![Fuji Electric logo](e-Front runners)

APPLICATION NOTE	AN-Mega-0006v104EN
Pump / compressor Duty Cycle control function with FRENIC MEGA	

Inverter type	FRENIC MEGA
Software version	1000 or later
Required options	Not required
Related documentation	MEGA UM MEH278a, INR-SI47-1359-E
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Use	Public, Web
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Version	1.0.4
Languages	English

Introduction.

FRENIC MEGA inverter does have the basic functionalities in order to control a pump/compressor in a pressure control system. It means that the inverter can perform a pressure control by means of its PID control (if the PID feedback is connected to a pressure transducer).

In addition, this inverter can perform some advanced functions as:

- Sleep Function: this function stops the pump/compressor when it has been rotating under certain speed level during certain specified time. If the speed level is set under the minimum working frequency of the pump/compressor, this function can be very useful to stop the pump/compressor due to a slow flow rate demand. Related parameters: J15 and J16
- Wake-up Function: this function starts up the pump/compressor again (after a stop due to Sleep Function) when the PID Manipulated value rises above certain level. It can be useful to start-up the pump/compressor once the flow demand is big enough to make the pump/compressor work within its working speed range. Related Parameter: J17

Sometimes, certain type of pumps/compressors need a waiting time to start-up again, once they have been stopped. It means that has to be possible to configure a period of waiting time between the "Sleep Function" and the "Wake-up Function". By means of the Customizable Logic, it's possible to build a logic circuit to avoid the pump/compressor to restart until certain waiting time after the pump's stop. This behaviour can enlarge the life of these pumps/compressors.

The aim of this document is to explain how to configure the FRENIC MEGA Customizable Logic, so the inverter will be able to wait a defined time and then

restart the pump/compressor. As this behaviour is a physical necessity of some pumps/compressors, the set-up described in this paper will apply the waiting time if the pump/compressor stops due to the "Sleep Function" and if the run command is removed.

Application Implementation.

The inverter's behaviour, in order to perform properly the intended function should be:

- After starting, the inverter must control the pump/compressor speed properly, according to the pump/compressor control system working point.
- If, due to the flow demand characteristics, the pump/compressor stops (Sleep Function), the inverter must wait a defined period of time to start-up the pump/compressor again, even if the system pressure decreases or if the RUN command is removed and given again whilst the PID is in stop state (sleep for slow flowrate mode).
- If the RUN command is removed, the inverter must wait the same time that the one explained above, regardless of the PID state.
- If, during the waiting time, the pump/compressor has to be started manually, a signal (assigned to X1 in this example) can be activated to force the start-up and cancel the waiting time.
- If the same signal keeps activated during all the time, the waiting time will be disabled.

Customizable Logic Set-up.

Using inverter's customizable logic, it's possible to design a logic circuit with the characteristics requested. The logic circuit that has been implemented is depicted in Figure 1:
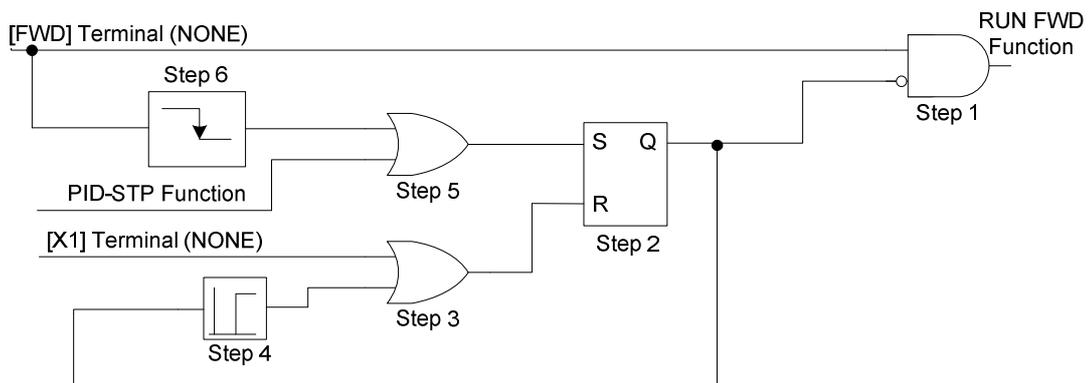

Figure 1: Logic Circuit designed

This logic circuit is based in the use of a reset priority flip-flop (Step 2 in the picture, available in FRENIC MEGA Customizable Logic), that will decide if the RUN command is given by means of the [FWD] terminal.

