TRI

THYRISTORS CONTROLLED CONVERTERS

FOR D.C. MOTORS SPEED REGULATION IN POWER RANGE FROM 2,7kW TO 2,7MW

TRI are converter series of compact design for the continous speed control of externally excited DC motors. The speed adjusment is effected by means of the armature voltage with constant field (constant torque range). Additional units with field regulation (**+TRP**) provide field weakening in speed range above rated speed (constant power range).

TRI devices are designed for single-phase and three-phase connections with one power rectifier for single-quadrant operation and two antiparallel power rectifier for four-quadrant operation (**+4K**). This compact devices are builted with thyristor modules mounted on same heatsink. This provide minimal possible dimension and mass, especially for four-quadrant drive because antiparallel group can be mounted on same heatsink. Because always works one rectifier group, there are no thermal problems.

The compact **TRI** series are designed as built-in units for wall-mounting, for single-phase mains connection of voltage **1x230V / 180(160)VDC** and/or **1x400VAC / 310(270)VDC** and output current from **15A** to **36ADC** (power ratings from **2,7kW** to **10,8kW**).

Devices for higher power ratings are designed for three-phase mains connection of voltage **3x400VAC / 470(420)VDC** and output current from **30A** to **1500ADC** (power ratings from **13,8kW** to **705kW**).

Devices for higher output current **TRI** series are manufactured in cabinet units as rectifier plant with components, such as main control switch, circuit-braker, line and ultra-speed fuses, mains reactors and control, measure and monitoring devices. This cabinet units are manufactured for mains voltage **3x750VAC / 900VDC** and output current to **3.000ADC** (power ratings to **2,7MW**) for single-quadrant and four-quadrant operation with and without field weakening and options, as required, for control functions in analog regulation and **PLC** applications.

A wide range of options of control electronics of **TRI** devices is available, permitting optimum adaptation of drive systems to the respective demands.

The very modern technology used ensures a good ratio of performance and power to price.

MAIN CHARACTERISTICS

- Easy built-in and small dimensions.
- Converters for single-quadrant and four-quadrant drive operation.
- Control electronics with modern integrated circuits.
- Same control principe of electronics in entire device's power range.
- Cascade control structure of drive including outer speed-, and inner current loop, providing safe drive operation with torque limit.
- Speed feed-forward with tacho-generator or voltage feed-forward with I*R compensation.
- Potential-free motor current and voltage measuring.
- Adjusting pulse firing set for mains frequency 50/60 Hz.
- Electronic starting interlock, providing together switching on power's and electronic's supply.
- Mains undervoltage monitor.
- Phase rotation monitor.
- Heat-sink temperature monitor.
- Controlled starting and braking by built-in adjustable ramp generator.
- Built-in three amplifiers for free use, providing many applications without use of additional modules.
- Built-in potentiometers as adjustment points, providing easy commissioning.
- LED indicators for "ready for operation", "regulator release", "ramp release", "JOG speed" and "active rectifiers group".
- Built-in potential-free relay changeover contact for "ready for operation".
- Potential-free digital command inputs +24VDC enabling direct connection with PLCs.
- Built-in rectifier for field winding supply.
- Firing thyristors with impuls series.
- In addition, as required for technology problems, more components can be installed.

Type designation:

TRI 230/180.2 - 24
TRI 400/310.4 - 36
TRI 400/270.8 - 24 +4K
TRP 230/180.2 - 24
TRI 400/470 - 100
TRI 400/400 - 100 +4K

Single-phase units
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Units for field supply
Three-phase units
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Four-quadrant units +4K
Rated type output current I_{dn}
Number of thyristors with 1-phase
Rated type output voltage U_{dn}
Rated type mains voltage
TRI standard series
TRP series for field supply

Type series:

Field suply converter TRP -	Type current I_n (A)	Type rating P_n (kW)
230/180.2-15	15	2,7
230/180.2-24	24	4,3
400/310.2-15	15	4,6
400/310.2-24	24	7,4

