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Operation with more than one motor (multi motor)

MICROMASTER 4

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1 Essentials to multiple motors

- It is possible, but not recommended, to connect or disconnect any of the motors while the inverter is running
  - The inrush current may cause the inverter to trip.
  - When the motor is disconnected high voltages may be generated which may damage the inverter
- V/f operating mode (P1300 = 0) should be used.
  - SVC (sensor less vector control) is not possible.
  - VC (vector control) encoder operation is only possible to a limited extent.
- The sum of the motor currents should be less than the inverter output current.
- The stator resistance should be set to that of the total motor resistance for all the motors in parallel (P0350).
- The motor current (P0305) and power (P0307) should be set to the total value of all the motors.
- The motor protection function provided in the frequency inverter cannot be used for multi-motor operation. We recommend that a specific overload protection is provided for each motor:
  - One PTC or KTY84 + one evaluation unit 1) + one contactor per motor
  - Or connect PTCs in series + one evaluation unit 2) --> at a digital input of the frequency inverter = "External fault" (P0701…P0708 = 29).
- The total cable length should not exceed that recommended for the inverter.
- An output choke can also be used to reduce heating in the protection devices, and therefore preventing overheating and premature tripping of the devices.

NOTE Hinweise zum Motorschutz in Kapitel 4

2 Control mode variation

It is possible to run multiple motors in two different control modes:

V/f control when load is not mechanical coupled

The V/f control is the typical option when multiple motors should turn with the same frequency. We can use it, when there is no high demand to the speed accuracy. The inverter gives the frequency setpoint and depending on the load the motors setting their slippage. Also depending from the application it is possible to switch on and off single motors during running mode.

Vector control with sensor when load is mechanical coupled

When using vector control with sensor you have to define one motor as a master motor with sensor. The encoder signal controls the master inverter. According to the mechanical coupled load the other motors take part at the whole torque.

Vector control without sensor does not make sense, because the exactness of the rotation speed measurement depends on the parametrization of the motor data. And in this case we do this for all motors together.

At vector control it is not possible to switch on or off single motors during running mode, because the Control Unit needs an exact motor model. The only possibility is to use the Drive Data Set selection (DDS, p820, p821). In this case you have to do the commissioning of the single DDS in several parts. The DDS however can only be switched in “ready to run” condition. To switch the DDS during the operation mode is not possible.

Note

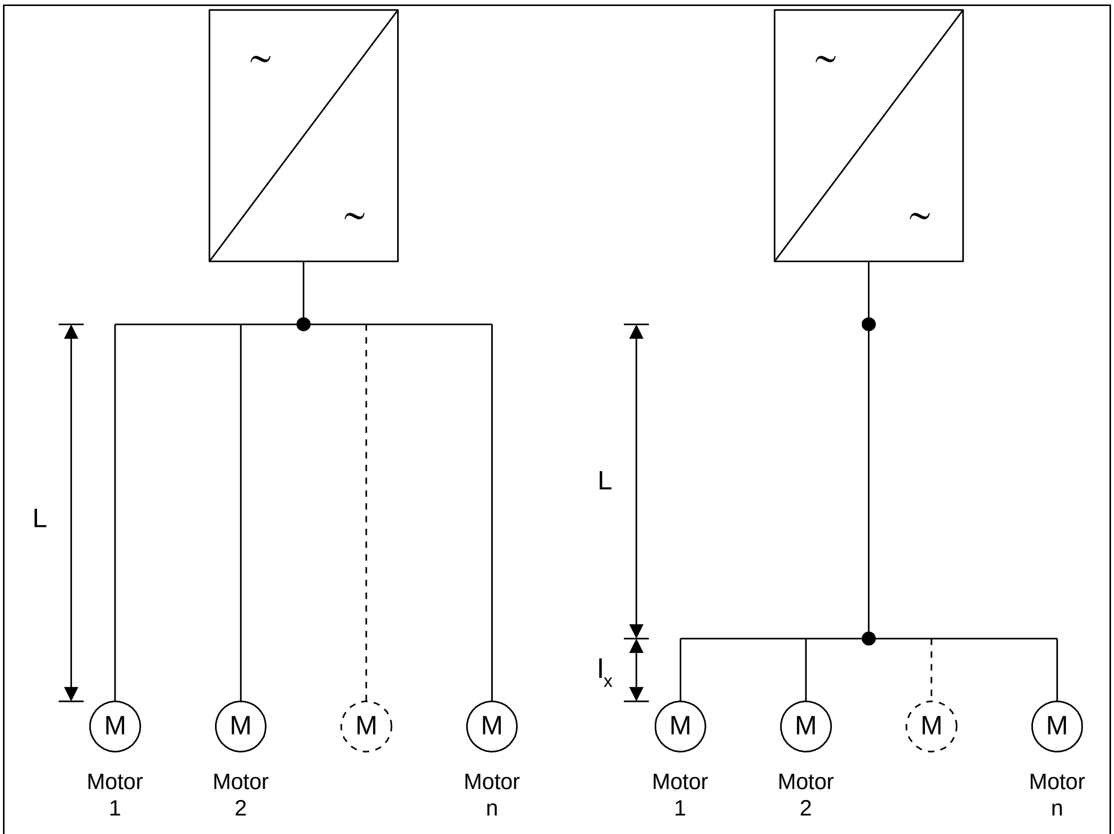
- The sum of all motor currents needs to be less than the inverter output current.
- The stator resistance (p0350) needs to be set to that of the total motor resistance for all the motors in parallel.
- The motor current (p305) and power (p307) needs to be set to the sum value of all motors
- When using different sizes of motors, it is necessary to parametrize the arithmetic mean of cos phi
- For V/f control as well as for vector control it is necessary to do a motor data identification routine.

