



CATALOGUE OF PRODUCTS

TRIOL CORPORATION

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The Triol AK06 — a variable frequency drive for electric submersible pumps

Purpose: to control and protect electric submersible pumping units (ESPU) with nominal power from 16 to 1450 kW [20 to 1945 hp].



The Triol AK06 provides open-loop scalar control (V/f control) for induction and synchronous motors, as well as sensor-less control for brushless DC motors. The construction of the AK06 is designed to facilitate operations and on-site repairs in adverse climate conditions.

Main Features

- Various operation modes simplify well equipment automation;
- Submersible motor protection;
- Easy operation and service;
- Extension of ESPU lifespan;
- Operates in adverse climate conditions at temperatures ranging from -60°C to 50 °C [-76 °F ... 122 °F];
- Reduces power consumption by up to 6% through intelligent system modes (Triol AK06-ASPED);
- Low harmonic distortion (THD < 5%) in input current (Triol AK06-***-2).

Modes of operation

Manual mode:

Allows the user to operate the drive directly from the control panel.

Automatic operation modes:

- Pressure regulation: maintains preset annular, suction, wellhead, or line pressure (using submersible telemetry);
- Current regulation: maintains a preset output current.

Soft start and braking:

Soft starting the motor reduces the inrush current and extends the ESPU lifespan.

Functionality

- Soft starts and stops of the ESP motor with preset acceleration and braking rates (Hz/s);
- “Manual”, “Automatic” or “Automatic with preset time” modes depending on whether or not the motor needs to start automatically after a fault occurs or instead this may require the operator’s command;
- An ESP “Flying start” mode to be applied when a counter-rotation is induced by the load on the pump (turbine rotation). The Triol AK06 smoothly reduces the shaft’s rotation speed and then reverses it to the forward direction without overcurrent. In oil extraction, this mode allows an immediate restart of the ESP motor, rather than having to wait for the oil to drain back into the pipe and for the turbine to stop;
- “Current optimization” mode to provide automatic output voltage adjustment in order to get the minimum full load current at fixed output frequency;
- On-site and remote parameter control;
- Automatically changes output frequency according to a preset time schedule;
- ESP delayed start after supply is delivered;
- Maintains technological parameters within preset limits (pressure, ESM current, liquid level, ESM load);
- ESP startup in “swinging” mode or “kick start swinging” mode can be used to unblock ESP in the case of mechanical jamming;
- “Soft start with synchronization” mode holds a frequency for a preset time upon startup and then continues acceleration;
- ESP startup in the “unjamming” mode delivers maximum torque at a low frequency;
- Timer mode.

Protection

The embedded output sine filter delivers pure sinusoidal voltage and current to the motor, which reduces motor derating. It also reduces transformer overheating if the transformer is used between the drive and the motor.

The Triol AK06 provides protection from the following:

- Network disturbances;
- Overload;
- Output short circuit;
- Underload (oil extraction interruption);
- Low ESP insulation resistance;
- ESP overheating (using submersible telemetry);
- High ESP temperature (using submersible telemetry);
- Low base oil pressure (using submersible telemetry);
- High vibration level (using submersible telemetry);
- High pipeline pressure (using contact pressure gauge);
- ESM current imbalance;
- Start while turbine rotation is present.

Specifications

Nominal output current	100 A ... 3200 A
Supply voltage	3 x 380 V (- 50%, + 25%), 50/60 Hz (± 2%) 3 x 480 V (- 15%, + 10%), 50/60 Hz (± 1%) 3 x 690 V (- 15%, + 10%), 50/60 Hz (± 1%) with solidly earthed or insulated neutral
Nominal output voltage	3 x 0 V...380 V (± 2%); 3 x 0 V...480 V (± 2%); 3 x 0 V...690 V (± 2%)
Output frequency	0 Hz ... 80 Hz (± 0.1%) for induction and synchronous motors 0 Hz ... 500 Hz (± 0.1%) for brushless DC motors
Overload	125% of nominal current for 300 seconds
Efficiency	> 95%
Operating mode	Continuous
Insulation resistance	> 20 MOhm
Control system	UMKA-03 controller
Controller memory size	8 MB (870000 records); 2 GB with SD memory card
Interface	RS 232; RS 485; GSM; GPRS
Data exchange protocol	Modbus RTU
Operating temperature	- 60 °C ... 50 °C [- 76 °F...122 °F]
Protection level according to IEC 60529	IP43

Model range

Model	Nominal output current, A	Active output power, kW [hp]	Output power, kVA	Dimensions, mm [in]
Triol AK06-100	100	55 [74]	64	950x1900x890 [38x75x35]
Triol AK06-160	160	80 [107]	106	950x1900x890 [38x75x35]
Triol AK06-250	250	132 [177]	176	950x1900x890 [38x75x35]
Triol AK06-320	320	160 [214]	182	950x1900x890 [38x75x35]
Triol AK06-400	400	200 [268]	263	950x1900x890 [38x75x35]
Triol AK06-630	630	315 [422]	414	1300x1900x1050 [51x75x42]
Triol AK06-800	800	400 [536]	526	1300x1900x1050 [51x75x42]
Triol AK06-1K0	1000	500 [670]	658	1850x1990x1080 [73x78x43]
Triol AK06-1K2	1200	600 [804]	789	2040x2000x1080 [80x79x43]
Triol AK06-1K4	1400	700 [938]	921	2040x2000x1080 [80x79x43]
Triol AK06-1K6	1600	800 [1072]	1053	2040x2000x1080 [80x79x43]
Triol AK06-2K0	2000	1000 [1340]	1316	1850x1990x1080 [73x78x43] (2 cabinets)
Triol AK06-2K5	2500	1250 [1374]	1644	2040x2000x1080 [80x79x43] (2 cabinets)
Triol AK06-3K2	3200	1600 [2145]	2106	2040x2000x1080 [80x79x43] (2 cabinets)

The Triol AK06—***—2 — a variable frequency drive made in compliance with EC standards

Purpose: to control and protect electric submersible pumping units (ESPU) with a nominal power from 50 to 160 kW [67 ... 218 hp].

The Triol AK06-***-2 provides open-loop scalar control (V/f control) for induction and synchronous motors, as well as sensor-less control for brushless DC motors.

The construction of the AK06-***-2 is designed to facilitate operations and repairs in adverse climate conditions.

Main Features

- Active power factor correction (power factor is more than 98%);
- Low harmonic distortion (THD < 5%) in sinusoidal input current;
- Allows to regenerate energy back to the supply main at generator mode of an electrical submersible motor or when the motor is braking;
- EMC filter reduces the radio frequency harmonics generated to the network;
- Various operation modes simplify well equipment automation;
- Submersible motor protection;
- Easy operation and service;
- Extension of ESPU lifespan;
- Operates in adverse climate conditions at temperatures from -30 °C to 40 °C [-22 °F...104 °F].

Modes of operation

Manual mode

Allows the user to operate the drive directly from the control panel.

Automatic operation modes

- Pressure regulation: maintains preset annular, suction, wellhead or line pressure (using submersible telemetric unit).
- Current regulation: maintains a preset output current

Soft start and braking

Soft starting the motor reduces the inrush current and extends the ESPU lifespan.



Functionality

- Soft starts and stops of the ESP motor with preset acceleration and braking rates (Hz/s);
- “Manual”, “Automatic” or “Automatic with preset time” modes depending on whether or not the motor needs to start automatically after a fault occurs or instead this may require the operator’s command;
- An ESP “Flying start” mode to be applied when a counter-rotation is induced by the load on the pump (turbine rotation). The Triol AK06-***-2 smoothly reduces the shaft’s rotation speed and then reverses it to the forward direction without overcurrent. In oil extraction, this mode allows an immediate restart of the ESP motor, rather than having to wait for the oil to drain back into the pipe and for the turbine to stop;
- “Current optimization” mode to provide automatic output voltage adjustment in order to get the minimum full load current at fixed output frequency;
- On-site and remote parameter control;
- Automatically changes output frequency according to a preset time schedule;
- ESP delayed start after supply is delivered;
- Maintains technological parameters within preset limits (pressure, ESM current, liquid level, ESM load);
- ESP start up in “swinging” mode; “kick start swinging” mode can be used to unblock ESP in the case of mechanical jamming.
- “Soft start with synchronization” mode holds a frequency for a preset time upon startup and then continues acceleration;
- ESP start up in the “unjamming” mode delivers maximum torque at low frequency;
- Timer mode.

Protection

The embedded output sine filter delivers pure sinusoidal voltage and current to the motor, which reduces motor derating. It also reduces transformer overheating if the transformer is used between the drive and the motor.

The Triol AK06-*-2 provides protection from the following:**

- Network disturbances;
- Overload;
- Output short circuit;
- Underload (oil extraction interruption);
- Low ESP insulation resistance;
- ESP overheating (using submersible telemetry);
- Low base oil pressure (using submersible telemetry);
- High vibration level (using submersible telemetry);
- High pipeline pressure (using contact pressure gauge);
- ESM current imbalance;
- Starting while turbine rotation is present.

