Note: Ramp / Soak Controller for AF-600

This note illustrates the use of the logic controller in the AF-600 to replace external ramp/soak controllers. The variations are many, so to generalize this application note uses multiple setups or multi-step frequencies, one for each ramp/soak stage.

For ramp/soak stages with individual ramp times it is necessary to use multiple setups. This opens up for more flexibility in each stage, in this note it is the accel / decel times and setpoints only that is changed for each stage. The drive must first be configured for multi-setup and linked all setups to the same. So that the drive will be able to change ramp/soak stage while the motor is running. (For more information on Keypad Set-up Operations please refer to the AF-600 FP™ Programming Guide DET-620).

For each ramp/soak stage a minimum set of parameters must be determined for commissioning:
- Set *Configuration Mode* [H-40] to open loop.
- Set *Accel Time 1 / Decel Time 1* [F-07/F-8] for this ramp/soak stage.
- Set *Reference Function* [F-54] to Sum and *Multi-step Frequency* [C-05.0] for the frequency command in this stage.

Setting up the logic controller is a sequential state machine of events/actions, and a start/stop event of the loop. The sequence for the ramp/soak controller is shown in Figure 1: Ramp/soak sequence. The parameters of programming are described below. (For more information on Logic Controller please refer to the AF-600 FP™ Programming Guide DET-620).

After activating the ramp/soak controller there can be programmed a waiting stage, where the process commonly is drifting towards the ambient conditions. In this example that is done by coasting the motor for a preprogrammed time:
- Set *Logic Controller Event* [LC-51.0] to TRUE and *Logic Controller Action* [LC-52.0] to select set-up 1, this will prepare for ramp/soak stage 1 (defined in set-up 1)
- Set *Logic Controller Event* [LC-51.1] to TRUE and *Logic Controller Action* [LC-52.1] to start timer 0, this will execute the waiting stage.
- Set *Logic Controller Timer* [LC-20.0] to the expiration time of the waiting stage. In this example the timer is set to 4 sec.

The first ramp/soak stage is where the drive is started to regulate the process after drifting:
- Set *Logic Controller Event* [LC-51.2] to logic controller time-out 0 and *Logic Controller Action* [LC-52.2] to run, this will begin the ramp/soak stage 1 after the waiting stage expired.
- Set *Logic Controller Event* [LC-51.3] to on reference and *Logic Controller Action* [LC-52.3] to start timer 1,
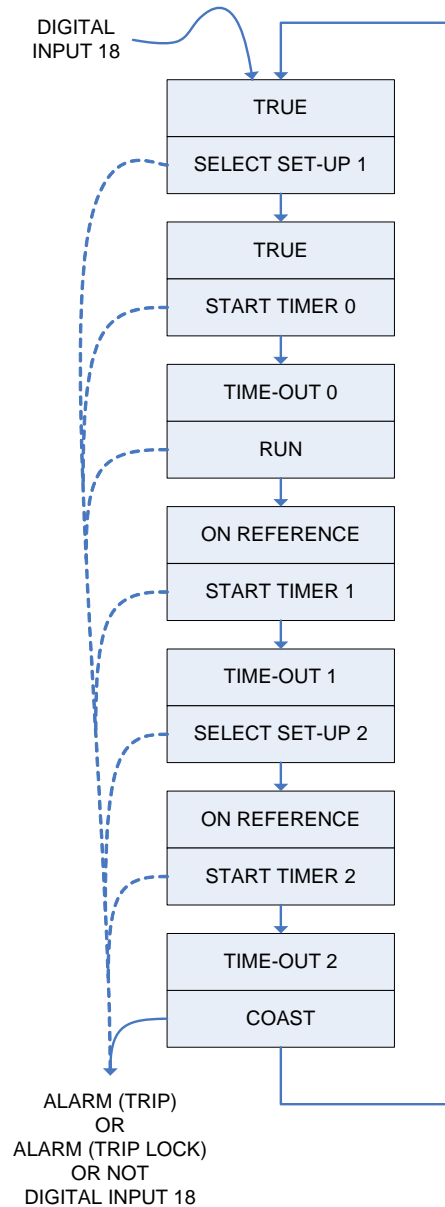

Figure 1: Ramp/soak sequence

this will ramp the process to setpoint of the stage and execute the soaking time.
- Set *Logic Controller Timer* [LC-20.1] to the expiration time of the ramp/soaking stage. In this example the timer is set to 20 sec.