3 Motor cable lengths

The sum of the individual motor cable lengths must be less than or equal to the maximum permissible motor cable length of the frequency inverter (refer to Catalog DA51.2).

In order to reduce the cable length, a cable can be routed close to the motor, and from there shorter cables are distributed to the individual motors.

Fig.2: Determining the complete cable lengths



$L_{gesamt} = L_1 + L_2 + ...L_n$

$L_{gesamt} = L + l_1 + l_2 + ...l_n$

4 Overload protection and dimensioning of switching devices

Overload protection

The motor protection function provided in the frequency inverter cannot be used for multi-motor operation. We recommend that a specific overload protection is provided for each motor. It is necessary to deactivate the internal motor protection (p601). The motor protection can be affected for a single motor or for a group of motors.

A motor manufacturer generally uses a separate sensor for each motor winding. The sensors are then already connected internally in series. There is a special version 3RN1062 for multi-motor monitoring. This permits up to 6 sensor circuits – i.e. also 3 sensor elements in series. An additional advantage is due to the fact that not only can all motors be shut down, but using LEDs, the motor whose sensor responded can be identified (i.e. the motor that is too hot). This simplifies troubleshooting.

Overload protection for every single motor

For every single motor you need a PTC or a KTY84 plus a SIRIUS evaluation unit plus one contactor per motor.

Overload protection for a group of motors

For a group of motors you need to connect several PTC’s in series with one SIRIUS evaluation unit per motor group. The digital output of the evaluation unit needs to connect with a digital input of inverter (e.g. external fault, p0701…p0708). We recommend the SIRIUS 3RN1062. This unit has 6 sensor circuits – i. e. also 3 sensor circuits in series are possible. With this variant all motors will be shut down and the motor which is faulty will be identified via LED. This simplifies troubleshooting.

Note

The PTC may be used in conjunction with 3RN1 evaluation units.

For PTC evaluation units, the series circuit is (limited) possible, as long as the total resistance in the measuring circuit lies below the response value of the 3RN1 unit. Normally, this is a maximum of 6 sensors in series. Additional evaluation units are required for more than 6 sensors. The units are then switched-out using the auxiliary contacts.

NOTE

The KTY84 can be used in conjunction with 3RS104 or 3RS204 evaluation units. It is not permissible to connect several KTY84 devices in series (nor parallel) and use these together with a 3RS104 or 3RS204 unit; the reason for this is that this would result in completely incorrect measurement results.

5 Description on the basis of an example

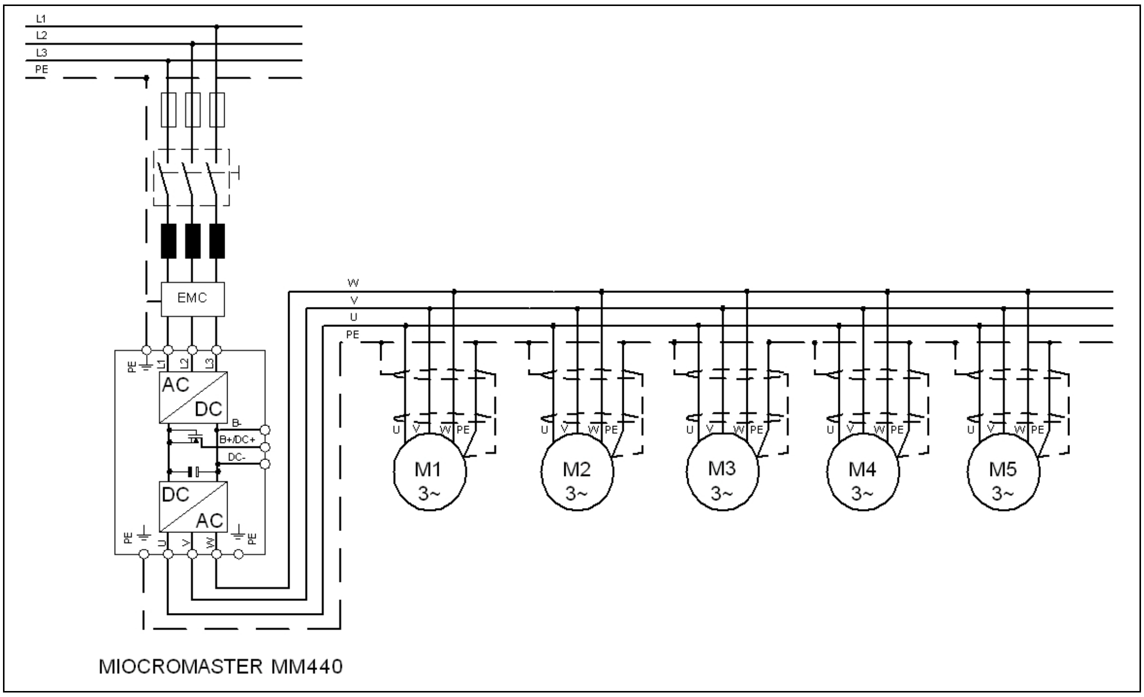
For many applications - e.g. for roller table drives or traversing gear drives – it makes sense to operate several motors connected in parallel to one frequency inverter. A description is provided in the following as to which details must be taken into account when engineering such drive systems.