Specifications

Nominal output current	100...800 A
Supply voltage	3 x 500 V (- 50%, + 25%), 50/60 Hz ($\pm 2\%$) with insulated neutral
Nominal output voltage	3 x 0 V... 500 V ($\pm 2\%$)
Output frequency	0 Hz ... 80 Hz for asynchronous motors ($\pm 0.1\%$) 0 Hz ... 500 Hz for brushless DC motors ($\pm 0.1\%$)
Overload	125% of nominal current for 300 seconds
Efficiency	> 93%
Total harmonic distortion in input current	< 5%
Operating mode	Continuous
Insulation resistance	> 20 MOhm
Control system	UMKA-03 controller
Controller memory size	8 MB (870000 records); 2 GB with SD memory card
Interface	RS 232; RS 485; CAN; USB; GSM; GPRS
Data exchange protocol	Modbus RTU
Operating temperature	- 30 °C ... 40 °C [- 22 °F...104 °F]
Protection level according to IEC 60529	IP43

Model range

Model	Nominal output current, A	Active output power, kW [hp]	Output power, kVA	Dimensions, mm [in]
Triol AK06-100-2	100	72 [98]	86	1350x1500x1000 [53x59x39]
Triol AK06-160-2	160	116 [157]	138	1350x1600x1000 [53x63x39]
Triol AK06-250-2	250	180 [244]	216	1400x1600x1120 [55x63x44]

The Triol AK06-ASPED — an intelligent variable frequency drive for electric submersible pumps

Purpose: to control and protect electric submersible pumping units (ESPU) with a nominal power from 16 to 1450 kW [20 ... 1945 hp]. VFD “smart” operating modes increase oil extraction yield, decrease power consumption and reduce downtime.



Main Features

- Various operation modes simplify well equipment automation;
- Increases oil extraction yield achieved through automatic output frequency adjustment in response to preset parameters;
- Automatic pump-off operation when a well inflow falls below ESP's nominal capacity;
- Reduces quantity of emergency stoppages;
- Increases well inflow through short-term pressure changes on the reservoir or through “jogging” and “surging” modes;
- Integration into a higher-level automated control systems (ACS) allows a sharing of energy consumption data and submersible telemetry data with the ACS;
- Provides automation of the technician's and operator's duties in the following processes: startup during turbine rotation, soft start, unjamming, start/stop time regulation;
- Reduces power consumption by up to 6% through intelligent system modes.

Modes of operation

Cyclical mode

The VFD launches a well using start/stop preset cycles. The operator determines the number and duration of each cycle. The launch is complete upon conclusion of the cycles or when a sufficient well inflow has been reached. The VFD operates with or without submersible telemetry unit.

Programmed mode

The VFD launches the well by raising the output frequency. The operator determines the time of a start and a final frequency. A submersible telemetry unit.

Soft launch mode

The mode is used in wells with a high percentage of solid material and after hydraulic fracturing. A submersible telemetry unit is required.

Functionality

- Soft starts and stops of the ESP motor with preset acceleration and braking rates (Hz/s);
- “Manual”, “Automatic” or “Automatic with preset time” modes depending on whether or not the motor needs to start automatically after a fault occurs or instead this may require the operator's command;
- An ESP “Flying start” mode to be applied when a counter-rotation is induced by the load on the pump (turbine rotation). The Triol AK06-ASPED smoothly reduces the shaft's rotation speed and then reverses it to the forward direction without overcurrent. In oil extraction, this mode allows an immediate restart of the ESP motor, rather than having to wait for the oil to drain back into the pipe and for the turbine to stop;
- “Current optimization” mode to provide automatic output voltage adjustment in order to get the minimum full load current at fixed output frequency;
- On-site and remote parameter control;
- Change output frequency according to preset parameters;
- ESP delayed start after supply is delivered;
- Maintains preset technological parameters within the preset limits (pressure, ESM current, liquid level, ESM load);
- ESP startup in “swinging” mode; “kick start swinging” mode can be used to unblock ESP in the case of mechanical jamming.
- “Soft start with synchronization” mode holds a frequency for a preset time upon startup and then continues acceleration;
- ESP startup in the “unjamming” mode delivers maximum torque at low frequency;
- Avoids emergency shutdowns caused by underload, overload, ESP overheating or supply overvoltage by automatically switching to other operating modes or changing the output frequency.

Protection

The Triol AK06-ASPED provides protection from the following:

- Underload (oil extraction interruption);
- Overload;
- Output short circuit;
- Supply undervoltage: automated algorithms enable the VFD to operate even when a supply voltage drops to 50% of the nominal value;
- Network disturbances;
- Low ESP insulation resistance;
- ESP overheating (using submersible telemetry);
- Low base oil pressure (using submersible telemetry);
- High vibration level (using submersible telemetry);
- High pipeline pressure (using contact pressure gauge);
- ESM current imbalance;
- Startup during turbine rotation.

Specifications

Nominal output current	100...3200 A
Supply voltage	3 x 380 V (- 50%, + 25%), 50/60 Hz ($\pm 2\%$); 3 x 480 V (- 15%, + 10%), 50/60 Hz ($\pm 1\%$); 3 x 690 V (- 15%, + 10%), 50/60 Hz ($\pm 1\%$) with solidly earthed or insulated neutral
Nominal output voltage	3 x 0 V ... 380 V ($\pm 2\%$)
Output frequency	0 Hz ... 80 Hz ($\pm 0.1\%$) for induction and synchronous motors 0 Hz ... 500 Hz ($\pm 0.1\%$) for brushless DC motors
Overload	125% of nominal current for 300 seconds
Efficiency	> 95%
Operating mode	Continuous
Insulation resistance	> 20 MOhm
Control system	UMKA-05 controller
Controller memory size	8 MB (870000 records); 2 GB with SD memory card
Interface	RS 232; RS 485; CAN; USB; GSM; GPRS
Data exchange protocol	Modbus RTU
Operating temperature	- 60 °C ... 50 °C [- 76 °F...122 °F]
Protection level according to IEC 60529	IP43

Model range

Model	Nominal output current, A	Active output power, kW [hp]	Output power, kVA	Dimensions, mm [in]
Triol AK06-ASPED-100	100	55 [74]	64	950x1900x890 [38x75x35]
Triol AK06-ASPED-160	160	80 [107]	106	950x1900x890 [38x75x35]
Triol AK06-ASPED-250	250	132 [177]	176	950x1900x890 [38x75x35]
Triol AK06-ASPED-320	320	160 [214]	182	950x1900x890 [38x75x35]
Triol AK06-ASPED-400	400	200 [268]	263	950x1900x890 [38x75x35]
Triol AK06-ASPED-630	630	315 [422]	414	1300x1900x1050 [51x75x42]
Triol AK06-ASPED-800	800	400 [536]	526	1300x1900x1050 [51x75x42]
Triol AK06-ASPED-1K0	1000	500 [670]	658	1850x1990x1080 [73x78x43]
Triol AK06-ASPED-1K2	1200	600 [804]	789	2040x2000x1080 [80x79x43]
Triol AK06-ASPED-1K4	1400	700 [938]	921	2040x2000x1080 [80x79x43]
Triol AK06-ASPED-1K6	1600	800 [1072]	1053	2040x2000x1080 [80x79x43]
Triol AK06-ASPED-2K0	2000	1000 [1340]	1316	1850x1990x1080 [73x78x43] (2 cabinets)
Triol AK06-ASPED-2K5	2500	1250 [1374]	1644	2040x2000x1080 [80x79x43] (2 cabinets)
Triol AK06-ASPED-3K2	3200	1600 [2145]	2106	2040x2000x1080 [80x79x43] (2 cabinets)

The Triol AK02 — a soft starter for electric submersible pumps

Purpose: to control and protect electric submersible pumping units (ESPU) with a nominal power from 16 to 500 kW [20 to 670 hp]. The Triol AK02 provides reduced voltage and a quasi-frequency soft start or direct start for induction (asynchronous) motors.



The Triol AK02 provides reduced voltage soft start or direct start for induction (asynchronous) motors. The soft starter is intended for technological control of start and cutoff of the electric submersible pump as well as for protecting the ESPU during operation.

The Triol AK02 is designed to ease operation and to be repaired on-site under adverse climatic conditions.

Main Features

- Submersible motor protection;
- Extends ESPU lifespan by providing a soft, unstressed motor start;
- Unjamming ESP by applying pulses with a nominal voltage amplitude in order to release (unjam) the ESP (“kick start”);
- Easy operation and service;
- Operating in severe climate conditions at temperature range from - 60°C to 50 °C [- 76 °F...122 °F].

Modes of operation

- Motor “soft start” using reduced voltage, “direct start” is also possible;
- “Kick start” mode allows startup of ESPs under extreme load conditions (jamming) by delivering nominal voltage amplitude pulses to the motor;
- “Manual”, “Automatic” or “Automatic with preset time” modes depending on whether the motor needs to start automatically after a fault occurs or await the operator’s command.

Functionality

The Triol AK02 offers other following functions:

- Starts and stops according to preset parameters;
- Blocks motor startup in the presence of turbine rotation;
- On-site and remote parameter control;
- Starts ESP a preset time after supply is delivered;
- Continuous monitoring of ESP insulation resistance and turning off the motor when insulation drops under a certain preset value.

