

FRENIC MEGA in Injection Moulding Machine's applications

| | |
|------------------------------|----------------------------------|
| 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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| Approved | David Bedford |
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| Version | 1.0.2 |
| Languages | English |

Introduction.

The aim of this document is to explain how to configure FRENIC MEGA inverters, in order to drive the motor of an injection moulding machine.

The idea is to use a FRENIC MEGA inverter to make a retrofitting of the injection moulding machine. There is a type of injection moulding machine that is called hydraulic machine. These machines use, normally, an electrical motor to drive one or some hydraulic pumps that provide the needed power to the system.

Without an inverter, the pumps are rotating always at the speed imposed by the commercial power supply. Then, the machine adapts the output of some of the proportional valves (normally, one for each main movement) to get the required oil flow. The rest of the flow is returned to the tank.

On the other hand, if the machine is using an inverter to drive the motor, is possible to adapt the speed of the pumps in order to get less oil flow (when required) and, consequently, to reduce the energy losses due to the oil returned to the tank.

In addition, the solution proposed must accomplish certain requirements:

- The use of an inverter cannot extend the machine cycle's time.
- The inverter must accelerate the motor fast enough, in order to avoid alarm trips in the injection machine. It demands a big inverter overload capacity.
- The minimum output frequency of the inverter must be set thinking about the motor refrigeration (normally this type of machines use self-ventilated motors).
- The inverter has to adapt its output, to fulfil the machine's flow demand. Therefore the system must be as automatic and simple as possible.

Application Implementation.

The injection moulding machine modified in this case is:

Machine data:

- Type: Hydraulic machine

Motor data:

- Rated Capacity: 75 kW
- Rated Current: 146 A
- Rated Speed: 1460 rpm
- Cos phi: 0,86
- Rated Voltage: 380 V.

Pumps:

- Pump 1: RKP 80 → 116 l/min; 230 bar; variable flow
- Pump 2: IPH 80 → 116 l/min; 230 bar; constant flow
- Pump 3: IPH 40 → 58 l/min; 230 bar; constant flow

All the pumps are driven by the main motor, and all the pumps can work at the same time and for all of the hydraulic movements (depending on the machine set-up).

Average Cycle time (with the tested mould): 57'7 seconds

Inverter proposed:

- FRN75G1E-4E (used in HD mode)

The solution proposed is based in the analog frequency command, connected to terminal [12]. This command is obtained from the machine's PLC, and it is the command signal from this PLC to the proportional valve. So, this signal can be useful to estimate the machine's flow demand.

However, in the tested machine where this solution was proposed, not all the machine's movements are controlled by means of this proportional valve. Therefore, Multi-Step Frequency command function is used also to apply certain speed levels at certain moments, in order to supply an accurate oil flow during the working cycle. In this test, the proportional valve was not active during "plastication" time, but this is the most demanding movement. Figure 1 shows the control signals connection diagram.

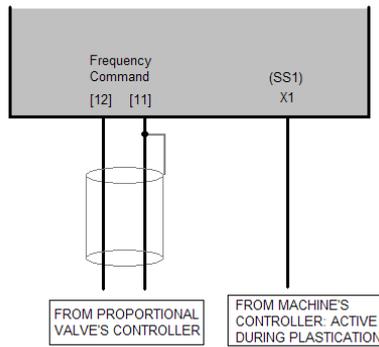


Figure 1: Control Signals connection diagram

Adjusting analog Input

Once we get this signal from the machine's PLC, we have to adapt the Command Frequency, in order to obtain an appropriate inverter response. It can be done by means of F18, C32, C50 and C34:

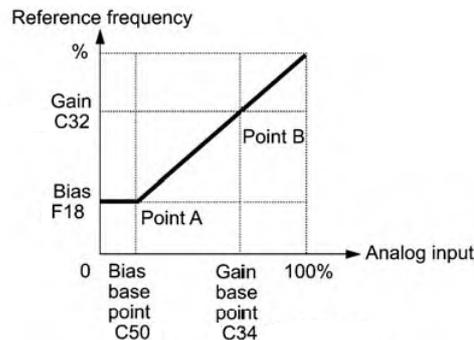


Figure 2: Frequency Command Bias and Gain

The set-up of these parameters can be done as follows:

- C35 = 1, this parameter sets the polarity of the signal. When its value is 1, it means a unipolar signal (0 to + 10 V DC)
- Set F18 as the minimum frequency. In this example, 66.6% (30 Hz)
- Set C50 as the level of the analog signal that's produced when the machine is not active (but with the pumps activated). In this example 20.0 % (2 V).
- Set C32 as the maximum output frequency. In this example, 100.0 % (50 Hz)
- Set C34 with the level of the analog input in the most demanding process. In this example, this moment was while closing the mould, and the value set was 62 % (6.2 V)

Setting Multi-Step Frequency and the ramps used.