Converter for single-phase connection TRI -	Type current I_n (A)	Type rating P_n (kW)
230/180.2-15	15	2,7
230/180.2-24	24	4,3
400/310.2-15	15	4,6
400/310.2-24	24	7,4
400/310.2-36	36	11,1
230/180.4-15	15	2,7
230/180.4-24	24	4,3
400/310.4-15	15	4,6
400/310.4-24	24	7,4
400/310.4-36	36	11,1

Converter for single-phase connection TRI -.....+4K	Type current I_n (A)	Type rating P_n (kW)
230/160.8-15	15	2,4
230/160.8-24	24	3,8
400/270.8-15	15	4
400/270.8-24	24	6,4
400/270.8-36	36	9,7

Converter for three-phase connection TRI -	Type current I_n (A)	Type rating P_n (kW)
400/470-30	30	14
400/470-60	60	28
400/470-120	120	56
400/470-240	240	114
400/470-400	400	188
400/470-500	500	235
400/470-800	800	376
400/470-1000	1000	470
400/470-1500	1500	705

Converter for three-phase connection TRI -.....+4K	Type current I_n (A)	Type rating P_n (kW)
400/420-30	30	12
400/420-60	60	25
400/420-120	120	50
400/420-240	240	100
400/420-400	400	168
400/420-500	500	210
400/420-800	800	336
400/420-1000	1000	420
400/420-1500	1500	630

Technical Data:

Rated voltage:	1x230V, 1x400V or 3 x 400VAC
Power connection voltage tolerance:	- 5 / + 10 %
Electronic connection voltage tolerance:	- 15 / + 10 %
Mains frequecy:	50 Hz or 60 Hz
Motor connection voltage:	180/310/470VDC for single-quadrant units 160/270/420VDC for four-quadrant units
Type power stack circuit:	B2, B2HZ for single-phase single-quadrant units (B2C)A(B2C) for single-phase four-quadrant units B6 for three-phase single-quadrant units (B6C)A(B6C) for three-phase four-quadrant units
Field rectifier:	I_{pmax} = 6 A for units rated to 400A I_{pmax} = 16 A for units rated from 500 A to 1500A
Operating temperature:	0 °C ... + 65 °C standard units - 20 °C ... + 65 °C in additional
Storage temperature:	- 20 °C ... + 65 °C
Cooling air inlet temperature at full load ($I_d = I_{dn}$):	
without fan:	40 °C max.
with fan:	35 °C max.
Type current reduction at full load with fan above 35 °C and without fan above 40 :	1,2 % / °C
Standard control structure:	Cascade including outer speed-, and inner current loop.
Control accuracy:	± 0,5 % for the fllowing disturbance values Load fluctuation: ± 50 % Mains voltage fluctuation: ± 5 % Temperature fluctuation: ± 10 °C
Adjustment range:	1 : 20 with voltage control. 1 : 100 with speed control.
Reference value input:	- 10 V ... + 10 V (- 20 mA ... + 20 mA)
Actual value input:	Differential input: 400V/250V/160V/90V/56V/0...10V Based upon 0V: 200V/125V/ 80V/45V/28V/0...10V
Ramp generator:	Run-up time 0,8 s ... 90 s.
Additional control loop:	PI controller and two amplifiers.
Monitoring:	Phase rotation detection. Phase failure and under-voltage. Voltage for electronic supply. Overtemperature applies to units with fan.
Signals "ready for operation":	Changeover contact (250 V / 2 A).
Protection class:	IP00
Cooling:	Without fan for units to 120 A. With fan for units from 120 A to 1500 A.
Fan:	1 x 220 V, 0,12 A, 120 m^3 / h for units from 120 A to 400 A. 3 x 380 V, 0,25 A, 800 m^3 / h for units from 500 A to 1500 A.
Altitude above sea level:	≤ 1000 m. Reducttion factor of load values is 1% / 100 m att installation altitudes above 1000 m.
Climatic class:	F prema DIN 40 040.
Insulation class:	VDE 0110 Group C.
Resistive from vibrations:	2g refer DIN 40 046.

UNITS FOR FIELD SUPPLY

For field winding supply with constant current regardless on motor temperature or variable current for regulation above rated motor speed with field weakening, **TRP** units are used. **TRP** are half-controlled single-phase thyiristor bridge. Control electronics include cascade control structure including outer voltage-, inner current-loop, and under-current monitoring.