The "Set" terminal of the flip-flop (Input 1 of Step 2) will come from a logic gate "OR" between the PID-STOP signal and a falling edge trigger from the FWD terminal. This signal means the beginning of the "waiting time" and will set the flip-flop output, so the inverter RUN command will be disabled.

The flip-flop "Reset" input will be given by means of a logic gate "OR" between the [X1] terminal and an "On-Delay" of the flip-flop output. This means that the flip-flop output will be reset if [X1] input is activated or some time after the output was set to 1, activating the RUN command (if the FWD terminal signal is kept activated).

As the flip-flop has been defined as "Reset Priority", the [X1] terminal can be used as a "Cancel" signal, and will disable the Waiting Time if it's activated.

Following, the process to set up properly this logic circuit is explained:

- First of all, set E01 and E98 to 100. It will assign to [X1] and [FWD] terminals the "No Use" function, and these signals will be only an input to Customizable Logic, without any other function assigned.
- To configure Step 1, set the following parameters:
  - U01 = 4010, the Input 1 of Step 1 is the FWD terminal
  - U02 = 3002, the Input 2 of Step 1 is the inverse of the Step 2 output.
  - U03 = 2, Step 1 is an "AND" logic gate
- To configure Step 2, set the following parameters:
  - U06 = 2005, the Input 1 of Step 2 is the Step 5 output
  - U07 = 2003, the Input 2 of Step 2 is the Step 3 output
  - U08 = 6, Step 2 is defined as a "Reset priority flip-flop" with its Input 1 as "Set" and Input 2 as "Reset"
- In order to set up Step 3, please change the following parameters:
  - U11 = 4001, Input 1 of Step 3 as [X1] terminal
  - U12 = 2004, Input 2 of Step 3 is the Step 4 output
  - U13 = 3, Step 3 is an "OR" logic gate
- Parameters related to Step 4:
  - U16 = 2002, Input 1 of Step 4 is Step 2 output
  - U18 = 1, Step 4 is "Through Output"
  - U19 = 1, Step 4 Timer is an "On-Delay" logic circuit
  - U20 = 10.00, the Step 4 Delay Time is 10 seconds
- Parameters related to Step 5:
  - U21 = 44, Input 1 of Step 5 is "PID-STOP" inverter's function
  - U22 = 2006, Input 2 of Step 5 is Step 6 Output
  - U23 = 3, Step 5 is an "OR" logic gate
- Parameters related to Step 6:
  - U26 = 4010, Input 1 of Step 6 is the [FWD] terminal
  - U28 = 8, Step 6 as "Falling Edge" detector

- Once the logic circuit has properly set, it's time to choose what will be the output of the designed logic circuit. It's possible to configure up to 5 outputs, by means of the function codes from U71 to U75. To use Step 1 Output as Customizable Logic output 1, please set U71 = 1
- When the Customizable Logic outputs have been decided, we can choose which function will have each one of these outputs by means of the function codes from U81 to U85. In this case, we will set Customizable Logic Output 1 as RUN Command (FWD), selecting U81=98.
- Finally, set U00 = 1, in order to enable the Customizable Logic.

Control Schematics.

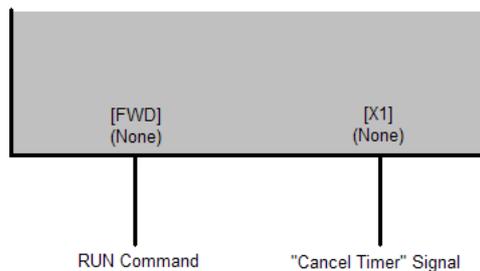Following, the wiring of the Control Terminals to use the setup described in this document is:

Figure 2: Control Schematics

Obtained Results.