NOTICE	When contactors are used upstream and downstream of frequency converters/inverters with pulsed voltages, physical effects arise which can result in excessive heat generation in the main contactor contacts or in the failure of the contactor operating mechanism (coil). The same applies for motor circuit breakers. Motor currents with higher basic frequencies (> 50/60Hz) cause higher power losses in the current paths as a result of the skin effect and the induction of eddy currents in electrical conductors – resulting in a higher temperature rise. This additional temperature rise depends on the basic frequency and the harmonic component of the current.

5.1 Principle structure

In the simplest case, the motors are directly connected to the frequency inverter.

Fig. 2: Principle structure of a multi-motor drive



5.2 Dimensioning the frequency inverter

When dimensioning the frequency inverter a differentiation must be made as to how the motors are to be operated.

- All of the motors starts simultaneously
- Motors selectively powered-up and powered-down

5.2.1 All motors starts simultaneously

When all of the motors are to be simultaneously powered-up this has the advantages that all of the motors are powered-up at the same instant in time at zero frequency – and are ramped-up to the operating frequency using the frequency inverter. This means that high starting currents do not occur. The frequency inverter has to be dimensioned for the sum of the motor currents.

Example:

Roller table drive with eight rolls, each roll is separately driven by a geared motor. This represents 8 Asynchronous motors (ASM) with 5.5 kW each.

Motor data:

ASM, 5,5 kW, 400 V star, 11,2 A, cos φ = 0,81, 1455 rpm

Dimensioning the frequency inverter:

Σ Motor currents = 8 x 11,2 A = 89,6 A

Σ Motor power = 8 x 5,5 kW = 44 kW

A frequency inverter with the following data is required:

- 400V power supply voltage
- I_{inv} > 89,6 A
- P_{inv} > 44 kW

MICROMASTER MM440

- 45 kW
- Iinv = 90 A
- VN = 380 – 480 V
- OrderNo: 6SE6440-2UE34-5FA1

5.2.2 Motors selectively powered-up and powered-down

In this case, several motors are connected to the frequency inverter; however, one or also several motors can be simultaneously powered-up.

- It must first be defined how many motors are to be simultaneously powered-up.
- The frequency inverter must be dimensioned so that its output current is greater than / equal to the sum of the motors connected to the frequency inverter plus the starting currents of the motors to be started.
- If motors with different sizes are used, the motor with the highest starting current must be taken into account.
- It must be taken into consideration that the starting currents (inrush currents) depending on the motor size, lie between 200% and 800% of the rated motor current
- Here it is absolutely necessary that V/f control is used!

Example:

Roller table drive with eight rolls, each roll is separately driven by a geared motor. This represents 8 Asynchronous motors (ASM) with 5.5 kW each. One motor should be powered-up in operation.

Motor data:

ASM 5,5 kW, 400V Y, 11,2 A, cos phi = 0,81, 1455 rpm,
Starting current I_{start} = 6,3 * I_{rated}

Dimensioning of frequency inverter:

Σ Motor current = 7 x 11,2 A = 78,4 A

Σ Starting current = 6,3 x 11,2 A = 70,56 A

A frequency inverter with the following data is required:

- 400V supply voltage
- I_{inv} > 89,6 A
- I_{peak} > 149 A

If starting is carried-out within 60 seconds, then the overload capacity of the frequency inverter can be used. The following inverters are then obtained:

MICROMASTER MM440

- 55 kW
- Iinv = 110 A
- VN = 380 – 480 V
- OrderNo.: 6SE6440-2UD35-5FA1