On demand, three-phase units with antiparallel bridge **+4K** are delivered with integrated units for field supply **+TRP** in same mechanical housing.

CABINET UNITS

Combinaining compact **TRI** units with required installation components in cabinet we get **electrical cabinet plant** ready for simple mains and motor connection and external commands. Using a cabinet units simplify and reduce time and cost of commisioning, designing, mounting and servicing.

With cabinet units for higher rated power of 705kW, delivering of rectifier rated power to 2,7MW for mains voltage 3x400V, 3x500V i 3x660V is also possible. Higher rated powers are derived from parallel connection of more rectifier. Except regulated rectifier, cabinet unit include components for:

- switching, protection and mesauring in power circuit,
- controlling switching-on and switching-off,
- accept signals for "ready of operation",
- additional supply,
- supplying and controlling motor field winding.

Specific technological expansions could be made by adding series of standardized additional components.

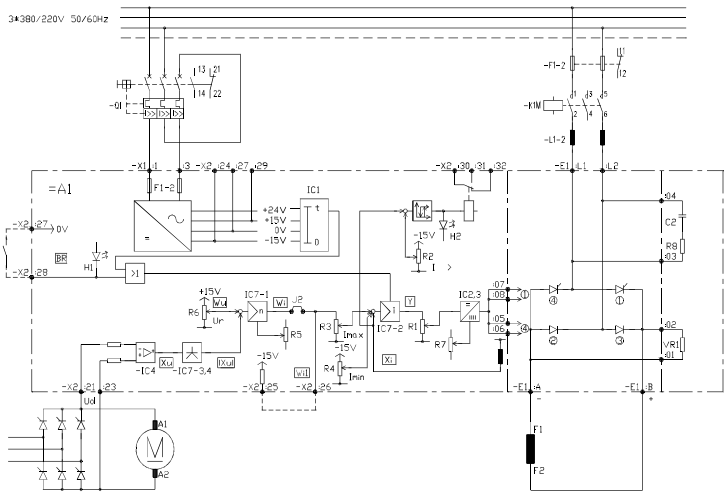
With them various function can be performed such as:

- reference switchable voltage source,
- outer control loop, highly accurate regulator,
- additional monitor for limit values,
- winding calculator,
- switching and control components for additional supply terminals, for example for auxillary motors.

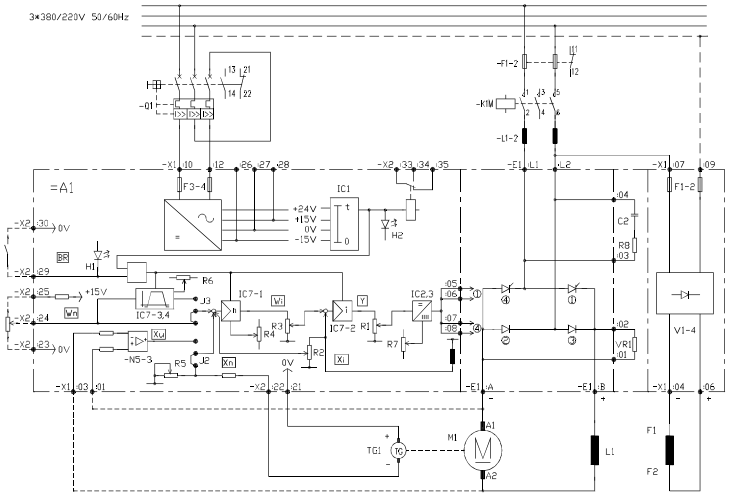
APPLICATIONS

TRI, thyiristor controlled converters have a simple control structure and feature excellent control characteristics, for speed as well as for torque controls. This results in high speed setting ranges and good response with excellent smooth running of the motor shaft. **TRI** four-quadrant controllers are equipped with integrated mains feedback in the generator mode.

