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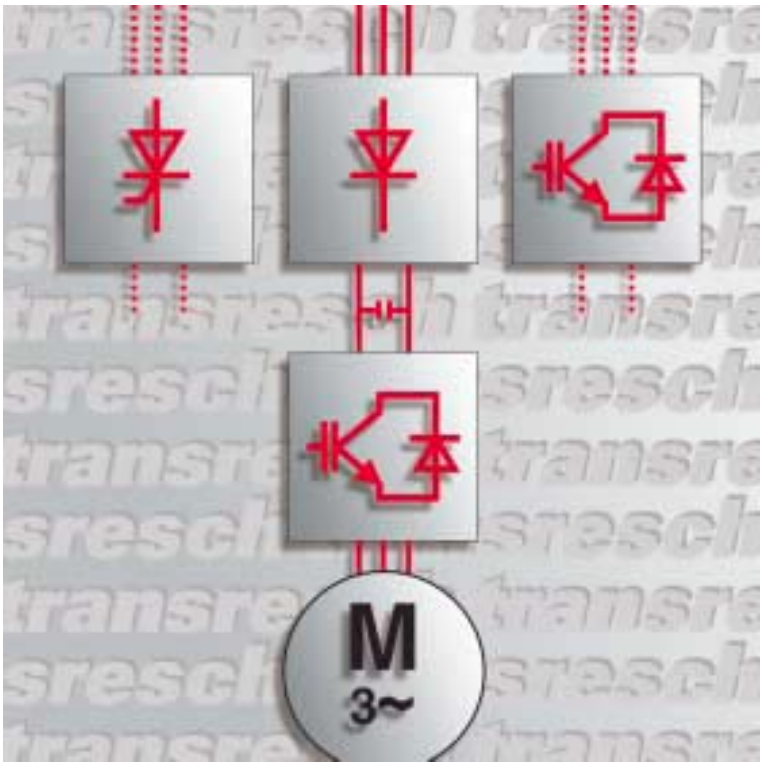
Movement Needs Concepts



Voltage Source Inverter VSI
Low and medium voltage AC Drives

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General

transresch Antriebssysteme Berlin supplies components and equipment, preferably for closed-loop speed control of electric motors in a power range from a few kilowatts up to several megawatts. Activities include development and application, planning and design, production planning, supply, commissioning, customer training and after-sales service. The company's customer represent almost all branches of industry, above all, however, plant manufacturers and, increasingly, motor manufacturers. Its products are being used throughout the world.

The range of products and services for variable-speed electric drives of transresch Antriebssysteme Berlin covers power and frequency converters and complete drive systems. The drive systems include motors, their power/frequency converters and transformers and switchgear, controls and programmable controllers in the drive environment.

History

Since its founding the company has gone through numerous changes regarding its legal status, ownership and – in this connection – corporate identity. The 50 years of history are closely connected with the development of power electronics, semiconductor technology and drive technology in Germany.

transresch Antriebssysteme Berlin GmbH was founded on 31st March 1999 on a partnership agreement by the purchase of a limited private company shell to carry on business under optimized conditions. It was registered in the Commercial Register B of Berlin-Charlottenburg under no. 69701 on the 27th May 1999.

The traditional converter and drive business is now carried on by an independent company with the same staff and the same range of products and services. transresch Antriebssysteme Berlin thus boasts the know-how of more than 50 years' development and manufacture of power and frequency converters for variable-speed drive systems and staff experience in the most diverse fields of application.

Products and Services

Extensive development work over many years has resulted in a wide range of very advanced converters available today under the well-known ***thyresch*** ® trademark. This range includes, among other things, rectifiers up to and exceeding 5 megawatts, frequency converters in various circuit configurations up to 5,8 megawatts and converters for special applications, for example, dynamic reactive-power compensation and process power supplies.

transresch Antriebssysteme Berlin is a certified member of the ABB Drives Alliance Group and therefore authorized to use the ABB inverter technology in the low and medium voltage range with Direct Torque Control (DTC) for a improved control accuracy by making speed encoders unnecessary.

The products of transresch Antriebssysteme Berlin satisfy all national and international standards applicable to power and frequency converters and are manufactured and documented to ISO 9001.

A competitive edge is the availability of customer- and branch-specific special designs in addition to the high-grade power and frequency converters for standard applications and a quick and high-quality service.