The Multi-Step Frequency command has a higher priority than the analog input signal when any of SS1, SS2, SS4 or SS8 is activated. Therefore, to get this behaviour we only need to set F01 = 1 and (voltage input to terminal [12] as analog frequency command), E01 = 0 (by default, digital input X1 as SS1) and C05 = 50 Hz (Multi-Step Frequency 1 as 50 Hz).

Concerning acceleration and deceleration times, the machine needs a quick response during the working cycle, but these short times are not required when the machine is starting up (when the motor starts from speed zero till certain level). To reproduce this behaviour, the FDT function and the Customizable Logic are used. In this way, it is possible to change from the acceleration and deceleration times in F07 / F08 to the ones in E10 / E11. By means of the Customizable Logic, is intended to apply the following logic circuit:

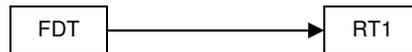


Figure 2: Connection of FDT and Selection of ACC/DEC Time

The necessary parameter modification to apply the schematic above is:

- U00=1, in order to enable the Customizable Logic in FRENIC MEGA
- U01=2, to assign the FDT as the Customizable Logic Step1, Input 1
- U02=2, to assign the FDT as the Customizable Logic Step1, Input 2
- U03=1, to set the Input Logic Step 1 as a “Through Output”, that means that the output will be equal to the input
- U04=0, to set no timer at the output of the Step 1
- U71=1, to assign the output of the Step 1 to one of the five outputs of the Customizable Logic.
- U81=4 (RT1), to use the Output 1 of the Customizable Logic to change between the acceleration / deceleration times in F07 / F08 and the ones in E10 / E11

Inverter set up.

The following table describes the function settings that are important to set up the FRENIC MEGA inverter:

| Function | Value | Description |
|----------|---------|---|
| F01 | 1 | Voltage input to terminal [12] (-10 to +10 VDC) |
| F02 | 1 | Terminal command |
| F05 | 380.0 V | Rated Voltage at Base Frequency 1 |
| F07 | 2.0 s | Acceleration time 1 |
| F08 | 2.0 s | Deceleration time 1 |
| F14 | 4 | Restart Mode after Momentary Power Failure |
| F16 | 30.0 Hz | Frequency limiter low |
| F18 | 66.6 % | Bias (Frequency Command 1) |
| F42 | 1 | Drive Control Selection 1 (Dynamic Torque Vector) |
| F44 | 200 % | Current Limiter (Level) |
| E01 | 0: SS1 | Digital input X1 programmed to SS1 |
| E10 | 0.50 s | Acceleration Time 2 |
| E11 | 1.00 s | Deceleration Time 2 |
| E24 | 2: FDT | Frequency (speed) Detected |
| E31 | 20.0 Hz | Frequency detection 1 LEVEL |
| C32 | 100.0 % | Analog Input Adjustment for [12]: GAIN |

| | | |
|-----|-------------------|---|
| C34 | 62.00 % | Analog Input Adjustment for [12]: GAIN BASE POINT |
| C35 | 1 | Analog Input Adjustment for [12]: POLARITY (unipolar) |
| C50 | 20.00 % | Bias (Freq. Command 1): BIAS BASE POINT |
| H69 | 5 | Automatic Deceleration (Mode selection): DC link bus voltage control with Force-to-stop disabled. |
| U00 | 1: Enable | Customizable Logic (Mode Selection) |
| U01 | 2: FDT | Customizable Logic Step 1 (Input 1) |
| U02 | 2: FDT | Customizable Logic Step 1 (Input 2) |
| U03 | 1: Through Output | Customizable Logic Step 1 (Logic) Circuit |
| U04 | 0: No Timer | Customizable Logic Step 1 (Type of Timer) |
| U05 | 0.00 | Customizable Logic Step 1 (Timer) |
| U71 | 1: Step 1 Output | Customizable Logic Output Signal 1 (Output Selection) |
| U81 | 4: RT1 | Customizable Logic Output Signal 1 (Function Selection) |

Conclusion

Some capabilities of FRENIC-MEGA can be used in order to succeed in some applications such as the one described in this application note. Apart from the overload capability widely used in this application (during some steps the inverter reaches 190% output current) the customizable logic is used for making the inverter acceleration/deceleration faster in some cases.

Document history.

| Version | Changes applied | Date | Written | Checked | Approved |
|---------|---------------------------------|------------|-----------|-----------|------------|
| 1.0.0 | Draft | 25/02/2009 | JM Ibáñez | J. Català | |
| 1.0.1 | Some changes are done, spelling | 2/03/2009 | J. Català | | |
| 1.0.2 | Control Schematic Added | 2/03/2009 | JM Ibáñez | J. Català | D. Bedford |