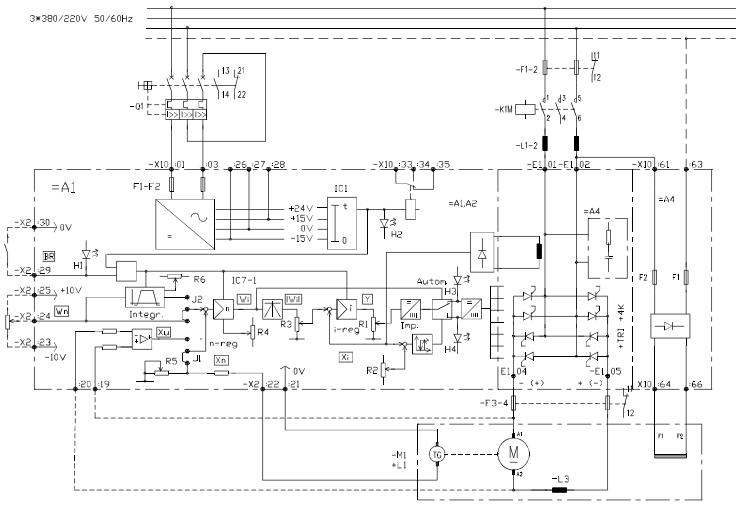
These advantages make **TRI** universal controllers for almost every applications: one and multi-motor systems, papir machines, conveyors (belts, rolls etc.), extruders, calanders, coating plants, winder drives, metal band plants, material accumulators, printing machines, wire drawing plants, cable twisting plants, cross cutters, positioning drives, lift and traction drives, packaging machines, excentar drives, pumps, air conditioning, test stands, heating and power stations, textile processing plants etc.



