning applications.

Homing Methods

As mentioned earlier, the home position for a stage is a unique location somewhere over the course of travel. The stage will accurately go to this position when commanded to "home." Upon reaching the home position, the position counter on the controller resets to zero (actually, the counter resets to the HomePreset value taken from the stages.ini file, which has a default value of 0). This position is taken as the reference point for all subsequent movements. This could be in the middle of travel, the positive or negative limit (end of travel), or the stage's current position.

The default homing method depends on the stage or actuator. There are seven different homing methods available on the XPS, as shown in Figure 1 below. These methods are called the Home Search Sequence Type, and are explained in detail in the XPS manual, section 8.2.

```
;--- HOME
HomeSearchSequenceType =    ; MechanicalZeroAndIndexHomeSearch
                            ; MechanicalZeroHomeSearch
                            ; MinusEndOfRunAndIndexHomeSearch
                            ; MinusEndOfRunHomeSearch
                            ; PlusEndOfRunHomeSearch
                            ; IndexHomeSearch
                            ; CurrentPositionAsHome
HomeSearchMaximumVelocity =          ; units / second
HomeSearchMaximumAcceleration =      ; units / second²
HomeSearchTimeout =                  ; seconds
```

Fig. 1 – Home Search Sequence Types

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How to Determine the Current Home Search Sequence Type

The current home search sequence type (also called the "homing method") for a particular stage or actuator is found in the stages.ini file. To find it simply follow the steps below.

From the web-based interface, navigate to Stage, then Modify. Shown now is a screen, similar to the one shown below, listing all the stages that have ever been connected to your XPS controller.

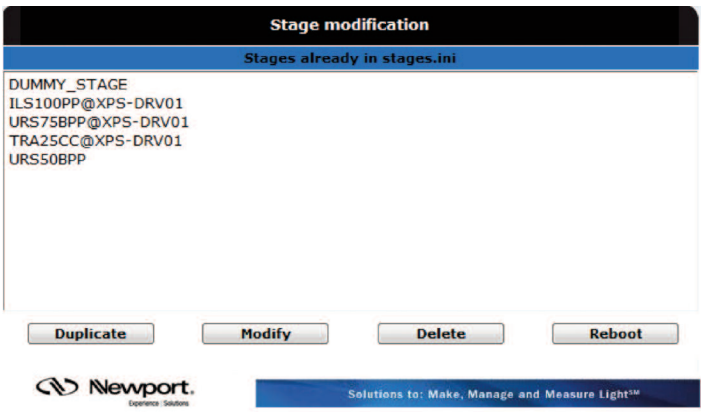
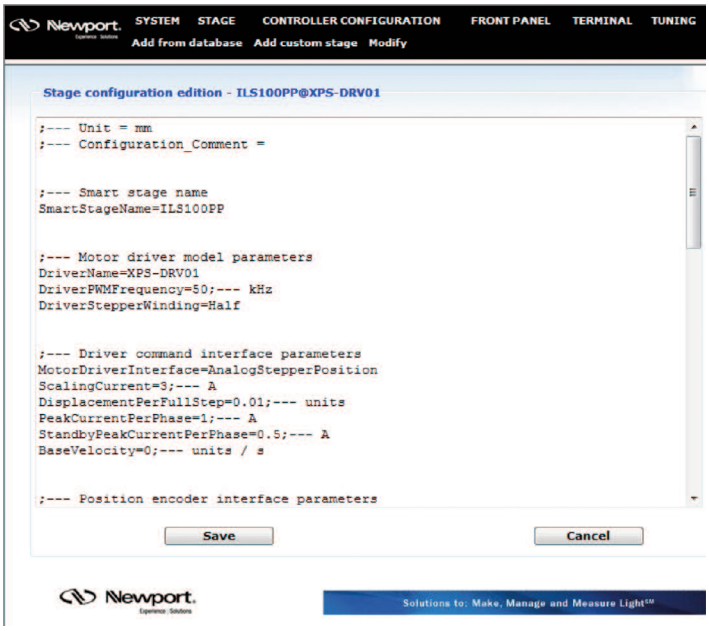
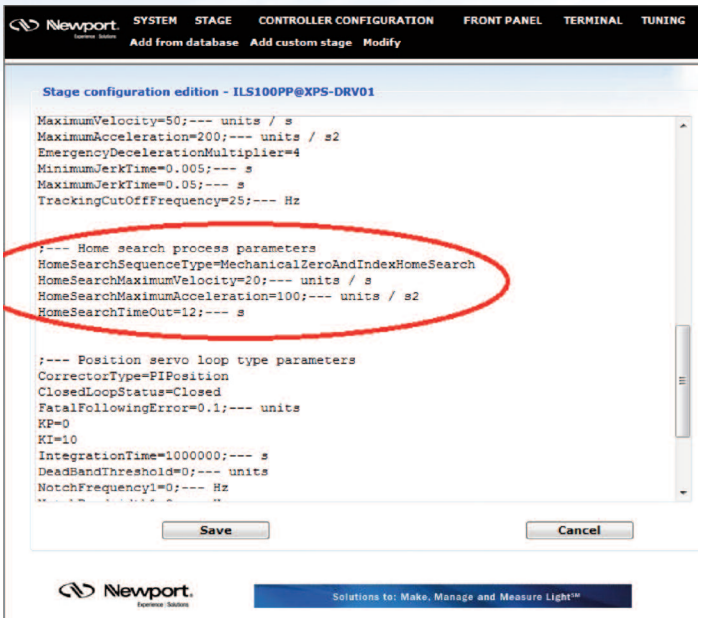