Protection

The Triol AK02 provides protection from the following:

- Output short circuit;
- Supply voltage imbalance;
- Supply network disturbances;
- Underload;
- Overload;
- Low ESP insulation resistance;
- ESP overheating (using submersible telemetry);
- Low base oil pressure (using submersible telemetry);
- High vibration level (using submersible telemetry);
- High pipeline pressure (using contact pressure gauge);
- ESM current imbalance;
- Startup during turbine rotation.

Specifications

Nominal output current	160...1000 A
Supply voltage	3 x 380 V (- 50%, + 25%), 50/60 Hz (\pm 2%); 3 x 480 V (- 15%, + 10%), 50/60 Hz (\pm 1%); 3 x 690 V (- 15%, + 10%), 50/60 Hz (\pm 1%) with grounded neutral
Nominal output voltage	3 x 0 V ... 380 V (\pm 2%); 3 x 0 V ... 480 V (\pm 2%); 3 x 0 V ... 690 V (\pm 2%)
Overload	125 % of nominal current for 300 seconds during motor operation from the supply mains 400 % of nominal current for 60 seconds during motor soft start
Efficiency	> 95%
Operating mode	Continuous
Insulation resistance	> 20 MOhm
Control system	UMKA-04 controller
Controller memory size	8 MB (870000 records); 2 GB with SD memory card
Interface	RS 232; RS 485; CAN; USB; GSM; GPRS
Data exchange protocol	Modbus RTU
Operating temperature	- 60 °C ... 50 °C [-76 °F...122 °F]
Protection level according to IEC 60529	IP43

Model range

Model	Nominal output current, A	Output power, kVA	Dimensions, mm [in]
Triol AK02-160	160	70	840x1900x675 [33x75x26]
Triol AK02-250	250	100	840x1900x675 [33x75x26]
Triol AK02-320	320	125	840x1900x675 [33x75x26]
Triol AK02-400	400	160	840x1900x675 [33x75x26]
Triol AK02-630	630	250	1140x1900x680 [45x75x27]
Triol AK02-800	800	290	1140x1900x680 [45x75x27]
Triol AK02-1000	1000	360	1140x2000x900 [45x75x27]

The Triol AT08 — an all-purpose variable frequency drive

Purpose: to control machines and mechanisms based on three-phase asynchronous electric motors with supply voltage of 660 V, and nominal power from 200 to 630 kW [268 ... 844 hp].

The Triol AT08 variable frequency drive is an efficient solution with respect to technological tasks for the automatic controlling efficiency of machines and mechanisms. This drive saves energy, resources and prolongs the operable lifetime of the used equipment.

The Triol AT08 frequency drive is commonly used with:

- Compressors;
- Electrical mine hoists;
- Conveyors and transporters;
- Mine pumps and fans;
- Open-mine excavators;
- Rock-drilling machines.



Main Features

- Optimized algorithms of high-frequency PWM-control;
- Laws of frequency regulation of the asynchronous electric motor;
- Scalar control;
- 6 Quantized inputs (10 ... 20 mA, load resistance 2 kOhm, type of signal – “dry contact”);
- 2 Analog inputs (optionally – up to 6, 0 (4) – 20 mA, 0 – to 10 V);
- 2 Programmable relay outputs (optionally – up to 6, 0.3 A, 250 V, type of signal – “dry contact ”);
- 2 Analog outputs (0 (4) – 20 mA, 0 – 10 V);
- 1 Channel of serial communication via the RS485 interface (data exchange by “Modbus” protocol).

Modes of operation

Manual mode

The drive processes the output frequency value, which has been set via the control console or automated control system. The rotation frequency of electric motor is thereby controlled.

The control console of the Triol AT08 is equipped with a graphic LCD, light indication and comfortable keyboard.

Local control is implemented by embedded control console.

Remote control is implemented by one of the following ways:

- Remote control console
- External automated control system or PC via channels of serial communications
- Discrete (quantized) or analog signals from external automated control station

Automatic mode

— The frequency is regulated in a closed loop system. The control is implemented in two ways:

1. By using an embedded PID control. This approach is based on signals from feedback sensors (speed sensor, sensor of process-dependent parameters, etc.).
2. By using a mathematical model of the controlled process (without sensors).

Functionality

- Controlling asynchronous motor operation in every mode:
 1. Start by preset algorithm;
 2. Long-term operation in a preset range of rotation and loading frequencies;
 3. Reversal motion;
 4. Dynamic breaking with energy dissipation through brake resistors;

5. Stop.

- Controlling process variables by means of PID control;
- Protecting the frequency converter, asynchronous motor and mechanisms at emergency conditions;
- Remote receipt and processing of control signals, setting parameters and modes (including via serial communication channels from controlling machines and high level systems);
- Signaling, displaying and remote transmission of information about parameters and operation modes;
- Calculating the number of hours worked;
- Registering refusals, off-nominal and emergency modes.

Specifications

Power range	200 kW ... 630 kW [268 hp ... 844 hp]
Supply voltage	3 x 660 V (+10%, -15%), 50 / 60 Hz (± 2%)
Output voltage	3 x 0 V ... 660 V (± 2%)
Output frequency	0 Hz ... 50 (100) Hz (± 0.05%)
Overload	120% of nominal current during 60 s
Efficiency (without motor)	> 0.97
Power factor (of electric mains)	> 0.95
Insulation resistance between circuits not connected galvanically Insulation resistance between circuits and chassis	10 MOhm 10 MOhm
Electric strength of insulation	4000 V, 50 Hz during 1 min
Environmental conditions:	
Operational temperature	1 °C ... 40 °C [34 °F ... 104 °F]
Air humidity (without condensation)	up to 90%
Protection level according to IEC 60529	IP21 (IP54)

Model range

Type of Triol AT08 variable frequency drive	M20	M25	M32	M40	M63
Nominal power, kVA	260	340	420	525	835
Nominal power of electric motor, kW [hp]	200 [268]	250 [335]	320 [429]	400 [536]	630 [844]
Nominal load current I _r , A	230	300	370	460	730
Dimensions, mm [in]	800x1500x450 [32x59x18]				1200x2000x600 [47x79x33]

The Triol AT23 — a medium voltage variable frequency drive

Purpose: to control automatically the rotation frequency and torque of production machines and mechanisms with three-phase asynchronous electric motors with nominal power from 90 to 1600 kW [121... 2145 hp], voltage class 6 kV. The Triol AT23 variable frequency drive () has a developed external interface, which allows its adaptation to up-to-date automatic systems. This device can be used as a basis for creating automatic control systems for different mechanisms.



Main Features

- Wide range of functional capabilities (up to 500 programmable parameters);
- Programmable frequency of pulse-width modulation: 2–6 kHz;
- Embedded and remote control panels with LCD;
- 6 Programmable digital inputs (10 mA, Load resistance 2 kOhm);
- 6 Programmable digital outputs (Relay, 250 V, 3 A);
- 4 Galvanically isolated, programmable analog inputs (0 – 5 mA, 0(4) – 20 mA, 0 – 10 V);
- 2 Programmable analog outputs (0 – 5 mA, 0(4) – 20 mA, 0 – 10 V);
- 2 Channels for a RS485 serial connection (for one cabinet variant);
- Channel for a RS232 serial connection (external RS485/232 converter is in the delivered set).

Modes of operation

Manual mode

The drive processes the output frequency value, which has been previously set via the control console or the automated control system. This in turns allows one to control the electric motor's rotation frequency.

Automatic mode

The frequency is regulated in a closed loop system. Control is exercised by using the embedded PID control. This approach is based on signals from feedback sensors (i.e. the speed sensor, or the sensor for the process-dependent parameter). The rotor's rotation speed may be changed in order to maintain a specified system parameter (flow rate, pressure, temperature, etc.), which makes it possible to optimize the motor's operation in line with actual operating conditions. A signal from a correspondent sensor is directly sent to the variable frequency drive.

Functionality

Besides operating in manual and automatic modes, the Triol AT23 variable frequency drive allows controlling a set of electric motors. This function enables controlling several electric motors in parallel by using one Triol AT23 VFD. Each electric motor is launched to a preset mode and then is switched over to the mains. The Triol AT23 variable frequency drive can be programmed for alternate controlling electric motors, in line with the chosen control algorithm.

Protection

The Triol AT23 provides protection from the following:

- Currents of prohibitive overload and short-circuiting (including ground short-circuiting);
- Abnormal overvoltage at power units;
- Fault values or loss of mains' voltage;
- Open-phase operation mode of a main or electric motor;
- Prohibited divergence of a technological parameter;
- Unauthorized access to programmable parameters.