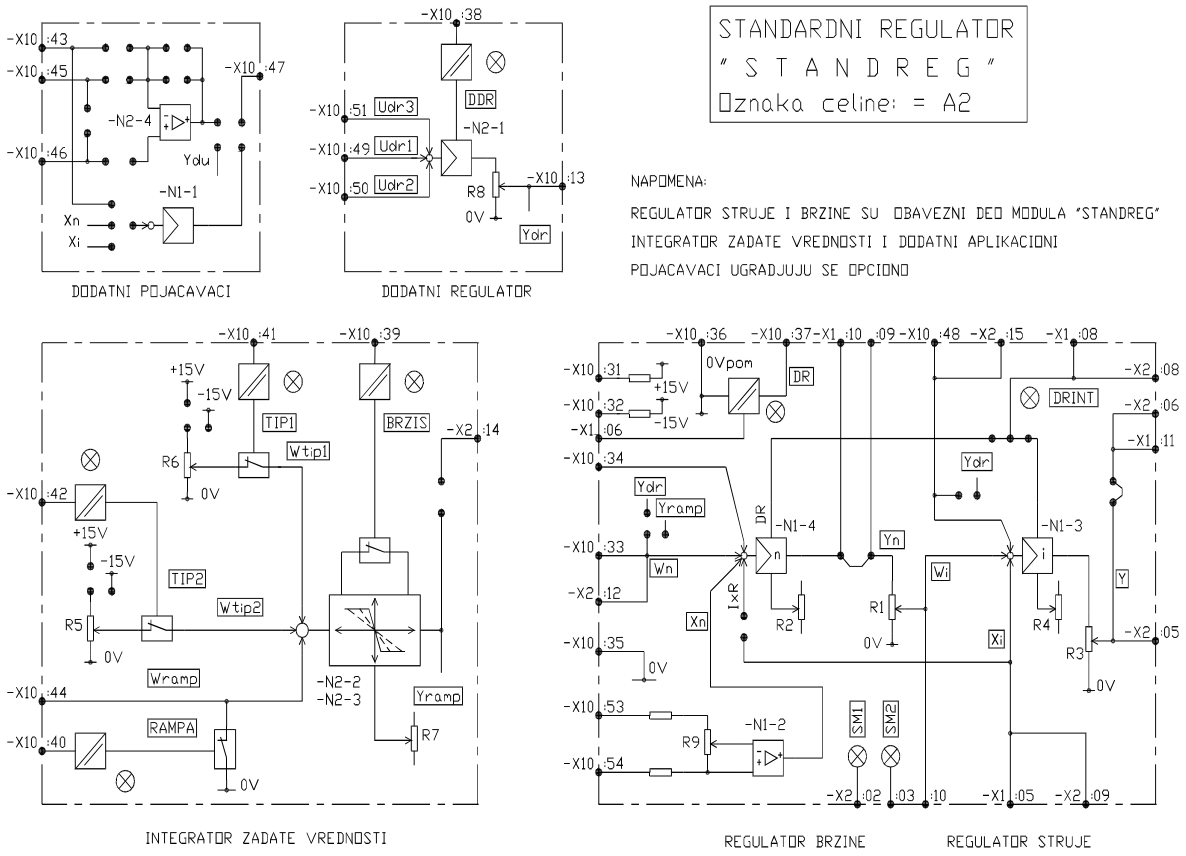
Block diagram units for field suply TRP



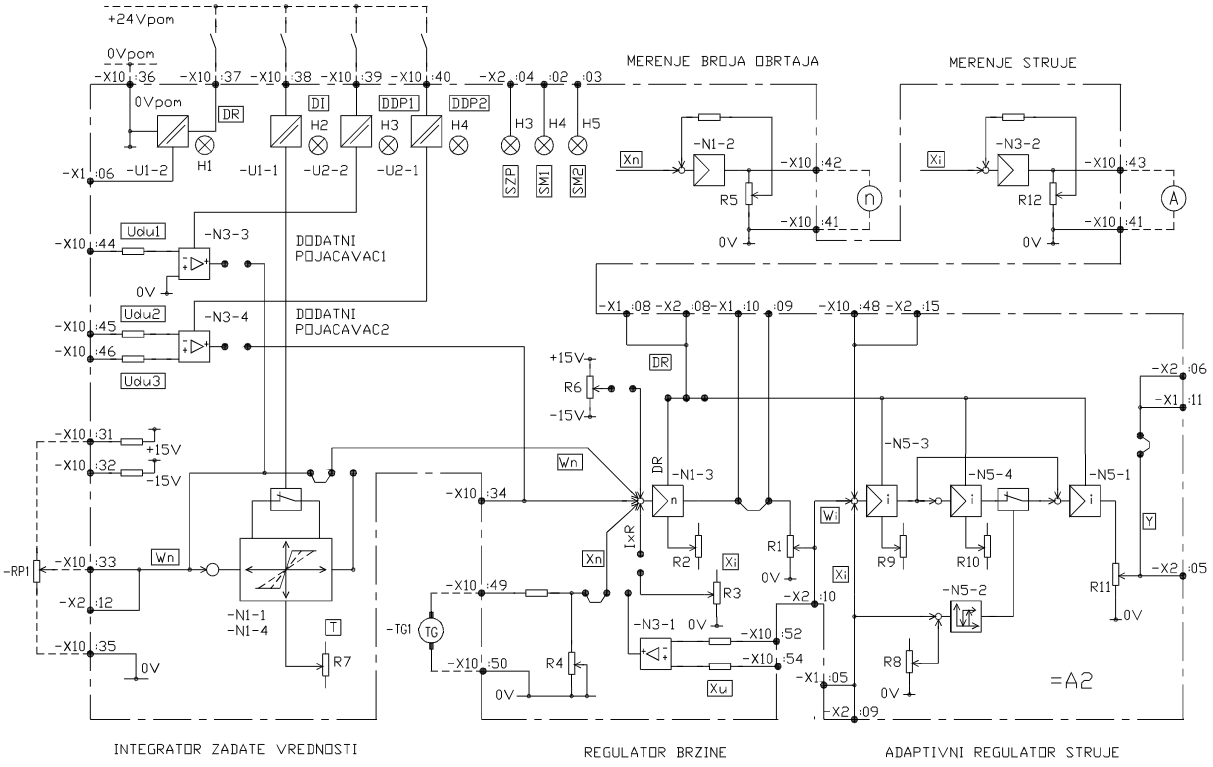
Block diagram units for single-phase TRI units



