bepat GmbH & Co. KG

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rotabench® 6P 100/60

Inverter for Laboratory- and Test Bench-Use
with sinus commutation and field oriented control for EC-motors

100A RMS (max.) / Phase continuous – max. 60 Volt DC-Bus Voltage

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UNIVERSAL INVERTER for AUTOMOTIVE EC-MOTORS

OVERVIEW

The inverters of the rotabench 6P series are developed from electric motor test bench designers for electric motor test bench designers. They are built and optimized for the daily usage in the lab and in the test bench environment. These devices are not designed for one or a few motor types; they can be parametrized for many different EC-Motors (PMSMs and BLDCs). Thanks to the integrated control functionality for Delta Elektronika PSUs, it's easy to set up a test environment with a PMSM within a few minutes. All you need is a Windows™ PC, an Ethernet switch, a rotabench® 6P inverter and a PSU.

OPERATION

Important machine parameters like number of pole-pairs, permanent flux linkage (aka "voltage constant"), rotor position and motor polarity are identified by the automatic "motor teach in" function. If the EPS add-on is activated this process can run fully automated.

The DSP creates a 3-phase rotating field based on space vector modulation, which is parametrized by the client software. The fast PID controllers apply the iD and iQ currents to the motor.

Motor parameters like inner resistance (Ri), D- and Q-axis stator inductances (LD and LQ) can be calculated automatically and precise thanks to a simultaneously sampling precision 8-channel ADC with 16 bit resolution, acquiring the DC- and AC voltages and currents with the PWM base frequency. An artificial neutral point is already included in the voltage signal conditioning. The Currents are measured by LEM LF-210 current transducers.

With the control software, the user can see the state of operation at any time, and can control the inverter and the DC-Bus. Important measurement values, like Phase Currents and –Voltages or DC-Current and the temperature of the power stage are visualized graphically and/or numerically.

If needed the inverter can be controlled without the windows software by an external software through a DLL, which encapsulates the communication.
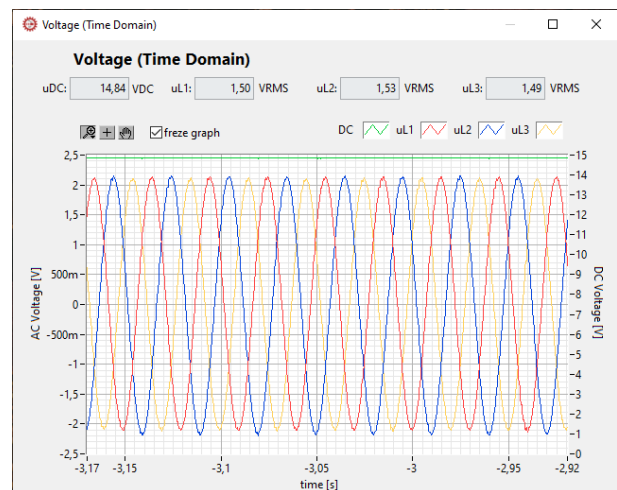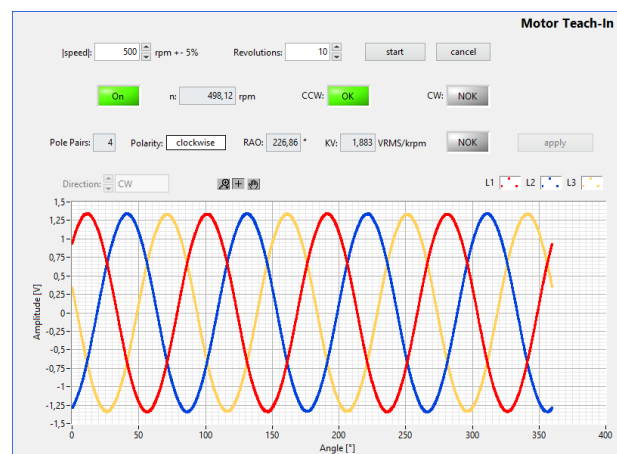
As rotabench® 6P is not only a frequency inverter but also a measurement device, the analog inputs for voltage and current can be calibrated. When delivered the device comes with factory calibrated inputs.

rotabench® 6P 100/60 HARDWARE

OVERVIEW

rotabench® 6P 100/60 is an inverter designed for laboratory- and test bench use with 3-phase PMSM with low DC-bus voltage and high phase currents. Its main components are a MOSFET power stage with 3 half bridges, an integrated signal conditioning, LEM current transducers, digital signal processing and a Windows™ software for control and visualization of the measurement data and the system status.

With the high currents up to 100 A RMS (cont.) and the max. DC-Bus voltage of 60V, it is designed to power small EC-motors up to 3 kW in a 12V, 24V, 36V or 48V main power supply environment. Thanks to the field-oriented control, it is easy to control an EC-motor, even with little knowledge about motor control.