Specifications

Supply voltage	3 x 380 V (+10%, -15%), 50/60 Hz (+/- 2%)
Auxiliary voltage	3 x 380 V (+10%, -15%), 50/60 Hz (+/- 2%)
Output voltage	3 x 0 V ... 380 V (\pm 2%)
Output frequency	1 Hz ... 50 (100) Hz (\pm 0.05%)
Overload	120% of nominal value during 120 s,
Efficiency (without electric motor)	> 95 %
Insulation resistance (between electrically non-connected circuits, between chains and case)	>10 MOhm
Electric strength of insulation for converter cabinet	2500 V, 50 Hz during 1 min
Nominal current of the electric drive low side	180 A ... 3200 A
Nominal output power	90 kW ... 1600 kW [120 hp ... 2144 hp]
Total output power	182 kVA ... 2106 kVA
Operating temperature	- 60 °C ... 50 °C [- 76 °F...122 °F]
Protection level according to IEC 60529	IP43

Model range

Type of Triol AT23	90K	M13	M16	M20	M25	M32	M40	M50	M63	M70	M80	1M0	1M2	1M4	1M6
Output power, kW [hp]	90 [121]	130 [174]	160 [214]	200 [268]	250 [335]	320 [429]	400 [536]	500 [670]	630 [844]	700 [938]	800 [1072]	1000 [1340]	1200 [1609]	1400 [1878]	1600 [2145]
Nominal current of primary power, circuit, A	180	260	320	400	500	630	800	1000	1200	1400	1600	2000	2400	2800	3200
Total output current, kVA	118	171	182	263	329	414	526	658	829	921	1053	1316	1579	1842	2106
Mass, kg [lb]	390 [860]	390 [860]	560 [1235]	560 [1235]	580 [1279]	740 [1631]	790 [1741]	850 [1874]	1200 [2645]	1200 [2645]	1250 [2756]	1700 [3747]	2400 [5291]	2400 [5291]	2500 [5511]

The Triol AT24 — a low-voltage variable frequency drive for controlling asynchronous and brushless DC motors

Purpose: to control induction (asynchronous) or brushless DC motors with variable or constant load torque requirements; the delivered power from 5.5 to 400 kW [7.4 ... 536 hp].

The Triol AT24 is a universal drive that can be used for motors with variable or constant torque load.



Applications

- Elevators;
- Pumps;
- Fans;
- Conveyors;
- Compressors.

Main Features

- Scalar or flux vector control with or without a speed sensor;
- Motor parameter measurement at standstill allows one to measure motor parameters while a load is connected without the need to fixing the shaft mechanically;
- Reduces power consumption due to various operating modes;
- DC injection braking makes it possible to quickly brake the motor by applying DC voltage to the motor windings;
- Rotation direction and speed control by analog input;
- Cascade control of up to 4 pumps;
- Wall and floor mounting;
- Evacuation mode for elevators;
- Transferring drive settings using control panel when several Triol AT24 drives with the same parameters need to be installed;
- Motor insulation resistance monitoring.

Modes of operation

- “Sleep” mode stops the motor if the pipeline pressure has reached its maximum value at the minimum preset output frequency;
- “Current optimization” mode to provide automatic output voltage adjustment in order to get the minimum full load current at fixed output frequency;
- The “Flying start” mode enables the motor to start while the shaft’s freewheeling rotation is present.

Functionality

- Linear and S-type rates of acceleration and deceleration;
- Controllable time of acceleration and deceleration, time from 0.5 s;
- Rotating at increased speed (the drive determines the shaft load and speed excess in comparison with the rated one);
- 3 modes of braking via an electric motor: applying brake, frequency braking, and dynamic braking;
- Complex motor overheat protection with or without temperature sensor gauge;
- Service software.

The AT24 elevator modification has the following features:

- Controlling and monitoring state of operability of elevator brakes;
- Controlling and monitoring state of operability of a motor contactor;
- A set of measures destined to ensure passenger safety in emergency situations;
- Evacuation mode: the drive operates by using one phase and AC 220 V only.

Specifications

Nominal power	5.5 kW ... 400 kW [7.4 hp ... 536 hp]
Supply voltage	3 x 380 V (- 15%, + 10%), 50/60 Hz (± 2%)
Nominal output voltage	3 x 0 V ... 380 V (± 2%)
Output frequency	0 Hz ... 400 Hz for asynchronous motors (± 0.1%) 0 Hz ... 500 Hz for brushless DC motors (± 0.1%)
Overload	120% of nominal current for 60 seconds
Efficiency	> 95%
Operating mode	Continuous
Insulation resistance	> 1 MOhm
Interface	RS 485; CAN
Data exchange protocol	Modbus RTU; CANopen; Profibus DP, DeviceNet
Operating temperature	1 °C ... 40 °C [34 °F... 104 °F]
Protection level according to IEC 60529	IP00, IP21, IP54

Model range

Model	Active output power, kW [hp]	Nominal output current, A	Output power, kVA	Dimensions, mm [in]
AT24-5k5	5.5 [7.4]	11	7.5	150x305x185 [5.9x12x7.3]
AT24-7k5	7.5 [10]	15	10	150x305x185 [5.9x12x7.3]
AT24-11k	11 [14.7]	22	15	150x305x235 [5.9x12x9.3]
AT24-15k	15 [20.1]	30	18	150x305x235 [5.9x12x9.3]
AT24-22k	22 [29.5]	45	28	240x420x235 [9.4x16.5x9.3]
AT24-30k	30 [40.2]	60	38	240x420x235 [9.4x16.5x9.3]
AT24-37k	37 [50]	75	45	235x515x330 [9.3x20.3x13]
AT24-45k	45 [60]	90	56	235x515x330 [9.3x20.3x13]
AT24-55k	55 [74]	110	72	250x670x330 [9.8x26.4x13]
AT24-75k	75 [100]	150	100	250x800x430 [9.8x31.5x16.9]
AT24-90k	90 [120]	180	120	250x800x430 [9.8x31.5x16.9]
AT24-M11	110 [147]	220	145	250x800x430 [9.8x31.5x16.9]
AT24-M13	130 [174]	260	175	580x950x420 [22.8x37.4x16.5]
AT24-M16	160 [214]	320	210	640x1190x391 [25.2x46.8x15.4]
AT24-M20	200 [268]	400	260	640x1190x391 [25.2x46.8x15.4]
AT24-M25	250 [335]	500	330	640x1190x391 [25.2x46.8x15.4]
AT24-M32	320 [429]	640	400	900x1100x420 [35.4x43.3x16.5]
AT24-M40	400 [536]	800	500	900x1100x420 [35.4x43.3x16.5]

The Triol AT27 — medium voltage multi-level PWM-controlled IGBT variable frequency drive

Purpose: to control induction (asynchronous) or brushless DC motors with variable or constant load torque requirements, nominal voltage 6 or 10 kV and the delivered power ranges from 200 to 6300 kW [268 ... 8445 hp].



Applications

— Pumps, fans, conveyors, compressors, blowers.

The Triol AT27 is a solution for:

- Municipal services;
- Metallurgy;
- Oil extraction and refining;
- Mining industry;
- Energy production;
- Pipelines;
- Electro motion systems;
- Transportation.

Main Features

- Reduces energy consumption for up to 60%;
- Low harmonic distortion in input current (THD<3%);
- High starting torque;
- High reliability due to two separate power supplies and optical signal transmission;
- High power factor (P.F. >96%) and high efficiency (η >96%);
- Drive bypass;
- Ideal sinusoidal output voltage (THD<4%);
- Controlling several motors.

Functionality

- Soft motor start and stop with preset acceleration and braking rate (Hz/s), limiting inrush current;
- “Manual”, “Automatic” or “Automatic with preset time” modes depending on whether the motor needs to start automatically after a fault occurs or await the operator’s command;

- “Current optimization” mode to provide automatic output voltage adjustment in order to get the minimum full load current at fixed output frequency;
- Start and stop according to a preset time schedule;
- Local, distant or ACS control modes enable the operator to choose the most convenient control source;
- Changes output frequency according to a preset time schedule;
- Cascade starting of several motors;
- Changing the motor’s speed of rotation according to a feedback from a technological parameter sensor (pressure, temperature, etc.);
- Self-diagnostic system enables the drive to find the exact place a failure occurs and save details of the failure in question in a log;
- Measures consumed energy;
- Restart after short time supply drop out (> 2.5 s) and continue operation.

Functionality

The Triol AT27 protects the motor from the following:

- Output short circuit;
- Underload;
- Motor reverse rotation;
- Overload;
- Supply voltage disturbances;
- Voltage surges.

