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Compendium

Edition: AN

simovert masterdrives

Vector Control

SIEMENS

1 System Description

1.1 Overview

The SIMOVERT MASTERDRIVES MC (Motion Control) belongs to the SIMOVERT MASTERDRIVES product group. This product group represents an overall modular, fully digital component system for solving all drive tasks posed by three-phase drive engineering. The availability of a high number of components and the provision of various control functionalities enable it to be adapted to the most diversified applications.

Control functionality

The control functionality is determined by the software stored in the inverter and converter modules. The following different control versions are provided within the SIMOVERT MASTERDRIVES product group:

- Vector control (VC)
  Vector control with encoder for applications requiring a high degree of torque precision and dynamic response,
  Vector control without encoder for simple applications (e.g. pumps, fans), and u/f control
- Motion control (MC)
  Vector control for servo applications, optionally with higher-level technology functions

Components

The SIMOVERT MASTERDRIVES product group comprises the following components:

- Converters
- Inverters
- Rectifier units
- Rectifier/regenerative feedback units (RE, AFE)
- Active front end (AFE) incoming units
- Braking units and braking resistors
- DC link bus for cabinet units
- Interference suppression filter
- Line commutating reactor
- Line filters
- Fuses
- Output filters (dv/dt and sine filter)
- Technology modules
- Optional boards:
  - Sensor boards (SBx) for speed and position sensing
  - Communication boards (CBx) for field bus interfacing
  - SIMOLINK (SLx) for fast transmission of setpoints and actual values
- Accessories

1.2 System description

The Vector Control functionality is matched to the drive system requirements. The vector current control enables fast current injection into the motor windings in conjunction with short sampling times. The related highly dynamic build-up of the torque provides a good basis for higher-level closed-loop control circuits.

It is possible to choose between current control types and U/f controls. The control type U/f control can be used to operate both synchronous and asynchronous motors. The current control types are available both without and with various different encoder types for speed acquisition for asynchronous motors.
As a special application, externally excited synchronous machines can be operated in control type speed control with encoders (current control type).

The Vector Control functionality is available both in converter and inverter modules which are designed for a line voltage range of 380 V -15 % to 480 V + 10 %.

All units are provided with a comprehensive basic functionality which can be expanded, if required, by extensive technology and communication functions by the use of software and hardware options. This enables the units to be adapted to the most diversified conditions of service. All closed-loop control functions are implemented with freely assignable function blocks which can be combined as desired. This enables the software to be flexibly adapted to various applications.

Menu structures stored in the unit software simplify start-up and visualization of the drives in conjunction with various operator control panels. PC-assisted tools enable effective parameter setting and data security.

Performance features

The units with Vector Control functionality have the following performance features:

- Available as a converter and as an inverter module
- Output range from 0.55 kW to 2300 kW
- Various configurations possible for multi-axis drives
- Integrated DC link bus module and fusing
- Integrated function "Safe STOP" (unit-specific)
- Control functions:
  - U/f characteristic curve
  - U/f characteristic curve for textile applications
  - Speed control with encoder
  - Torque control with encoder
  - Encoderless speed control
- Integrated USS interface for the configuration of simple bus systems
- Interfacing of various field buses:
  - PROFIBUS
  - CAN bus
- Drive networking with up to 200 nodes via SIMOLINK
- Integrated technology functions for positioning, synchronism and cam disk
- Start-up and diagnostics functions
- Comprehensive converter functions:
  - Restart on the fly
  - Kinetic back-up
  - Automatic restart
  - Flexible yielding
  - DC braking
- Menu prompting
- Graded operator control and visualization by means of an integrated simple standard operator control panel, a user-friendly operator control panel or via PC
- Uniform PC-capable programming software (DriveMonitor)
- In accordance with the currently applicable European standards, CE designation
- UL/CSA approval

1.3 Construction sizes

The power components (converter, inverter, rectifier unit and regenerative feedback unit) used for the vector control functionality are available in two types of construction. With reference to the converter/inverter, control versions are available which are assigned to the following output ranges:

- Compact 2.2 kW to 37 kW
- Chassis 45 kW to 2300 kW
- Compact PLUS type 0.55 kW to 18.5 kW

2 Configuration and Connection Examples

DANGER

The device must be disconnected from its voltage supplies (24 V DC electronics supply and DC link / mains voltage) before the control and encoder leads are connected or disconnected!

2.1 Compact PLUS type units

2.1.1 Single-axis drive

The single-axis drive (see Fig. 2-1) is used if only single-drive tasks need to be accomplished or if power equalization through several axes is either undesired or not possible.

For this purpose, a converter is used that is directly connected to the 3-phase supply via an external main contactor, a line filter and a line reactor as necessary. Any regenerative energy is stored in the capacitor module or reduced in the braking resistor.