A large number of references on high-demanding applications throughout the world bears testimony to the know-how and competence of transresch Antriebssysteme Berlin. Constant improvement of the converters is necessary to constantly increase customer advantage and to strengthen the market position and is, therefore, a key business objective.

Voltage Source Inverter

Voltage source inverters are used to regulate the speed of three-phase squirrel cage motors by changes the frequency and the voltage and consist of input rectifier, DC link and output converter. They are available for low voltage range and medium voltage range.

Low Voltage Inverter

The three-phase low voltage air cooled frequency inverter is a cabinet built single or multi drive designed for industrial applications and for customised solutions too and is available in 1-quadrant and 4-quadrant operation for 6-pulse and 12-pulse mains supply connection. The used semi-conductors are diodes and IGBT's.

Voltage and power range

1-quadrant operation, 6- / 12-pulse

3 AC 400 V	3 – 1845 / 609 - 1845 kVA
3 AC 500 V	4 – 2312 / 765 - 2312 kVA
3 AC 690 V	15 – 3310 / 750 - 3310 kVA

4-quadrant operation

3 AC 400 V	123 – 1125 kVA
3 AC 500 V	97 – 1380 kVA
3 AC 690 V	210 – 1382 kVA

Characteristic features

- Cabinet ready for connection
- Alphanumeric multilingual control panel
- Direct torque control (DTC)
- Adaptive programming with 15 function blocks without additional hardware
- Easy and fast commissioning procedure with Start-up Assistant
- Process interface for fieldbus control
- Control solutions for specific drive applications

Cabinet ready for connection

Main standard hardware features

- Inverter module
- Electronic interface
- Isolator or main breaker
- Extensive, programmable I/O
- Inputs galvanically isolated
- IP 21 protection class

Available Accessoires

- EMC filter
- Fieldbus modules
- Pulse encoder interface module
- Analog and digital I/O extension modules
- Emergency stop function
- Brake chopper
- Common mode filters for motor protection
- Sine wave filter for motor protection
- Ethernet module
- Software tool for Start-up and maintenance

Example for 3 AC 400 V, 361 kVA

General technical data

Mains connection:

Supply voltage	3AC 380 … 690 V
Voltage tolerance	± 10%
Frequency	48 … 63 Hz
Power factor	0,98 (fundamental) 0,93 … 0,95 (total)
Efficiency	98% at rated power

Motor connection:

Output voltage	0 … U_{Supply}
Frequency control	0 … ± 300 Hz 0 … ± 120 Hz with du/dt filters
Speed range	1 : 100 without encoder 1 : 1000 with encoder
Control software	Direct Torque Control (DTC) U/f control

Environmental limits:

Ambient temperature for:	
Transportation	-40 … +70°C
Storage	-40 … +70°C
Operation	0 … +40°C +40 … +50°C at reduced output current
Relative humidity	5 … 95%, no condensation
Altitude	0 … 1000 m 1000 … 2000 m with derating

Control Panel

The control panel is a multilingual alphanumeric display with 4 lines x 20 characters. The panel is normally mounted on the cabinet door and is removable for mounting in DCS or externally too.

Advantages

- Display three separate actual values simultaneously
- Set value input
- Built-in fault memory stores information the latest 64 faults
- Copy feature, parameters can be copied from one to another inverter
- One panel can control up to 31 drives
- Simple arrangement
  Parameters are organised into groups for easy programming
- Start-up assistant guides through the commissioning procedure
- Adaptive programming with 15 function blocks without additional hardware

Inputs / Outputs

- 3 analogue inputs,
  galvanically isolated as a group
  - One ±0(2) … 10 V, resolution 12 bit
  - Two ±0(4) … 20 mA, resolution 12 bit
- 2 analogue outputs
  - 0(4) … 20 mA, resolution 12 bit
- 7 digital inputs
  galvanically isolated as a group
  - Input voltage 24 V
- 3 relay (digital) outputs
  - Switchover contact
  - 24 v or 115/230 V, max. 2 A
- Reference voltage output
  - ±10 V ±0,5%, max. 10 A
- Auxiliary power output
- - +24 V ±10%, max. 250 mA

Optional Accessories

- Analog I/O extension moduleRAIO-01
- Digital I/O extension moduleRDIO-01
- Pulse encoder interface module RTAC-01

Fieldbus modules

The fieldbus gateways are snap-on modules for mounting inside the cabinet and for connection to the DCS. There are a wide range of fieldbus gateways for automation systems.