The following figures are intended to show the behaviour of the circuit designed with the Customizable Logic. In figure 3, it's possible to see how the inverter behaves, after a stop due to Sleep Function. In this way, the inverter will wait until the end of the waiting time and, then, it will decide if the manipulated value level is enough to start-up the pump/compressor again.
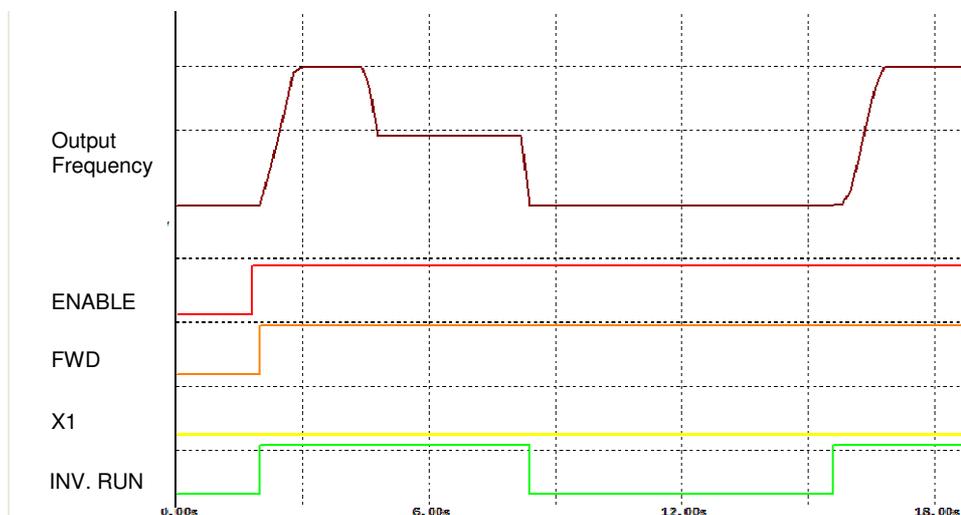

Figure 3: Sleep Function Stop. Wake-up due to high flow demand

In Figure 4, can be seen how the "Cancel Waiting Time" Signal behaves (assigned to [X1]). When it is activated, the signal will cancel the waiting time, and the inverter will start up the pump/compressor if the manipulated value increases above the level in J17.
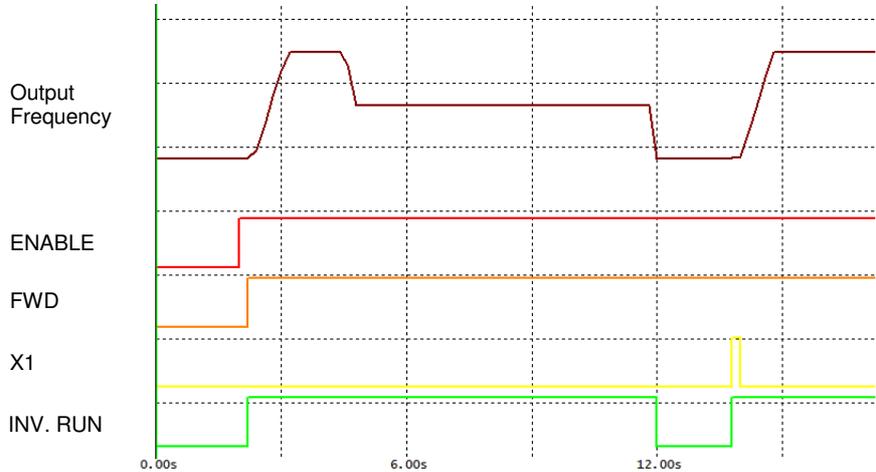

Figure 4: Sleep Function Stop. Wake-up due to "Cancel Waiting Time" signal

As explained before, the system will wait as well although the RUN Command is removed in FWD input (Figures 5 and 6).
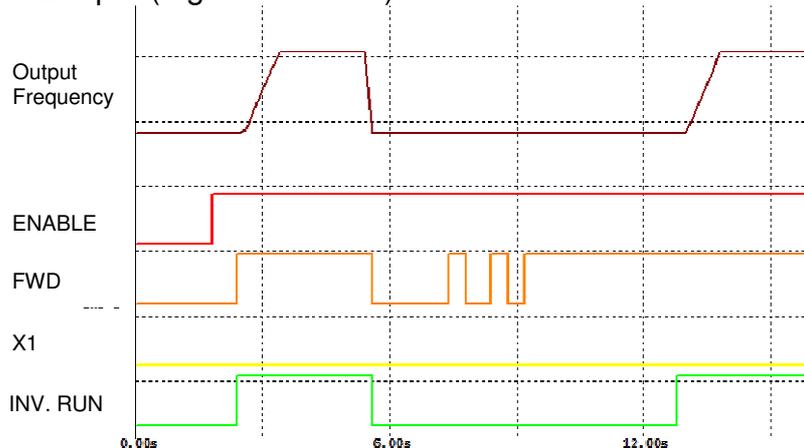