Fig. 2 – List of stages in the stages.ini file

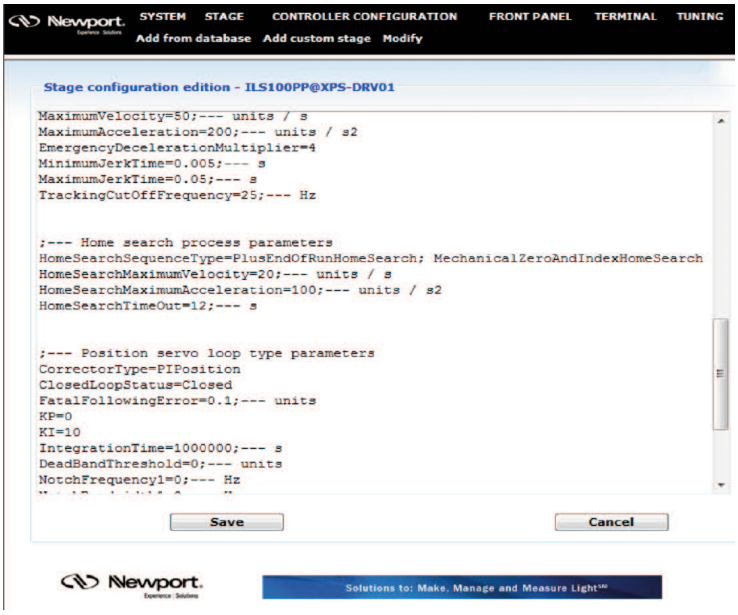
Select the stage of interest and then click on Modify. This will bring up the stages.ini file for that stage.



Scroll down to the section on homing.



This is the section where the home search method can be changed. The home search velocity, acceleration and time out period can also be changed here. In the above example, the ILS100PP stage is currently using the home search method MechanicalZeroAndIndexHomeSearch. If changing the homing method is required, simply delete the old method and type a new one. It is good practice, however, to keep the default method there, as a comment. Anything on a line that follows a semi-colon is ignored by the controller and treated as a comment. Simply put a semi-colon in front of the old method and type the new one. An example is shown below.



In this example the homing method was changed to PlusEndOfRunHomeSearch. Notice that the old homing method is still there, but is ignored as a comment. Care must be taken when entering a new homing method here. If something isn't typed exactly correct, then it will generate an error when rebooting. After clicking Save the earlier screen showing the list of stages (Fig. 2) will be displayed. The change will not be implemented until you reboot the controller. After rebooting, refresh the web interface and the positioner will now use the new homing method.

Which Homing Method is Best?

So what homing method should you choose? The most common home search method and the default method for most Newport stages is the MechanicalZeroAndIndexHomeSearch method. This highly accurate and repeatable homing method places the home position at the mid-point of the positioner's travel. By homing not only to the home switch, but then to the nearest index pulse, a high repeatability is ensured.