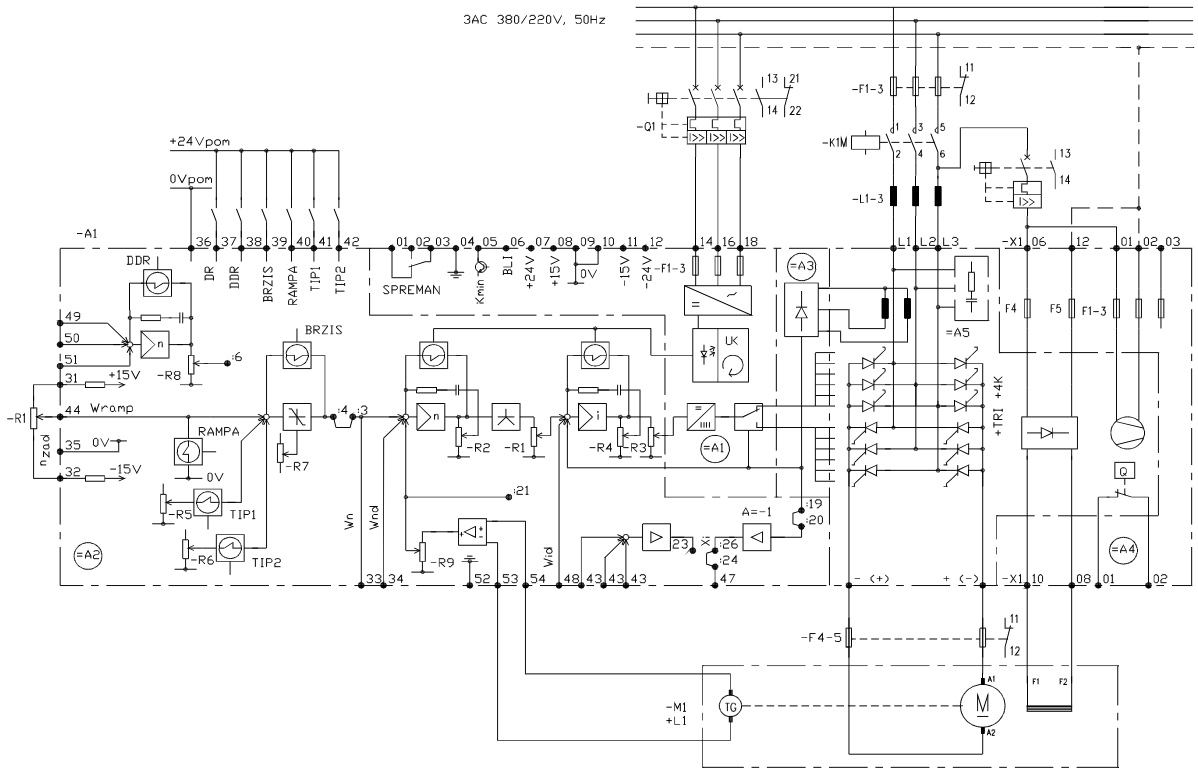
Block diagram units for single-phase TRI units for four-quadrant operation