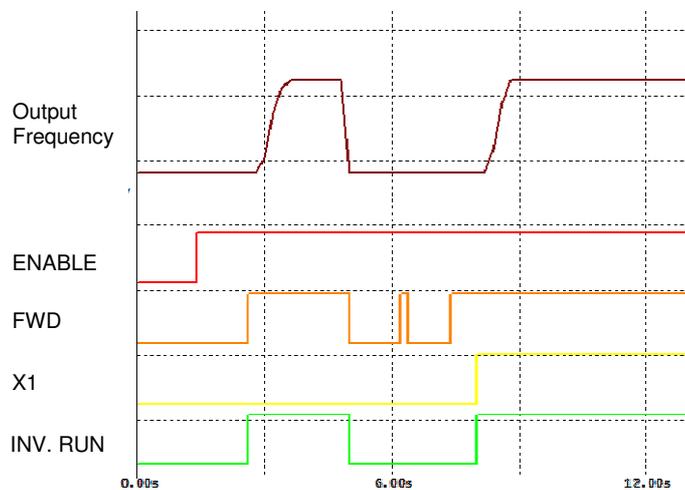*Figure 5: RUN Command removed (FWD input). Wake-up due to flow demand*

Figure 6: RUN Command removed (FWD input). Wake-up due to "Cancel Waiting Time" signal

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Inverter set up.

The following table describes the function settings that are important to set up the FRENIC MEGA inverter (different from default):

Function	Value	Description
U00	1: Enable	Customizable Logic (Mode Selection)
U01	4010: FWD	Customizable Logic Step 1 (Input 1)
U02	3002: Step 2 Output (Neg)	Customizable Logic Step 1 (Input 2)
U03	2: AND	Customizable Logic Step 1 (Logic Circuit)
U06	2005: Step 5 Output	Customizable Logic Step 2 (Input 1)
U07	2003: Step 3 Output	Customizable Logic Step 2 (Input 2)
U08	6: Reset priority flip-flop	Customizable Logic Step 2 (Logic Circuit)
U11	4001: X1	Customizable Logic Step 3 (Input 1)
U12	2004: Step 4 Output	Customizable Logic Step 3 (Input 2)
U13	3: OR	Customizable Logic Step 3 (Logic Circuit)
U16	2002: Step 2 Output	Customizable Logic Step 4 (Input 1)
U18	1: Through Output	Customizable Logic Step 4 (Logic Circuit)
U19	1: On-Delay Timer	Customizable Logic Step 4 (Type of Timer)
U20	10.0 s	Customizable Logic Step 4 (Timer) Time ADJUSTABLE by the USER depending on the Customer requirements (0.0s to 600.0s)
U21	44: PID_STOP	Customizable Logic Step 5 (Input 1)
U22	2006: Step 6 Output	Customizable Logic Step 5 (Input 2)
U23	3: OR	Customizable Logic Step 5 (Logic Circuit)
U26	4010: FWD	Customizable Logic Step 6 (Input 1)
U28	8: Falling edge detection	Customizable Logic Step 6 (logic Circuit)
U71	1: Step 1 Output	Customizable Logic Output Signal 1 (Output Selection)
U81	98: FWD	Customizable Logic Output Signal 1 (Function Selection)
J01	1: Enable	PID Control (Mode Selection)
J15	26.0 Hz	PID Control (Stop Frequency for slow Flowrate)
J16	5.0 s	PID Control (Slow Flowrate Level stop latency)
J17	30.0 Hz	PID Control (Starting Frequency)
E01	100 (No use)	Terminal [X1] Function
E98	100 (No use)	Terminal [FWD]

Notes:

- The Starting Frequency (J17) must be bigger than the stop frequency for Sleep Function (J15)
- The parameters of the PID Control (P Gain - J03, Integral Time - J04, and Differential Time - J05) must be properly set, in order to get the desired application's behaviour.

Conclusion

Using FRENIC MEGA Customizable Logic it is possible to adapt the inverter behavior, adding certain functions, to make the inverter more suitable for certain applications.

In this document it has been demonstrated that the Customizable Logic can be useful to adapt FRENIC MEGA to pump/compressor control systems. Actually, a new function has been implemented using Customizable Logic that can be used when the inverter is driving a pump/compressor that require a waiting time after each stop.

Document history.

Version	Changes applied	Date	Written	Checked	Approved
1.0.0	Draft	23/03/2009	JM Ibáñez	J. Català	
1.0.1	Some text corrections	23/03/2009	J. Català		
1.0.2	Some text corrections. Logic circuit modified. Control Schematics added	23/03/2009	JM Ibáñez	J. Català	
1.0.3	Logic Circuit Corrected	24/03/2009	JM Ibáñez	J. Català	
1.0.4	Text corrections	06/04/2009	JM Ibáñez	J. Català	D. Bedford