The best homing method to choose is sometimes dictated by the type of stage and at other times by the application. Not all homing methods are available to all stages. For example, if a stage or actuator does not have an encoder (common with stepper motor-driven stages), then it will also not have an index. Therefore, any homing method that uses an index pulse will generate an error. Many actuators do not have a dedicated home switch, so the default home position may be the negative limit switch (MinusEndOfRunHomeSearch).

At other times the choice of homing method may be completely application dependent. For example, if power is lost and then later restored, it might be necessary that the stage remains in its current position. In that case, change the homing method to CurrentPositionAsHome in the stages.ini file. This change will ensure that the stage will not move when initialized and homed. However, this introduces some new concerns and brings up an important point that is often overlooked by many users. That is the topic of software limits.

Software Limits

In the stages.ini file there are two parameters that define the software limits of the stage or actuator: MinimumTargetPosition and MaximumTargetPosition. The other important parameter for this discussion is HomePreset (see Figure 3). Taken together, these values control the travel range of the positioner. For example, on an ILS100PP stage the default values for Minimum Target Position and MaximumTargetPosition are -50 and +50, respectively. The HomeSearchMethod is MechanicalZeroAndIndexHomeSearch and the HomePreset value is 0. Since this stage has a 100 mm travel range, these values ensure that the stage will never hit the limit switches or the hard stops.

But consider if the homing method was set to CurrentPositionAsHome and the controller suddenly lost power at the +40 mm position. This would represent a potential problem. After Initialization and Homing of the stage, the physical position of the stage would still be at +40, but the position counter would be reset to 0. Unless the software limits were adjusted to take this into account, the stage would be allowed to run into the positive limit switch, disabling the stage and triggering an error message. Also, the controller would not utilize the stage's full negative travel range (only allowing the stage to move to the -10 mm position, while the counter reported a -50 mm position).

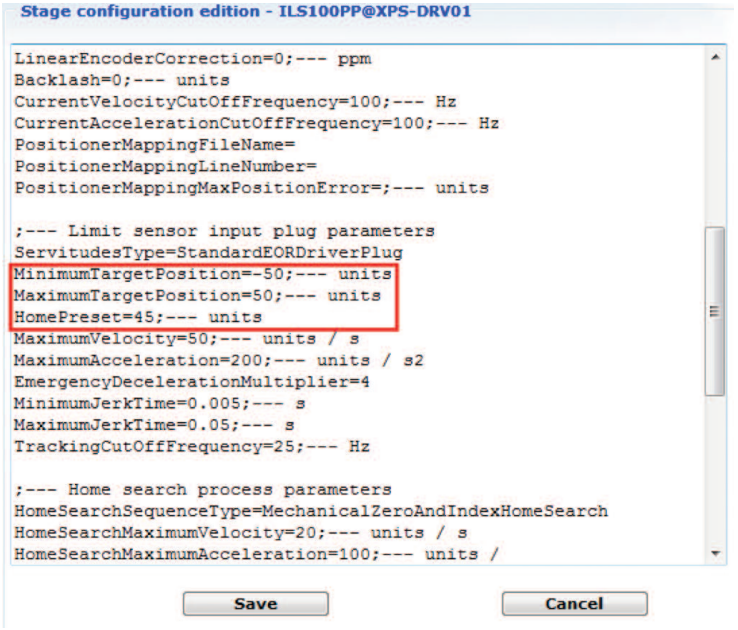


Fig. 3 – Software limits in Stages.ini file

In the above example, the user should change the MinimumTargetPosition and MaximumTargetPosition to -90 and +10, respectively, to ensure that the full travel of the stage will be allowed.

The HomePreset value determines what value the position counter will be set to after a homing sequence. So similar adjustments to the software limits need to be made when changing the HomePreset value. Using the above ILS100PP stage again as an example, if the home method is MechanicalZeroAndIndexHomeSearch and the HomePreset value has been changed to 40, then, after a homing sequence, the MinimumTargetPosition and MaximumTargetPosition values should be changed to -10 and +90 to coincide with the real, physical ends of travel of the stage.

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