2.1.2 Multi-axis drive up to 3 axes

In the case of multi-axis drives (see Fig. 2-2) a converter (AC-AC) can be combined with inverters (DC-AC). The converter rectifies the line voltage and supplies the inverters with direct voltage via the DC link bus module. The power supply integrated in the converter further provides the 24 V supply voltage for the electronics of a maximum of 2 inverters.

CAUTION

If more than 2 inverters are connected, the 24 V supply for the electronics must be provided by an external power supply.

The total rated output currents of the inverters supplied by a converter must not exceed the rated output current of the feeding converter (in the case of 6SE7021-0EP60 only half the rated output current).

The regenerative energy generated in one axis can either be used up by the other motors, stored in the capacitor module or reduced in the braking resistor.

2.1.3 Multi-axis drive

In the case of multi-axis drives (see Fig. 2-3) with more than 3 axes, several inverters are connected to the line voltage via a common rectifier unit.

An external power supply is required for the 24 V supply voltage for the inverter electronics.

The regenerative energy originating in one axis can be used by the other motors, stored in the capacitor module or dissipated in the braking resistor.

2.1.4 Configuration and connection examples (Compact PLUS)

NOTE

The following explanations refer to the numbered gray triangles in Figs. 2-1 to 2-3. These figures are just examples of possible configurations of drives. The necessary individual components have to be clarified according to the specific task.

The information and notes required for dimensioning the individual components and the respective order numbers can be found in the Catalog.

1) Line contactor Q1

All the equipment is connected to the line via the line contactor, which is used to separate it from the line if required or in the event of a fault. The size of the line contactor depends on the power rating of the connected converter or inverter.
If the line contactor is controlled from the converter, the main contactor checkback time P600 should be set to at least 120 ms.

2) Line fuses

According to their response characteristic and to suit the requirements, the line fuses protect the connected cables and also the input rectifier of the unit.

3) Line commutating reactor

The line commutating reactor limits current spikes, reduces harmonics and is necessary for keeping system perturbations to within the limits laid down by VDE 0160.

4) 24 V power supply

The external 24 V supply is used to maintain the communication and diagnostics of the connected-up units even with powered-down line voltage.

The following criteria apply regarding dimensioning:

- A current of 1 A must be provided for the rectifier unit, and a current of 2 A for each inverter connected.
- When the 24 V supply is powered up, an increased inrush current will be generated that has to be mastered by the power supply.
- No controlled power supply unit has to be used; the voltage must be between 20 V and 30 V.

5) ON/OFF

In the case of a single drive and a multi-axis drive without a rectifier unit, a switch is used to energize or de-energize the line contactor. When they are switched off, the drives are not brought to a controlled standstill, but are braked only by the load.

In the case of a multi-axis drive with a rectifier unit, a pushbutton is used to energize the line contactor. The line contactor is kept energized by means of a lock-type contact connected to the fault signaling relay of the rectifier unit, as long as no fault is detected at the rectifier unit.

6) OFF switch

Operating the OFF switch causes the line contactor to open immediately.

The drives are not brought to a controlled standstill, but are braked only by the load.

7) **Fault signaling relay**	If a fault occurs in the rectifier unit, a fault message is output via the connecting contacts of the signaling relay. When the 24 V supply is connected, the relay closes as long as no fault is present. In the event of a fault, the lock of the line contactor is opened, the contactor drops out and the drives coast down.
8) **Internal USS bus**	The USS bus is used for the internal communication of the units and only has to be connected if it is required.
9) **X101**	The digital inputs and outputs and the analog input and output have to be assigned according to the requirements of the drives. **CAUTION**: Terminal X101.1 may **not** be connected with the external 24V supply.
10) **X320 interface of the rectifier unit**	The X320 interface of the rectifier unit serves only for permanently connecting the user-friendly OP1S operator control panel and for connection to the on-line inverters. Please refer to the relevant operating instructions for the applicable measures and notes for correct operation.
11) **X103 serial interface**	The serial interface is used to connect the user-friendly OP1S operator control panel or a PC. It can be operated either according to the RS232 or the RS485 protocol. Please refer to the relevant operating instructions for the applicable measures and notes for correct operation.
12) **Precharging the capacitor module**	When a capacitor module is used, the terminals for precharging the capacitors must be connected.
13) **Output contactor**	The use of an output contactor is purposeful if a motor needs to be electrically isolated from the converter/inverter with the DC link charged.
14) **Line filter**	Use of a line filter is necessary if the radio interference voltages generated by the converters or rectifier units need to be reduced.
15) **Motor supply line**	The Siemens cables described in the catalog should be used for connecting the converter and the motor to each other.
16) **Safe STOP (Option)**	The "Safe Stop" option enables the power supply for the transmission of pulses into the power section to be interrupted by a safety relay. This ensures that the unit will not generate a rotating field in the connected motor.
17) **Auxiliary contactor**	The auxiliary contactor is used to interrupt the self-holding condition of the main contactor in the event of a fault signal. It must be used if the control voltage for line contactor Q1 is 230 V AC. The auxiliary contactor is not required if a line contactor with a control voltage of 24 V DC is used.
18) **Pulse generator**	Used to acquire the motor speed and allows speed-controlled operation with the highest degree of dynamic response and precision.