Specifications

Nominal power	200 kW ... 6300 kW [268 hp ... 8445 hp]
Supply voltage	3 x 6/10 kV ($\pm 10\%$), 50/60 Hz ($\pm 10\%$)
Nominal output voltage	3 x 0 kV ... 6/10kV ($\pm 2\%$)

Output frequency	0 Hz ... 120 Hz ($\pm 0.1\%$)
Overload	120 % of nom. current for 60 s; 150 % of nom. current for 3 s; 200 % of nom. current for 10 ms
Efficiency	> 96 %
Total harmonic distortion in input current	< 3 %
Total harmonic distortion in output voltage	< 4 %
Operating mode	Continuous
Insulation resistance	> 20 MOhm
Control system	UMKA27 controller
Controller memory size	8 MB (870000 records)
Interface	RS 485; Ethernet; USB
Data exchange protocol	Modbus RTU
Operating temperature	1 °C ... 40 °C [34 °F ... 104 °F] – base modification, -65 °C ... 50 °C [-85 °F ... 122 °F] – block-box modification
Protection level according to IEC 60529	IP30 – base modification; IP43 – block-box modification

Model range

Model	Nominal voltage, kV	Nominal output current, A	Nominal power, kW [hp]	Dimensions, mm [in]	Mass, kg [lb]
AT27-M20-6	6	25	200 [268]	4500x1000x1800 [177x40x71]	2880 [6349]
AT27-M25-6	6	30	250 [335]	4500 x 1000 x 1800 [177 x 40 x 71]	3110 [6856]
AT27-M315-6	6	40	315 [422]	4500 x 1000 x 1800 [177 x 40 x 71]	3620 [7981]
AT27-M40-6	6	50	400 [536]	4800 x 1000 x 1800 [189 x 40 x 71]	3910 [8620]
AT27-M50-6	6	60	500 [670]	4800 x 1000 x 1800 [189 x 40 x 71]	4490 [9900]
AT27-M63-6	6	75	630 [844]	4800 x 1000 x 1800 [189 x 40 x 71]	5070 [11177]
AT27-M80-6	6	95	800 [1072]	4800 x 1000 x 1800 [189 x 40 x 71]	5340 [11773]
AT27-1M0-6	6	125	1000 [1340]	5200 x 1200 x 2100 [205 x 47 x 83]	6060 [13360]
AT27-1M25-6	6	155	1250 [1675]	5200 x 1200 x 2100 [205 x 47 x 83]	6320 [13933]
AT27-1M6-6	6	195	1600 [2145]	5200 x 1200 x 2100 [205 x 47 x 83]	6930 [15378]
AT27-2M0-6	6	245	2000 [2681]	5200 x 1200 x 2100 [205 x 47 x 83]	7520 [16580]
AT27-2M5-6	6	305	2500 [3351]	6400 x 1400 x 2200 [252 x 55 x 87]	8780 [19386]
AT27-3M2-6	6	400	3200 [4288]	6400 x 1400 x 2200 [252 x 55 x 87]	10700 [23589]
AT27-4M0-6	6	500	4000 [5362]	7000 x 1700 x 2300 [275 x 67 x 90]	12500 [27558]
AT27-5M0-6	6	625	5000 [6702]	7000 x 1700 x 2300 [275 x 67 x 90]	14500 [31967]
AT27-6M3-6	6	790	6300 [8445]	7700 x 1800 x 2300 [303 x 71 x 90]	18600 [41006]
AT27-M50-10	10	40	500 [670]	5900 x 1300 x 1900 [232 x 51 x 74]	6240 [137568]
AT27-M63-10	10	50	630 [844]	5900 x 1300 x 1900 [232 x 51 x 74]	6470 [14264]
AT27-M80-10	10	65	800 [1072]	5900 x 1300 x 1900 [232 x 51 x 74]	6740 [14860]
AT27-1M0-10	10	75	1000 [1340]	6400 x 1300 x 2100 [252 x 51 x 83]	7100 [15653]
AT27-1M25-10	10	95	1250 [1675]	6400 x 1300 x 2100 [252 x 51 x 83]	7520 [16580]
AT27-1M6-10	10	115	1600 [2145]	6400 x 1300 x 2100 [252 x 51 x 83]	8780 [19357]
AT27-2M0-10	10	155	2000 [2681]	6400 x 1300 x 2100 [252 x 51 x 83]	9850 [21715]
AT27-2M5-10	10	190	2500 [3351]	7800 x 1400 x 2200 [307 x 55 x 87]	10900 [24030]
AT27-3M2-10	10	245	3200 [4288]	7800 x 1400 x 2200 [307 x 55 x 87]	13000 [28660]
AT27-4M0-10	10	305	4000 [5362]	8600 x 1700 x 2300 [339 x 67 x 90]	14300 [31526]
AT27-5M0-10	10	360	5000 [6702]	8600 x 1700 x 2300 [339 x 67 x 90]	17300 [38140]
AT27-6M3-10	10	455	6300 [8445]	9500 x 1800 x 2400 [256 x 71 x 94]	22100 [48722]

The Triol AS25 – a medium-voltage soft starter for asynchronous motors

Purpose: to ensure a smooth start for medium-voltage asynchronous motors with variable torque load, and with power from 160 to 10000 kW [214 ... 13404 hp]. This device eliminates all constraints during the starting phase.

The Triol AS25 starter is used in belt conveyors to avoid dynamic shocks in conveyor equipment, and also in press, where pumps need to be turned on frequently. For the transmission/reception of external commands, settings and data signals, the soft starter Triol AS25 includes the following:

- 6 isolated programmable digital inputs;
- 1 analog input;
- 4 programmable digital (relay) outputs.



Main Features

- Soft start;
- Lower Energy losses;
- Bypass;
- Smooth motor breaking;
- Technological process simplification;
- Starting two or more motors.

Motor starting modes:

- Soft start mode;
- Direct start mode;
- Quasi-frequency start mode.

Functionality

- The Triol AS25 supplies the motor a gradually increasing voltage so that the inrush current is naturally limited. The rotor starts gearing gradually, and mechanical and electrical stress is thereby minimized;
- Lower Energy losses. When operating the soft starter in the quasi-frequency mode, the loss of energy in the motor is 2-4 times lower than at direct start, and 4-7 times lower than at soft start;
- A quasi-frequency start is required when the motor is repeatedly re-activated: if the motor's temperature does not have enough time to cool down to an ambient temperature, then one can use the quasi-frequency start algorithm;
- After the motor has started, the thyristors are shunted by a special contactor, directly connecting the motor to the grid. By using a bypass contactor, this leads to an improvement in the system's efficiency, an extension of the thyristors' service life, and cancelling out the effect of semi-conducting components on the grid;
- The Triol AS25 has an external front-end interface, which is adaptable to existing automation systems and generates automated control systems for different mechanisms;
- The core of the starter's control system is a microprocessor-based controller, which performs motor control algorithms of any complexity;
- The Triol AS25 archives the motor and starter event logs. This data, along with other statistical information under the MODBUS RTU protocol (channel RS-485), can be read by a top-level ACS. Similarly, all parameters from the Triol AS25 are read and recorded by the same protocol. It is remote control supported;
- Soft starting of synchronous or asynchronous motors;
- Using an ad-hoc algorithm for breaking the motor driving the pump, installation eliminates the hydrodynamic kickback in valves;
- For friction-type mechanisms, a soft starter can be used with one or more initial pulses of current (quick start), thereby eliminating slippage and clutch pulley;
- The Triol AS25 high-voltage soft starter can handle starting several motors (up to three motors). The motor is switched on with the assistance of the High Voltage Switching Unit (HVSU-1-1). The HVSU-1-1 with high-voltage contactor is designed for use as part of the soft starter system for two or more motors.

Protection

The Triol AS25 provides protection from the following:

- Supply network disturbances;
- Overload;
- Low motor insulation resistance;
- Short-circuiting.

Specifications

Nominal power	160 kW ... 10000 kW [214 hp ... 13404 hp]
Power circuits supply voltage	3 x 3, 6, 10 kV ($\pm 10\%$), 50/60 Hz ($\pm 2\%$)
Control circuits supply voltage	3 x 380 V (-15%, +10%), 50/60 Hz ($\pm 2\%$)
Nominal output voltage	3 x 3, 6, 10 kV ($\pm 10\%$), 50/60 Hz ($\pm 2\%$)
Efficiency	> 95%
Launch time	3 ... 300 seconds
Operating mode	Continuous
Insulation resistance	> 20 MOhm
Interface	RS 232
Data exchange protocol	Modbus RTU
Operating temperature	1 °C ... 40 °C [34 °F ... 104 °F]
Protection level according to IEC 60529	IP21

Model range

Model	Nominal voltage, kV	Nominal output current, A	Nominal motor power, kW [hp]
Triol AS25-3-80	3	80	160...320 [214...429]
Triol AS25-3-160		160	400...630 [536...844]
Triol AS25-6-80	6	80	160...630 [214...844]
Triol AS25-6-160		160	710...1250 [952...1675]
Triol AS25-6-250		250	1600, 2000 [2145, 2681]
Triol AS25-6-320		320	2500 [3351]
Triol AS25-6-500		500	3150, 4000 [4222, 5362]
Triol AS25-6-600		600	5000, 6300 [6702, 8043]
Triol AS25-6-800		800	8000 [10724]
Triol AS25-10-80	10	80	320...1000 [429...1340]
Triol AS25-10-160		160	1250...2000 [925...2681]
Triol AS25-10-200		200	2500...3150 [3351...4222]
Triol AS25-10-320		320	4000...5000 [5362...6702]
Triol AS25-10-500		500	6300 [8043]
Triol AS25-10-800		800	10000 [13404]

The Triol TM-01-03 telemetry system for measuring parameters of oil-well and ESM

Purpose: is used for monitoring actual parameters of oil well and electric submersible motors (ESM), as listed below:

- ESM oil temperature;
- Base oil temperature;
- ESM windings temperature (option);
- ESM oil pressure or Base oil pressure (option);
- Root-mean-square (RMS) of vibration acceleration of electric submersible motor along the X/Y or Z axes;
- Insulation resistance of the circuit “AC-voltage oil transformer – submersible electric cable – ESM”.