TECHNICAL DATA / SPECIFICATION

Name of the device:	rotabench® 6P 100/60
Chassis:	19'' Rack 4 HU Box with integrated cooling fans
Weight:	ca. 9 kg
Dimensions:	ca. 44,5 x 42,5 x 18,5 cm (L x W x H)
Power supply (Electronics):	180 - 240 VAC, 50 Hz, (integrated DC PSUs)
PWM base frequency:	20 - 40 kHz, selectable in 5 kHz steps
PID Loop-Rate:	20 - 40 kHz, in sync with PWM
Max. DC-Link voltage:	60 Volt DC, typ: 12/24/36/48 Volt DC-Bus
Max. AC-Currents:	100 A RMS continuous, short time overload

CONNECTORS

Speed / Rotor Positon:	Encoder-Input /w A-, B- and Z-line (5 Volt TTL)
DC Link:	Screw Terminals M6 (max. 150 A)
Electronic Supply:	IEC Power Socket /w grid filter and fuses
Control / Ethernet:	LAN (RJ45), USB, RS485 (D-Sub)
Digital IO:	Interlock (Safety) / 6x DO, 4x DI (5 Volt TTL): D-Sub
Analog input:	3 analog inputs ± 10 Volt, 12 bit, 1 kHz: D-Sub
Encoder Out:	A-, B- and Z-Line, in sync with Encoder IN, 5 V TTL: D-Sub
Motor-Phases L1-L3:	High current connectors (max. 150 A), similar to „AMP Radsok"

rotabench® 6P SOFTWARE

OVERVIEW
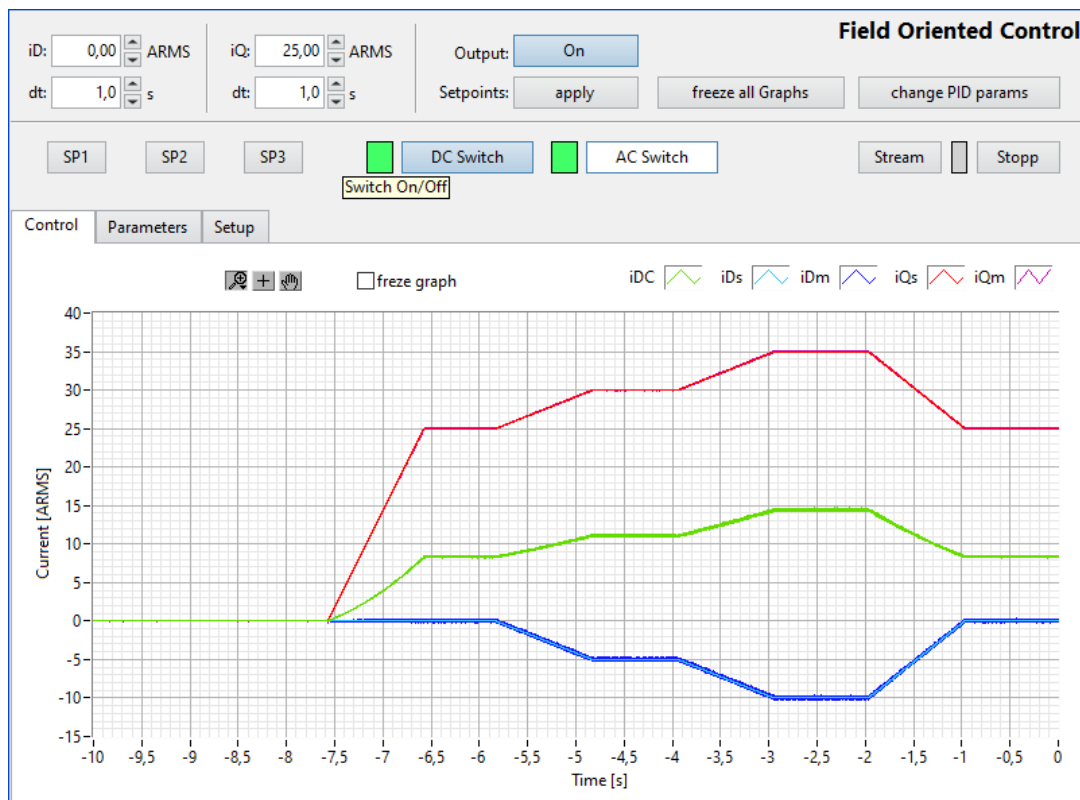
The rotabench® 6P software is a distributed system, consisting of a firmware on the mainboard of the device (base on an STM32H7/G4 Microcontroller and the firmware written in "C") and a control software, that can be installed on any of-the-shelf Windows™ PC. The client software communicates with the DSP ("mainboard") over LAN (Ethernet). Measurement data are streamed with 5 kHz sample rate from the DSP to the PC for visualization.

FEATURES / FUNCTIONALITY

- field oriented control for PMSM (iD, iQ). PID Loop frequency 20 to 40 kHz (typ. 25 kHz)
- setpoints: manual setpoints (on demand), setpoint table based on the speed (automatic)
- PID Control: fixed PID parameters, autotuning at start, continuous autotuning, gain scheduling (depending on the speed), PID calculator to calculate PID params based on the magnitude optimum criterion
- import and export of the setpoint-table and PID gain table to/from an Excel compatible file format
- Optional: continuous identification of Ri (inner resistance) and Ld/Lq (stator inductances) for cont. autotuning.
- Function for automatic identification of the rotor position, voltage constant(Ψ_{PM}), number of pole pairs and motor polarity based on a simple back-EMF measurement
- cont. current and voltage measurement, calculation of el. power (accuracy class: 0.2%)
- Measurement data can be displayed graphically and numerically, in time domain and in DQ-domain
- Digital IO, 24 Volt Digital IO with add-on PCB
- Optional: Delta Elektronika PSU control
- Optional: EPS add-on PCB for drive / brake engine control /w 24V DIO and analog setpoints (± 10 Volt), incl. Interface to a Kistler 4503 torque sensor with encoder