- PROFIBUS-DP
- DeviceNet
- CANopen
- ModbusPlus
- Modbus
- Ethernet
- Interbus-S

Brake Choppers and Resistors

Brake choppers and resistors are available for all standard frequency inverters.

Adaptive Programming

The adaptive programming consists of 15 programmable function blocks, which can be programmed to perform any of the predefined set of functions. All the common functions for making a real block program are available.

The adaptive programming can be made by the panel or by an available PC tool DriveAP

Advantages of DriveAP

- Easy to use tool, no special skills reqiured
- Documentation of programs
- Upload and storage existing programs from the drive

Start-up and Maintenance Tool

For commissioning and maintenance the user friendly software DriveWindow can be used. DriveWindow is a easy-to-use tool, which is able to deliver all necessary data for commissioning or fault diagnosis.

Specific features

- Signal values can be viewed as graphs from the drive
- Parameters and signals can be monitored and edited off- or on-line
- Fault diagnosis of the status of drive and fault history data
- Back-up of drive parameters
- Reloading of drive parameters
- Several drives connected and monitored at the same time

Remote Monitoring Tool

The intelligent Ethernet module gives simple access to the drive via the Internet communicating via a standard web browser. The user can set up a virtual monitoring room wherever there is a PC with an Internet connection or via a simple dial-up modem connection. This enables remote monitoring, configuration, diagnostics and, when needed, control.

Specific features

- Monitoring, configuration of parameters, diagnostic
- Browser based access via
  - Intra- / extra- / Internet or
  - Simple dial-up modem
- E-mail alerts to predefined addresses
- No PC needed at the local end
- Use as a Modbus/TCP bridge for control purposes

Figure 1-1

Example for 2 x 3 AC 690 V, 1690 kVA 12-pulse solution

Medium Voltage Inverter

As a certified member of ABB Drives Alliance Group transresch deliver engineered drive solutions with medium voltage drives by using the air or water cooled medium voltage inverter ACS1000 of ABB and add the drive control functions like the customer's requirement.

KeyTechnology

Two main technology features distinguish the ACS 1000 from other types on the market:

- The motor control platform is based on Direct Torque Control (DTC) which achieves the ultimate torque and speed performance is the same unique motor control method for AC drives as used in low voltage drives. The inverter switching is directly controlled according to the motor core variables flux and torque..

  DTC allows the speed of any standard squirrel cage induction motor to be controlled without the need for expensive and fragile encoders or tachogenerator feedback devices.

- For the first time in any AC drive, a new power semiconductor switching device is utilized. Known as IGCT (Integrated Gate Commutated Thyristor), the device provides an intrinsically less complex, more efficient and reliable drive. This is achieved by fast switching and inherently low losses which mean less cooling equipment is needed.

  IGCTs do not require snubber circuits and allow power bridge implementation with fewer power devices than conventional medium- voltage drives. While reliability is improved, the physical size of the ACS 1000 is compact.

Power Part

Input Stage

The medium voltage inverter features a 12-pulse diode rectifier input stage. This is adequate for most networks an normally meets the harmonic requirements demanded by standards such as IEEE 519.

For networks that are more demanding, the ACS1000 can be supplied optionally with a 24-pulse configuration for air cooled and for water cooled types.

Output Stage

The used semi-conductors are IGCT's (**I**ntegrated **G**ate **C**ommutated **T**hyristor), which are self protected against destructive failures and are developed specifically for the medium voltage market.

As a standard the medium voltage inverter is equipped with a low pass LC sine filter in its output stage. Current feedback is used to actively control filter operation. The low pass frequency is designed to be well below the lowest switching frequency used by the inverter output stage. This greatly enhances the purity of both the voltage and current waveforms applied to the motor.

The integrated sine filter provides many important benefits.