The Triol TM-01-03 telemetry system consists of:

- The TMN-01-03 ground unit is a ground measuring and computational center;
- The TMP-01-03 submersible unit is a down-hole sensor.

A variety of adapters and intermediate flanges allows connecting the submersible unit of the Triol TM-01-03 to different types and dimensions of ESM.



Main Features

- Maximal withstanding dielectric breakdown voltage – 7500 V;
- Maximal measured ambient temperature for down-hole sensor – 150 °C [302 °F];
- Maximal measured ESM windings temperature – 200 °C [392 °F];
- Maximal measured pressure for down-hole sensor – 400 atm [94054 oz/in²];
- Connection to a drive or an automated control system with the help of either RS-232 or RS-485 channels;
- Submersible units are available in both basic and corrosion-resistant versions;
- Embedded protection algorithm: each cycle of measurements begins with the measurement of insulation resistance.

Functionality

The TMP-01-03 submersible unit is fixed to an ESM, measures parameters and transmits data to the ground unit.

The TMN-01-03 ground unit runs as follows:

- measures insulation resistance;
- establishes connection with the submersible unit;
- receives and processes data from the submersible unit;
- transmits data to a variable frequency drive controller or an automatic control system.

Specifications

ESM oil temperature	0 °C ... 200 °C [32 °F ... 392 °F] (±1%)
Base oil temperature	0 °C ... 150 °C [32 °F ... 302 °F] (±1%)
ESM windings temperature (option)	0°C ... 200°C [32 °F ... 392 °F] (±1%)
ESM oil pressure or Base oil pressure (option)	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²] (±1%)
RMS of vibration acceleration amplitude at vibration along radial and axial directions in the area of ESM hanging up	0 m/s ² ... 30 m/s ² [0 ft/s ² ... 98.4 ft/s ²] (±5 %)
Insulation resistance of circuit “AC-voltage oil transformer – submersible electric cable – ESM” in ranges	10 kOhm ... 1000 kOhm (±2%) 1000 kOhm ... 10000 kOhm (±5%)

The TMN-01-03 ground unit

Nominal input voltage	220 V ($\pm 40\%$)
Supply frequency	50/60 Hz ($\pm 2\%$)
Maximal consumed power	40 W
Operating temperature	- 60 °C ... 75 °C [-76°F ... 167 °F]
Relative air humidity at temperature 25 °C [77 °F]	100%
Maximal height above sea level	1000 m [3280 ft]
Protection level according to IEC 60529	IP21
Operation mode	Continuous
Overall dimensions	212 x 240 x 142 mm [8.3 x 9.5 x 5.6 in]
Maximal mass	6 kg [13 lb]

The TMP-01-03 submersible unit

Ambient temperature	0 °C ... 150 °C [32°F ... 302°F]
ESM oil temperature (a temperature sensor is placed in place of the ESM hanging up)	0 °C ... 200 °C [32 °F ... 392 °F]
ESM windings temperature (a temperature sensor is placed in place of the ESM hanging up, option)	0 °C ... 200 °C [32 °F ... 392 °F]
ESM oil pressure or Base oil pressure in area of ESM hanging up (option)	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²]
Depth of submergence	3500 m [11483 ft]
Index of protection according to IEC 60529	IP68
Operation mode	Continuous
Overall dimensions:	
Maximal diameter*	96 mm [3.8 in]
Maximal length*	655 mm [25.8 in]
Maximal mass	22 kg [48.5 lb]
* Embodiment of the submersible unit can be tailored to the customer's individual needs	

The Triol TM-01-04 monitoring system for the high-precision measuring parameters of oil well and ESM

Purpose: to monitor parameters of oil wells and electric submersible motors (ESM). The monitoring system is a hardware-software solution used to provide high-quality measures of oil-well parameters at the durational influence of the complex environment.



- ESM oil temperature;
- Base oil temperature;
- ESM windings temperature;
- Base oil pressure;
- Root-mean-square (RMS) of vibration acceleration of ESM along the X/Y or Z axes;
- Insulation resistance of the circuit “AC-voltage oil transformer – submersible electric cable – ESM”.

The Triol TM-01-04 monitoring system consists of:

- The MN-01-04 ground unit is a ground measurement and computational center;
- The TMP-01-04 submersible unit is a down-hole sensor.

A variety of adapters and intermediate flanges allows connecting the submersible unit of the Triol TM-01-04 to different types and dimensions of ESM.



Main Features

- Two Modes of operation main mode and scanning mode;
- In scanning mode – 18 pressure measurements per 7-seconds cycle;
- Maximal withstanding dielectric breakdown voltage – 2500 V;
- Maximal measured base oil temperature – 150 °C [302 °F];
- Maximal measured ESM windings temperature – 200 °C [392 °F];
- Maximal measured base oil pressure – 400 atm [94054 oz/in²];
- Connection to a drive or an automated control system with the help of either RS-232 or RS-485 channels;
- Submersible units are available in both basic and corrosion-resistant versions;
- Embedded protection algorithm: each cycle of measurements begins with the measurement of insulation resistance.

Modes of operation

Main mode

The main mode provides the measuring technological parameters and the parameters of the state of the ESP unit. These parameters are transmitted to the UMKA-03 controller, embedded in the Triol AK06 variable frequency drive. It makes the operation of an electric submersible pump unit more effective and profitable. In the “main mode”, the Triol TM-01-04 monitors the parameters listed below:

- ESM oil temperature;
- Base oil temperature;
- ESM windings temperature;
- Base oil pressure;
- RMS of vibration acceleration of ESM along the X/Y or Z axes;
- Insulation resistance of circuit “AC-voltage oil transformer – submersible electric cable – ESM”.

The data is updated every 60 seconds or faster.

Pressure scanning mode

In the pressure scanning mode, the following parameters are scanned and transmitted:

- Base oil temperature (1 measurement);
- ESM windings temperature (1 measurement);
- Base oil pressure (18 measurements);
- Insulation resistance of circuit “AC-voltage oil transformer – submersible electric cable – ESM” (< 3 seconds).

The data packet is updated every 7 sec or less.

The monitoring log storages following parameters:

- Time and date of measurement;

- Base oil pressure;
- Base oil temperature;
- ESM rotation frequency;
- ESM loading.

Operation:

The TMP-01-04 submersible unit is fixed to an ESM, measures parameters and transmits data to the ground unit.

The TMN-01-04 ground unit runs as follows:

- measures insulation resistance;
- establishes connection with the submersible unit;
- receives and processes data from the submersible unit;
- transmits data to a variable frequency drive controller or an automatic control system.

Specifications

Parameter	Main mode	Pressure scanning mode
Base oil temperature	0 °C ... 150 °C [32 °F ... 302 °F] (± 1%)	0 °C ... 150 °C [32 °F ... 302 °F] (± 1%)
ESM oil temperature	0 °C ... 200 °C [32 °F ... 392 °F] (± 1%)	—
ESM windings temperature	0 °C ... 200 °C [32 °F ... 392 °F] (± 1%)	0 °C ... 200 °C [32 °F ... 392 °F] (± 1%)
RMS of vibration acceleration along the radial and axial directions (in place of ESM hanging up)	0 m/s ² ... 30 m/s ² [0 ft/s ² ... 98.4 ft/s ²] (± 5%)	—
Base oil pressure	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²] (± 0.25%)	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²] (± 0.25%) (pressure resolution – 0.01 atm [2.35 oz/in ²])
Insulation resistance of circuit “AC-voltage oil transformer – submersible electric cable – ESM” within the ranges	10 kOhm ... 1000 kOhm (± 2%) 1000 kOhm ... 10000 kOhm (± 5%)	10 kOhm ... 1000 kOhm (± 5%)

The TMN-01-04 ground unit

Nominal input voltage	220 V ±40%
Supply frequency	50/60 Hz ±2%
Maximal consumed power	40 W
Operating temperature	- 60 °C ... 75 °C [-76 °F to 167 °F]
Relative air humidity at temperature 25 °C [77 °F]	100%
Maximal height above sea level	1000 m [3280 ft]
Protection level according to IEC 60529	IP21
Operation mode	Continuous
Overall dimensions	212 x 240 x 142 mm [8.3 x 9.5 x 5.6 in]
Maximal mass	6 kg [13 lb]

The TMP-01-04 submersible unit

Ambient temperature	0 °C ... 150 °C [32 °F ... 302 °F]
ESM oil temperature (a temperature sensor is placed in place of the ESM hanging up)	0 °C ... 200 °C [32 °F ... 392 °F]
ESM windings temperature (temperature sensor is placed in end windings of ESM lower part)	0 °C ... 200 °C [32 °F ... 392 °F]
Maximal pressure in area of ESM hanging up	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²]
Depth of submergence	3500 m [11483 ft]
Protection level according to IEC 60529	IP68
Operation mode	Continuous
Overall dimensions:	
Maximal diameter*	96 mm [3.8 in]
Maximal length*	677 mm [26.4 in]
Maximal mass	22 kg [48.5 lb]
* Embodiment of the submersible unit can be tailored to the customer's individual needs	

The Triol TM-01-05 telemetry system for measuring oil well parameters at both the low part of ESM and at ESP discharge



Purpose: is used for monitoring actual parameters of oil well and ESM, as listed below:

- ESM oil temperature;
- Base oil temperature;
- ESP discharge temperature;
- Base oil pressure;
- ESP discharge pressure;
- Root-mean-square (RMS) of vibration of ESM in planes X/Y and Z;
- Insulation resistance of circuit “AC-voltage oil transformer – submersible electric cable – ESM”.