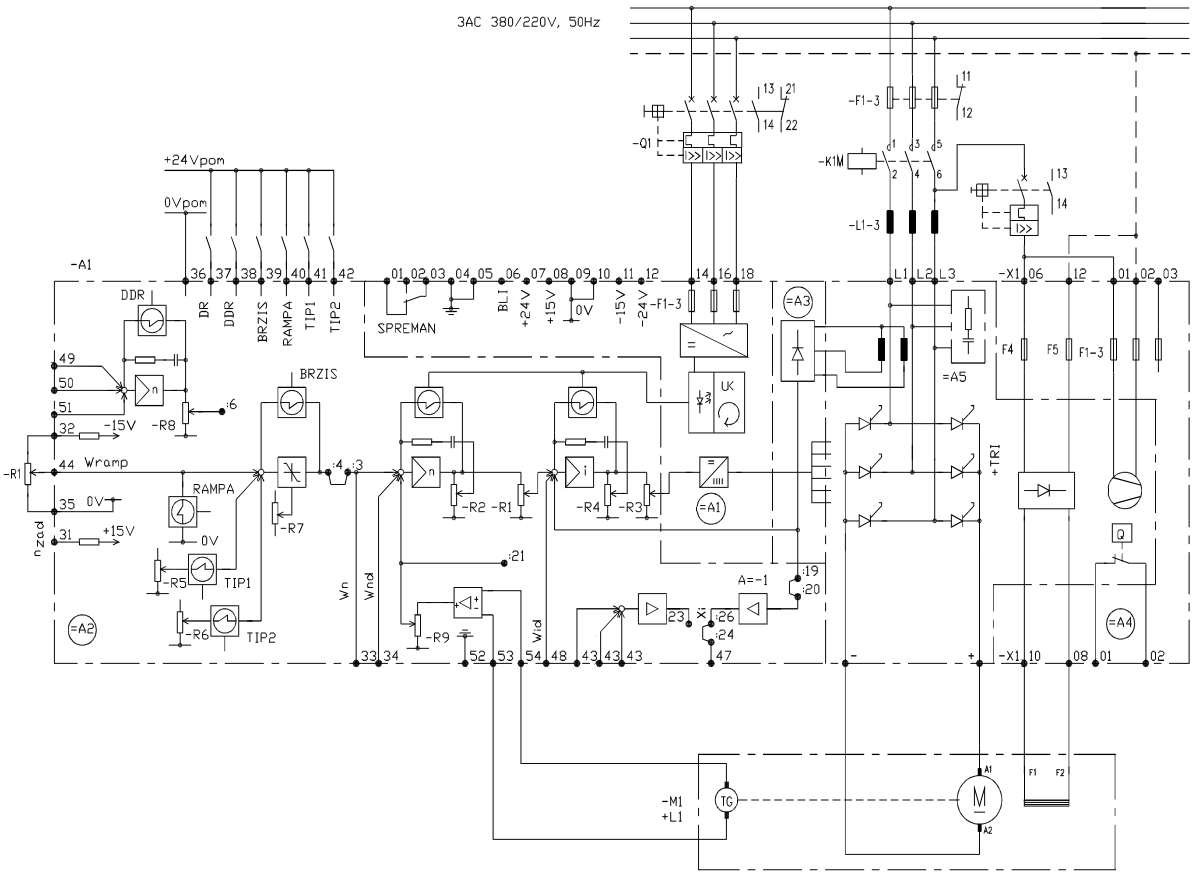
Block diagram standard cascade control structure with outer speed-, and inner current loop



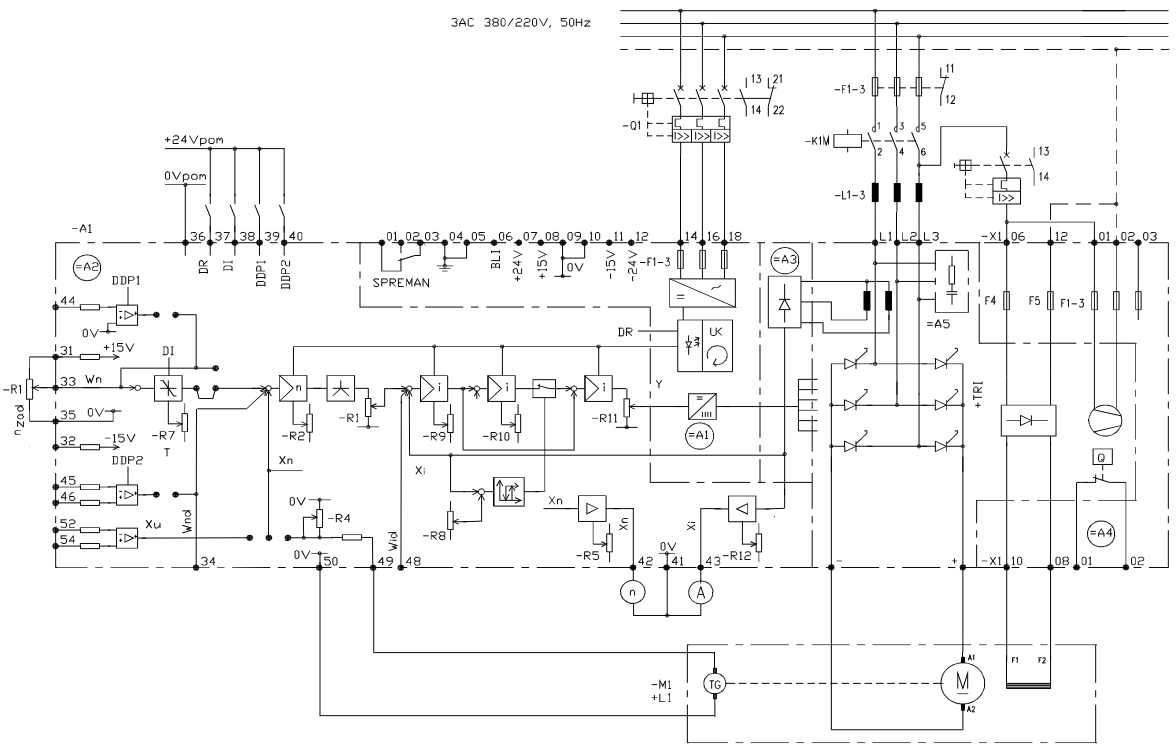
Block diagram adaptive cascade control structure with adaptive current control