Summary of benefits

- Motor efficiency as under DOL operation
- No motor derating required
- Saves motor insulation and bearings
- No voltage reflections
- No limitation of cable length
- Use of standard cables possible
- No EMC problems
- No additional motor noise

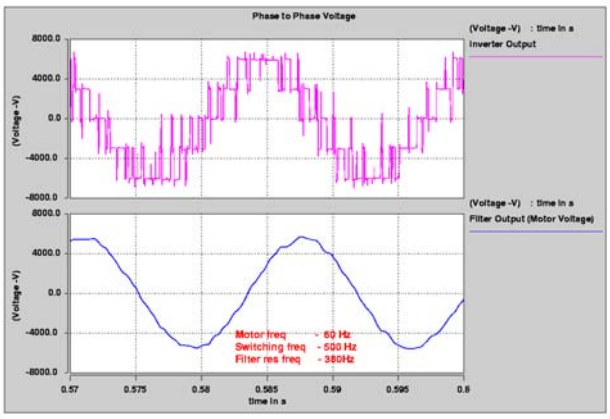

Figure 2-1

Inverter (top) and filter (below) output voltage

Elementary Diagram

Figure 2-2 show the elementary circuit diagram of a 12-pulse version of the ACS 1000.

The 3-phase AC line voltage is supplied to the rectifier bridges through the 3-winding converter transformer. In order to obtain 12 - pulse rectification, appropriate phase shift is necessary between the secondary windings of the transformer.

The two fuseless rectifier bridges in the 12-pulse scheme (*Figure 2-2*) are connected in series, such that the DC voltages are added

up. Therefore, the full DC bus current flows through both bridges. In the 24-pulse scheme, 2 such bridge arrangements are connected in parallel as shown in *Figure 2-3*.

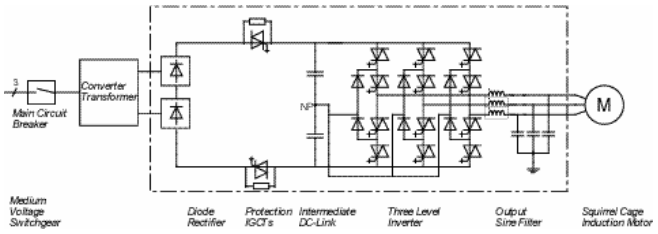

Figure 2-2

Elementary Diagram - ACS 1000, 12-Pulse Version

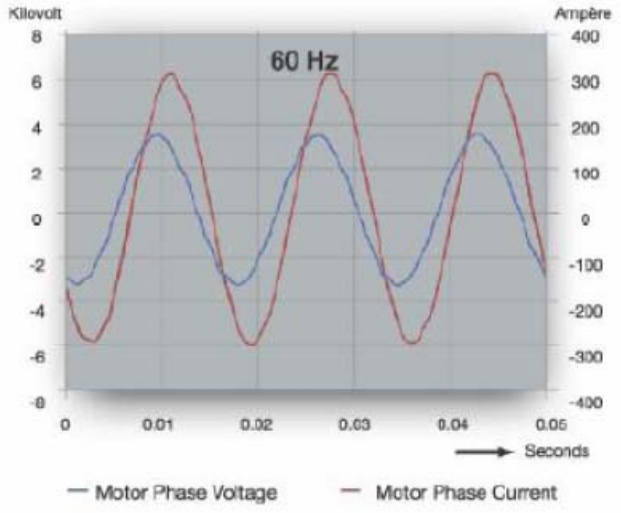

Figure 2-3
Sinusoidal output waveforms for motor voltage and motor current throughout the full operating range

Voltage and power range

Motor Voltage [kV]	Type of Cooling	Max. cont. Power [kVA]
2,3	Air	400 - 1350
3,3	Air	400 - 2150
3,3	Water	2400 - 5950
4,0	Air	400 - 2000
4,0	Water	2300 - 5800

Control Unit

The ACS 1000 can be controlled from several control locations:

- The detachable CDP 312 control panel mounted on the ACS 1000 front door of the control section
- External control devices, e.g. a supervisory control system, connected to the analog and digital I/O terminals on the standard I/O Boards (IOEC)
- Fieldbus adapter modules
- PC Tools (Drive*Window* and DDrive*Support*) hooked up via a PC adapter to the ACS 1000 control board

Drive Protection Functions

The drive provides a wide range of protection, fault and alarm functions including:

- Motor temperature monitoring
- Motor stall
- Underload
- Overspeed
- Undervoltage
- Battery condition monitoring
- Motor phase loss
- Overvoltage
- Short circuit in the rectifier bridge
- Charging fault
- Supply phase loss
- Overcurrent
- Short circuit of the inverter
- Measurement loss
- Communication fault
- Cooling circuit monitoring (water-cooled converters)
- Earth fault monotoring

The ACS 1000 features a selection of pre-programmed and standardized application macros for the configuration of inputs, outputs, signal processing and other parameters.