The Triol TM-01-05 consists of three units:

- TMN-01-05 ground unit is a ground measurement and computational center;
- TMP-1 submersible unit is a down-hole sensor located at lower part of an electric submersible motor;
- TMP-2 submersible unit is a down-hole sensor located at an ESP discharge.

Main Features

- Measures pressure and temperature of a base oil at an ESP discharge;
- Maximal withstanding dielectric breakdown voltage – 7500 V;
- Maximal measured base oil temperature at ESP discharge – 150 °C [302 °F];
- Maximal measured ESM oil temperature – 200 °C [392 °F];
- Maximal measured pressure for down-hole sensor – 400 atm [94054 oz/in²];
- Connection to a drive or an automated control system with the help of either RS-232 or RS-485 channels;
- Embedded protection algorithm: each cycle of measurements begins with measurement of insulation resistance.

Modes of operation

The TMP-2 submersible unit measures temperature and pressure of a liquid flow at discharge of an electric submersible pump and transmits them to the TMP-1 submersible unit.

The TMP-1 submersible unit carries out several tasks:

- establishes connection with the TMP-2 submersible unit;
- receives data measured by the TMP-2 submersible unit;
- measures oil well and ESM parameters;
- transmits all the data to TMN-01-05 ground unit.

The TMN-01-05 ground unit runs as follows:

- measures insulation resistance;
- establishes connection with the TMP-1 submersible unit;
- receives and processes data from the TMP-1 submersible unit;
- transmits data to a variable frequency drive controller or an automatic control system.

The Triol TM-01-05 telemetry system operates in three stages:

1. Insulation resistance measurement stage;
2. TMP-1 unit activation stage;
3. Transmission data from TMP-1 and TMP-2 units stage.

These stages run in a cycle one after another.

Specifications

The TM-01-05 enables to control and display parameters listed further:

Base oil temperature	0 °C ... 150 °C [32 °F ... 302 °F] (±1 %)
ESM oil temperature	0 °C ... 200 °C [32°F ... 392°F] (±1 %)
Base oil pressure	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²] (±1 %)
RMS of vibration acceleration along radial and axial directions in the area of ESM hanging up	0 m/s ² ... 30 m/s ² [0 ft/s ² ... 98.4 ft/s ²] (±5 %)
Base oil temperature at pump discharge	0 °C ... 175 °C [32 °F ... 347 °F] (±1 %)
Base oil pressure at pump discharge	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²] (±1 %)
Insulation resistance of circuit "AC-voltage oil transformer – submersible electric cable – ESM" in ranges	10 kOhm ... 1000 kOhm (±2 %) 1000 kOhm ... 10000 kOhm (±5 %)

The TMN-01-05 ground unit

Nominal input voltage	220 V ±50 %
Supply frequency	50/60 Hz ±2 %
Maximal consumed power	40 W
Operating temperature	- 60 °C ... 75 °C [-76 °F ... 167 °F]
Relative air humidity at temperature 25 °C [77 °F]	100 %
Maximal height above sea level	1000 m [3280 ft]
Protection level according to IEC 60529	IP21
Operation mode	Continuous
Overall dimensions	212 x 240 x 142 mm [8.3 x 9.5 x 5.6 in]
Maximal mass	6 kg [13 lb]

The TMP-1 submersible unit

Ambient temperature	0 °C ... 150°C [32 °F ... 302 °F]
ESM oil temperature	0 °C ... 200°C [32 °F ... 392 °F]
Maximal pressure in area of ESM hanging up	400 atm
Depth of submergence	3500 m [11483 ft]
Protection level according to IEC 60529	IP68
Mode of operation	Continuous
Overall dimensions:	
maximal diameter*	110 mm [4.3 in]
maximal length*	955 mm [37.6 in]
Maximal mass	38 kg [83.7 lb]
* Embodiment of the TMP-1 submersible unit can be tailored to the customer's individual needs	

The TMP-2 submersible unit

Ambient temperature	0 °C ... 150 °C [32 °F ... 302°F]
Liquid temperature at pump discharge	0 °C ... 175 °C [32 °F ... 347 °F]
Maximal pressure in area of TMP-2 hanging up	0 atm ... 400 atm [0 oz/in ² ... 94054 oz/in ²]
Depth of submergence	3500 m [11483 ft]
Protection level according to IEC 60529	IP68
Mode of operation	Continuous
Overall dimensions:	
maximal diameter*	117 mm [4.6 in]
maximal length*	780 mm [30.7 in]
Maximal mass	31,5 kg [12.4 lb]
* Embodiment of the TMP-2 submersible unit can be tailored to the customer's individual needs	

The UMKA-03 controller — an automated system controller



- Purpose:** — Can be embedded into control and informational automated systems of technological processes;
- Maintains the required modes and algorithms of equipment's performance;
 - Creating a system for blocking and emergency protection;
 - Distribution of access rights;
 - Viewing information about the operation of technological systems in real time;
 - Information acquisition, storage and output by the event log.

Information from the UMKA-03 controller is displayed on a widescreen LCD display with a resolution of 320x240 pixels. The display has a backlight for improving visibility in low-light conditions. A contrast can be controlled both automatically and manually.

The intelligible interface and simple algorithm for setting set values allows one to immediately start working with the controller.

All information about state, protection activity, operating parameters values, etc. is displayed in text form without any use of numeric codes or symbols requiring interpretation.

A status menu which the user can customize allows the operator to assess the situation at a glance.

Service software designed and manufactured by Triol to operate with the UMKA-03 controller and makes it possible to:

- Read information from the VFD;
- View event-logs;
- Investigate the cause of emergencies;
- Analyze data about the state of VFD during an emergency;
- Control the VFD remotely by changing the set values.

Main Features

- High capacity;
- Simplicity and reliability;
- Working with different telemetry manufacturers;
- Comprehensive information about the well.

Software parameters

At the Customer's request the specialized software can be developed for solving specific problems. On default it contains:

- "ESM actual parameters" — intended for viewing the ESM operating characteristics;
- "VFD actual parameters" — intended for viewing VFD operating characteristics and monitoring the mains;
- "Actual input parameters" — intended for viewing the VFD's actual parameters;
- "Modes of operation" — intended for setting the VFD operating modes and for controlling the FC output frequency;
- "Modes of start" — enables one to adjust the VFD starting mode for various conditions;
- "Drive settings" — allows for setting the FC operating parameters and calibrating the current and voltage measurement circuits;
- "Protections" — here a user may find set values for protections, as well as the parameters defining the ARC debugging in the automatic operation mode;
- "Downhole measure equipment" — intended for setting telemetry;
- "Installation parameters" — contains set values characterizing a particular field, cluster or well;
- "Calculation of step-up transformer tap voltage" — allows for calculating the ACVOT tap voltage automatically;
- "System" — allows the controller to set system variables;
- "Event log" — intended for viewing the controller event log and for changing the parameters of the information being recorded in the event log and their viewing. Contains data-recording and data-scanning settings;
- "Start-up graph" — intended for viewing startup diagrams representing parameter changes within 30 seconds from the start;
- "Emergency graph" — intended for viewing emergency diagrams.

Functionality

- The processor capacity enables one to perform a large amount of computations in order to simulate the processes occurring in the well;
- For user convenience, the controller is equipped with a USB interface, making it possible to read the event logs from the UMKA-03 controller. Information transmission to the PC is performed by ordinary flash memory in less than 15 seconds. Software updates are performed from the USB flashcard without stopping ESP; this lasts about 5-10 seconds. The user can also estimate the equipment's operating time using information read from the UMKA-03 controller, and then document and archive the information obtained;
- Wide function package. Data processing (data can be transmitted from sensors, echo-sounders, submersible telemetry, as well as from working devices, etc.) and data transmission to the "upper level" are fulfilled.
- There is an embedded system for measuring electricity and/or registering energy consumption parameters in the automated system;
- The contextual menu is used for quick access to the frequently used functions. The service software features pop-up help regarding the control elements' functions in order to make it easier for inexperienced users to use the software.
- Supports interaction with external automatic control systems by using RS-485;
- Supports data exchange by GPRS protocol (if the modem is embedded to VFD);
- Shows diagrams of VFD and ESM parameters changing;
- Simultaneously displays 12 parameters from the group chosen by user;
- Records active parameters and information about reasons of ESM starts and stops to embedded nonvolatile memory;
- Allows the use of USB flash drives in order to update firmware, save logs and diagrams.