3 Instructions for Design of Drives in Conformance with EMC Regulations

3.1 Foreword

The modular design of SIMOVERT MASTERDRIVES permits a large number of possible drive converter/equipment combinations so that it is not practical to provide a separate description for every individual combination here. It is more purposeful for this document to provide basic information and generally applicable rules so that you can configure your particular drive converter/equipment combination in an "electromagnetically compatible" manner.

The drives are operated in widely varying environments and any additionally used components (control systems, switch-mode power sections, etc.) can differ considerably as far as their noise immunity and noise emission levels are concerned. For this reason, it is permissible to deviate from the EMC regulations on a case-to-case basis after individual investigation.

In the context of the EMC Law, SIMOVERT MASTERDRIVES are considered as "components" rather than "units". For a better understanding of these instructions, however, the generally used term "units" is used.

With effect from June 1996, the "EMC product standard including special test methods for electric drive units" EN 61800-3 (VDE 0160 T100, IEC 1800-3) is applicable for frequency converters. Before this product standard came into force, the standards EN 50081 with EN 55011 and EN 50082 with IEC 801 were applicable. These are no longer relevant for frequency converters now that the product standard has come into force.

Please contact your local Siemens office regarding any other queries you may have relating to EMC.

3.2 Principles of EMC

3.2.1 What is EMC?

EMC stands for "Electromagnetic Compatibility" and, in accordance with the EMC Law §2(7), it defines "the capability of a unit to operate satisfactorily in an electromagnetic environment, without itself causing electromagnetic disturbances which would be unacceptable for other electrical units in this environment".

In principle, this means that units should not interfere with each other. And this is a feature that you have always looked for in your electrical products!

3.2.2 Noise emission and noise immunity

EMC is dependent on two characteristics of the units concerned - the emitted noise and the noise immunity. Electrical equipment can either be treated as a noise source (transmitter) and/or a noise receiver. Electromagnetic compatability exists when the existing interference sources do not affect the function of the noise receivers. It is also possible for a unit to be both an interference source and an interference receiver at the same time. For example, the power section of a frequency converter can be regarded as a noise source, whereas the control section can be regarded as a noise receiver.

The **noise emission** of frequency converters is governed by the European Standard EN 61800-3. The cable-related noise at the mains connection is measured under standard conditions as radio interference voltage. Electromagnetically emitted noise is measured as radio interference (radiated noise). The standard defines limit values "First environment" (public supply networks) and "Second environment" (industrial networks).

When the equipment is connected up to the public supply, the maximum harmonics specified by the local power supply company must be observed.

The **noise immunity** of a unit describes how it behaves when subjected to electromagnetic noise/interference. The requirements and evaluation criteria for the behaviour of the electrical units are also laid down in standard EN 61800-3.

3.2.3 Industrial and domestic applications

Limit values are laid down for emitted noise and noise immunity depending on the application for which the units are envisaged. A differentiation is made between industrial and domestic environments. In industrial environments, the noise immunity of the units must be very high, but lower requirements are made concerning the emitted noise. In domestic environments, i.e. when connected to public supply systems, there are strict regulations concerning emitted noise but, on the other hand, the units can be designed with a lower noise immunity.

If the drive is an integral part of a system, it does not initially have to satisfy any demands regarding emitted noise and noise immunity. However, the EMC Law specifies that a system must as a whole be electromagnetically compatible within its environment. Within the system, the owner will, in his own interest, make sure that his equipment is electromagnetically compatible.

Without a radio interference suppression filter, the emitted noise of the SIMOVERT MASTERDRIVES frequency converters exceeds the limit value "First environment". Limit values are currently still under discussion for the "Second environment" sector (see EN 61800-3 section 6.3.2). However, their high noise immunity makes them insensitive to the noise emitted by units in their vicinity. If all control components of the system (e.g. automation devices) have a noise immunity suitable for industrial environments, then it is not necessary for every drive to maintain this limit value.

3.2.4 Non-grounded systems

In some industrial sectors, non-grounded supplies (IT supplies) are used to increase the availability of the plant/installation. In the event of a ground fault, no fault current flows, and the plant can still produce. However, when a radio interference suppression filter is used, a fault current will flow when a ground fault occurs, which may cause shutdown of the drives or even the destruction of the radio interference suppression filter. In order to minimize this fault current, the radio interference suppression filter has to be designed differently which will quickly reach the physical limits. Radio interference suppression filters additionally affect the concept of non-grounded supply networks and can thus result in a safety risk when used with these networks (see Product Standard EN 61800-3: 1996). If required, radio interference suppression should thus be realized at the grounded primary side of the supply transformer or with a single special filter at the secondary side. The special filter also generates leakage currents to ground. A ground-leakage monitor which is usually used in non-grounded systems has to be adjusted to the special filter.

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