Any additional ramp/soak stages are consisting of a set-up shift as preparation for the stageand a timer for the soaking, the ramp to the setpoint will then automatically occur:
- Set *Logic Controller Event* [LC-51.4] to logic controller time-out 1 and *Logic Controller Action* [LC-52.3] to select set-up 2, this will prepare for ramp/soak stage 2 (defined in set-up 2).
- Set *Logic Controller Event* [LC-51.5] to on reference and *Logic Controller Action* [LC-52.5] to start timer 2, this will ramp the process to setpoint of the stage and execute the soaking time.
- Set *Logic Controller Timer* [LC-20.2] to the expiration time of the ramp/soaking stage. In this example the timer is set to 60 sec.
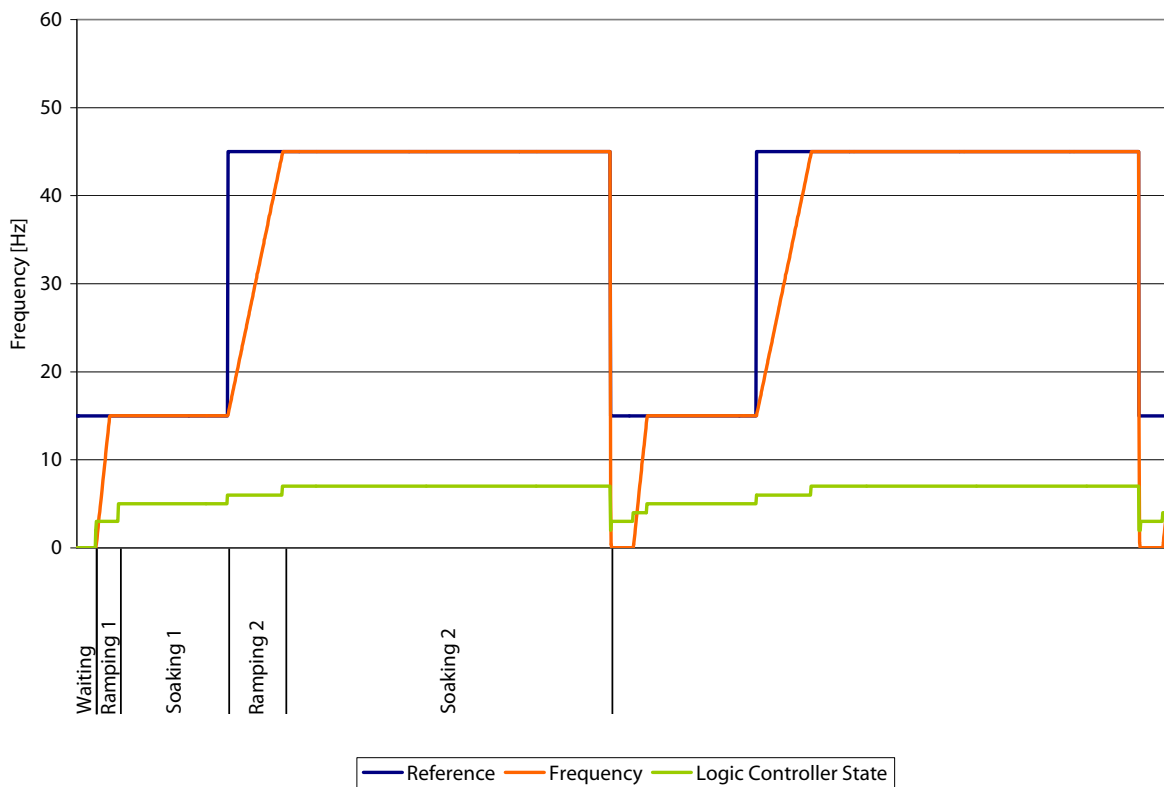

Figure 2: Ramp/soak sequence in function

The start and stop events is in this example determined by a digital input. It can be desired to stop with the sequence in case of an alarm, so a logic rule is implemented for the stop event.
- Set *Logic Controller Mode* [LC-00] to on that will activate the logic controller.
- Set *Start Event* [LC-01] to digital input DI18.
- Set *Stop Event* [LC-02] to logic rule 0.
The logic rule for the stop event takes three Boolean arguments.
- Set *Logic Rule Boolean 1* [LC-40.0] to alarm (trip).
- Set *Logic Rule Operator 1* [LC-41.0] to OR.
- Set *Logic Rule Boolean 2* [LC-42.0] to alarm (trip lock).
- Set *Logic Rule Operator 2* [LC-43.0] to OR NOT.
- Set *Logic Rule Boolean 3* [LC-44.0] to digital input DI18.

If multi-step frequencies are used alone with a common accel / decel profile in all ramp/soak stages. Simplifications can be done by replacing the select set-up actions with select preset ref and enter the setpoints in Multi-step Frequency [C-05]. E.g. Logic Controller Action [LC-52.3] to select preset ref 2, and enter the setpoint into C-05.2.

If coasting to stop is used for the waiting stage it is advisable to catch the motor which can be spinning freely depending on the time intervals and the system inertia. It is recommended to set a few parameters to optimize the search time for the motor speed.

- Set parameter *Start Mode* [H-09] to enable.
- Set *Reverse Lock* [H-08] to clockwise, if reverse operation is not required, to minimize the search time.
- Set *Max Output Frequency 1* [F-03] to minimize the search time, since the search will begin from this frequency and towards zero. E.g. if the application is not meant to run faster than 60Hz, it is recommended to set F-03 to 60Hz.
- Optimize *DC Brake Current* [B-01] and *DC Braking Time* [B-02] for the case that the frequency is not found, the drive will produce a DC injection for holding the shaft at standstill.