Specifications

Supply voltage	220 V ($\pm 50\%$)
Operating temperature	- 25 °C ... 60 °C [-13 °F ... 140 °F]
Overall dimensions	290x212x72 mm [11.4x5.3x2.8 in]
Protection level according to IEC 60529	IP40
Operating mode	Continuous
Supply voltage	+24 (± 3) V
Consumed power:	
Power of the hardware	15 W
Power of the heating elements	14 W
Resources:	
Program memory	512 kB
RAM	96 kB
Non-volatile clock-calendar	32 kB
Log memory size	8 MB (870000 records) 2 GB with SD memory card
Interfaces:	
RS485	3
RS232	2
USB	1
CAN	1
GPRS	1
Optical channel (for internal exchange)	1
Data exchange protocol	Modbus RTU

The Triol ESP WorkBench — a system for testing electric submersible pumps

Purpose: **Acceptance testing.** Detection of flow rate, flow pressure, rotational frequency, power and efficiency.
Qualification testing. Running-in, obtaining pressure characteristics and power characteristics.
Parametrical tests. Detection of flow rate, flow pressure, rotational frequency, power, and efficiency at different values of ESP rotary speed.
 The Triol ESP WorkBench enables measuring and calculating the following parameters and ESP characteristics:



Measuring parameters:

- flow rate
- input pressure
- output pressure
- shaft torque
- rotational velocity
- fluid temperature
- pressure characteristics
- ESP vibration
- temperature of ESP body

Calculated characteristics:

- power characteristics;
- efficiency characteristics.

Functionality

Running-in.

The pump is run in at a rated rotational frequency for 15 minutes.

Obtaining pressure and power characteristics.

These characteristics are being defined at the nominal rotary speed of a pump. Upon changing the pressure characteristics, the following dependencies are determined: pump thrust $H=f(Q)$, mechanical shaft power $P=f(Q)$, pump efficiency $\eta=f(Q)$, pump flow $V=f(Q)$.

The characteristics are drawn by varying the flow rate via a controllable throttle valve at an ESP output. The entire testing process is carried out automatically. All tests result in graphic expressions of the dependencies described above.

All the tests could be carried out in manual mode. It allows to get characteristics at different values of rotary speed.

During all tests, when necessary, the vibration and temperature of ESM bodies are controlled. The Triol ESP WorkBench is completely engineered and manufactured by the Triol Corporation. All parameters and the construction of the workbench can be tailored to the customer's individual needs.

Specifications

Electrical parameters

Parameters	Value
Supply voltage	3x380 V
Consumed current	< 300 A
Supply frequency	50 Hz
Power of ESP electric drive	90 kW [120 hp]
Booster pump head	11 kW [15 hp]

Measuring parameters

Parameter	Value	Tolerance
Flow rate	0.4 m ³ /h ... 33.5 m ³ /h [14 ft ³ /h ... 1183 ft ³ /h]	4 % ... 1 % correspondingly
Input pressure	0 MPa ... 1 MPa [0 oz/in ² ... 2320 oz/in ²]	± 0.5 %
Output pressure	0 MPa ... 25 MPa [0 oz/in ² ... 58015 oz/in ²]	± 0.5 %
Vibration acceleration at three points	up to 160 mm/s [6.3 in/s]	± 5 %
Temperature at three points	-50 °C ... 250 °C [-58 °F ... 482 °F]	± 0.5 %
Torque	0 N*m ... 500 N*m [0 lb*ft ... 368.8 lb*ft]	± 0.5 %
Rotary speed	1000 rpm ... 3000 rpm	± 1 rpm

Hydraulic system

Parameter	Value
Quantity of reservoirs	2
Volume of each reservoir	10000 l [2641.7 gal]
Maximal pressure in input unit	10 atm [2351 oz/in ²]
Maximal pressure in output unit	250 atm [58750 oz/in ²]
Flow rate of booster pump	0 m ³ /h ... 40 m ³ /h [0 ft ³ /h ... 1413 ft ³ /h]
Head of booster pump	0 m ... 63 m [0 ft ... 207 ft]

Compressor

Parameter	Value
Air flow rate	250 l/min [66 gal/min]
Pressure	10 atm [2351 oz/in ²]
Volume of receivers	100 l [26.4 gal]

The Triol ESM WorkBench — a system for testing electric submersible motors

Purpose: is used for acceptance testing of ESM, periodical testing of ESM, ESM washing, ESM running in, and ESM conservation.

The WorkBench allows following tests:

- Checking the rotation direction of a motor shaft;
- Short-circuit tests;
- Running-in of ESM with the simultaneous monitoring of no-load parameters;
- Detection of ESM creep voltage;
- Rotor rundown time measurement;
- Insulation resistance test at constant current when ESM is cold;
- Phases resistance measurement when ESM is cold or heated;
- Protection level testing (hydrostatic test);
- Detection of maximal or minimal torque;
- Detecting the dependence of mechanical losses on stator winding temperature;
- Detection of efficiency, power factor, sliding factor;
- Detection of minimal starting torque;
- Detection of current and losses at idle running;
- Heating testing: detection stator winding temperature;
- Over-speed test;
- Short-term over-current test; etc.

Functionality:

- Unique power system with efficient recuperation allows to avoid additional energy losses;
- Allows to carry out testing in both automatic and semiautomatic operation modes;
- In the base modification, the Triol ESM WorkBench makes it possible to test electric submersible motors of the following diameters: 96, 103, 117, and 130 mm [3.7, 4, 4.6, 5.1 in]*.
- Cover for short-circuit testing fixes a rotor of tested ESM rigidly.
- A cover for running-in, identification of the rotation direction and rotor rundown time measurement, contains inductive sensors, transition shaft with marks, and a fitting for a connection to an expansion oil tank.
- Oil circulation system provides washing of, circulation through, conservation and pressure testing of the ESM.
- Pumping units provide pressure up to 2.5 MPa [5875 oz/in²].
- The workbench is provided with the cooling system which allows to dissipate up to 40 kW [53.5 hp] of heat power.
- 200 kW [268 hp] asynchronous motor is used as a load.

* The Triol ESM WorkBench is completely engineered and manufactured by the Triol Corporation. All parameters and the construction of the WorkBench can be tailored to meet the customer's needs.

Parameter	Value	Tolerance
Nominal ESM power	< 160 kW [214 hp]	—
ESM diameters	96, 103, 117, 130 mm [3.7, 4, 4.6, 5.1 in]	—
Supply voltage	3 x 380 V, 50/60 Hz	-15...+10 %
Auxiliary voltage	220 V, 50/60 Hz	± 10 %
Output voltage	3 x 300 V ... 3000 V	± 2 %
Output frequency	0 Hz ... 99 Hz	± 0.1 %
Nominal output power	400 kVA	—
Nominal output current (at low side)	1000 A	—
Maximal continuous current (at high side)	78 A ... 112 A	—
Overload	125 % during 300 s	—
Harmonic distortion factor of output voltage	< 5 %	—
Dimensions of technological area	14000x2800x4500 mm [546x109x176 in]	—

Cooling system specifications

Maximal dissipated heat power	40 kW
Pump power	0.75 kW [1 hp]
Power of fan which blow round the radiator	3 kW [4 hp]
Volume of buffer reservoir	3 m ³ [106 ft ³]
Modes of operation	1) filling of the water jacket; 2) emptying of the water jacket; 3) circulation in the water jacket.

Client Questionnaire

In order to maintain a high level of products and services, we at Triol Corporation constantly gather feedback from our stakeholders. Please take several minutes to fill out the form bellow. If a question is not applicable to you, please skip it. The information you provide will remain secure and will only be used by the Triol Corporation. Send us the filled out form by post or electronic mail using the contacts on the back cover of the catalogue. You may use any of contacts provided interchangeably.

Contact information:

Your full name: _____
Your occupation: _____
Your phone number: _____
Your e-mail address: _____
Other contact information (skype, facebook, etc): _____

Please specify which is a more convenient way to reach you:
 by personal meeting;
 by phone;
 by e-mail;
 other (in this case, please specify): _____

Company Information: _____
Company name: _____
Postal address: _____
Phone number: _____
Fax number: _____
e-mail: _____
Website: _____

Business information:

What type of business or service do you provide?

Please describe your company in one or two sentences:

How old is your company?

What is the size of your company (quantity of employees, offices in domestic countries, offices in foreign countries)?

Who are your customers?

Who are your partners?

Product interest information:

What have been the most important factors for you, when choosing equipment (reliability, price, integration capabilities, novelty, etc.)? Please specify characteristics in descending order beginning with the most important to you:

Do you use power electronics devices analogous to those presented in this catalogue? If yes, please specify which ones?

Whose equipment do you usually use?

What applications do you use the equipment listed above for?

How often do you purchase power electronics devices similar to those presented in this catalogue?

Does your company require extra equipment? Please specify what kind, in what quantity, and when it is needed:

Are you interested in any of products listed in this catalogue? If yes, please list them below:

Which additional functions, features or gadgets would you like our products to provide?

Which technological processes in your business need to be improved, changed, or established for the first time?

General questions:

How did you get this catalogue?

- by e-mail;
 by post;
 at an exhibition (in this case, please specify the exhibition):

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Whom else in your company may this catalogue interest?

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