Retrofit

Due to its specific topology the ACS 1000 can supply standard medium voltage motors (existing or new) withput applying thermal derating factors. In addition, due to its sinusoidal waveform, standard medium voltage winding insulation is sufficient.

To avoid risk of bearing currents and related consequential damages, one motor bearing should be insulated (the one at the non-driven shaft end). This is actually a typical accessory even for most direct on-line operated motors. If, nevertheless, such a bearing is not available (e.g. for older existing motors), a grounding brush can be installed on either shaft end.

Although from an electrical point of view no restrictions exist for variable speed operation with retrofit motors, attention should be paid to possible motor and load restrictions such as insufficient lubrication or reduced cooling at low speed, critical speed areas within the targeted operating range that need to be avoided, etc. Also the maximum (i.e. rated) speed of the motor should under no circumstances be increased without authorization from the manufacturer of each component of the drive train concerned.

Inverter using for 6 … 7.2 kV Motors

A very simple method for using an existing DOL operated 6.0…7.2 kV Motor for a variable speed drive with Frequency Inverter is to re-connect the motor winding from star to delta. With the delta connection of the motor, the motor phase voltage is by the factor $\sqrt{3}$ higher than the stator voltage, because the motor phase voltage is equal to the phase-to-phase voltage. On the other hand the motor phase current is by the factor $1/\sqrt{3}$ lower than the stator current.

Motor Requirements

A star motor can only be delta connected, when the mid-point conductors are accessible outside of the stator. In case of application of new motors this feature is usually no substantial cost adder, but needs to be specified. It mainly requires a bigger terminal box with six instead of three phase connections.

But even with existing motors, which do not have the mid-point conductors accessible at the main terminal box, the necessary modifications can usually be made at very reasonable costs. Anyway, in case of retrofitting a VSD to an existing (old) motor, it may be wise to send the motor to the factory for a general revision to ensure trouble free operation for further years. In such a case also those mid-point conductors can be brought out to the terminal box at the same time without major effort.

Synchronized Bypass

The synchronized bypass allows for automatic synchronization of a motor with the line after a soft start. Two versions are available:

- synchronized bypass for 1 motor
- synchronized bypass for up to 4 motors

The bypass cabinet which is attached to the left hand side of the ACS 1000 houses the following control hardware:

- the interface for external commands and feedback signals
- the signal interface(s) for the control of motor and bypass breakers
- the control unit for synchronizing and switching coordination
- the optional voltage measuring equipment

Air-Cooled Type

The air-cooled type of the ACS 1000 is designed with inverter stacks, output filter and DC link capacitor in one section (see *Figure 2-4*).

This section experiences maximum air flow which is advantageous for the temperature sensitive capacitors. The construction of the inverter stacks allows easy exchange of IGCTs by means of a specially designed tool which is part of the supply.

The middle section accommodates cooling fan, rectifier stack, protection IGCTs and filter reactor. The construction is such that the fan can be exchanged easily.

The air intake is provided with an air filter in order to prevent dust and particles from entering into the converter. The air filter can be replaced from outside while the drive system is in operation.

Figure 2-4:
Air cooled Medium Voltage Inverter

Water-Cooled Type

The water-cooled type of the ACS 1000 (see F*igure 2-5*) is equipped with a closed circuit water cooling system. Part of the cooling system is a fan and an air-to-water heat exchanger to maintain cooling of all components which cannot be cooled by water.

As with the air-cooled type, the construction of the inverter stacks allows easy exchange of IGCTs by means of a specially designed tool which is part of the supply.

Figure 2-5:
Water cooled Medium Voltage Inverter

Electromagnetic Compatibility

The riveted and folded cabinet construction of the ACS 1000 ensures an extremely strong yet flexible and self-supporting framework which avoids the need for additional skeletal support. Compared with traditional bolted frames the cabinet provides extremely effective protection against electromagnetic emissions.

The design fulfils the requirements of international standards like UL 347A.

Electromagnetic Compatibility (EMC) has been achieved by applying a cabinet design consisting of folded, galvanized sheet metal plates and minimizing the spacing between the rivets. The cabinet's inside walls are not painted, because paint tends to reduce the effectiveness of metallic bonding which is paramount to successful EMC.

Accordingly, only the front of the ACS 1000 cabinet is painted while all other walls are galvanized. However, the cabinet can be ordered optionally with the whole of the outside painted.

EMC performance is further enhanced by the use of metal cable channels.

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