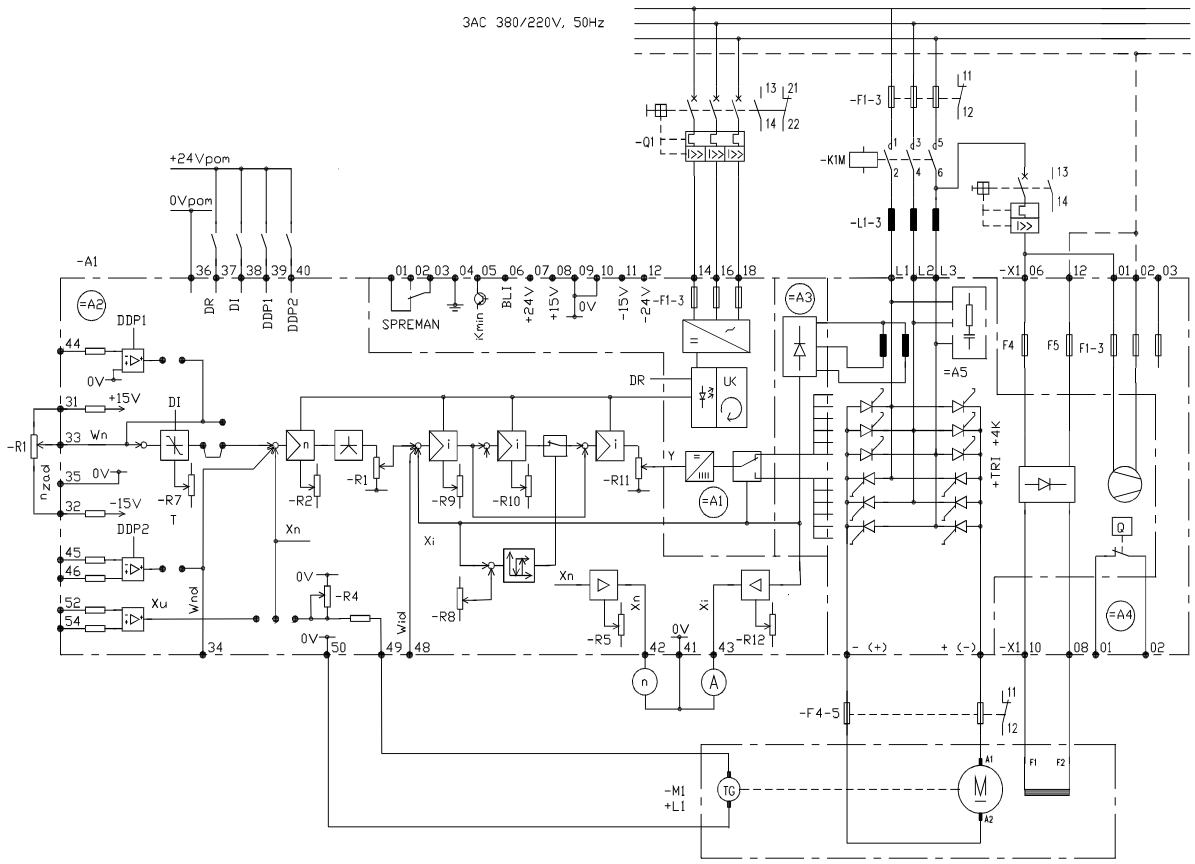
Block diagram units for three-phase TRI units with standard controller



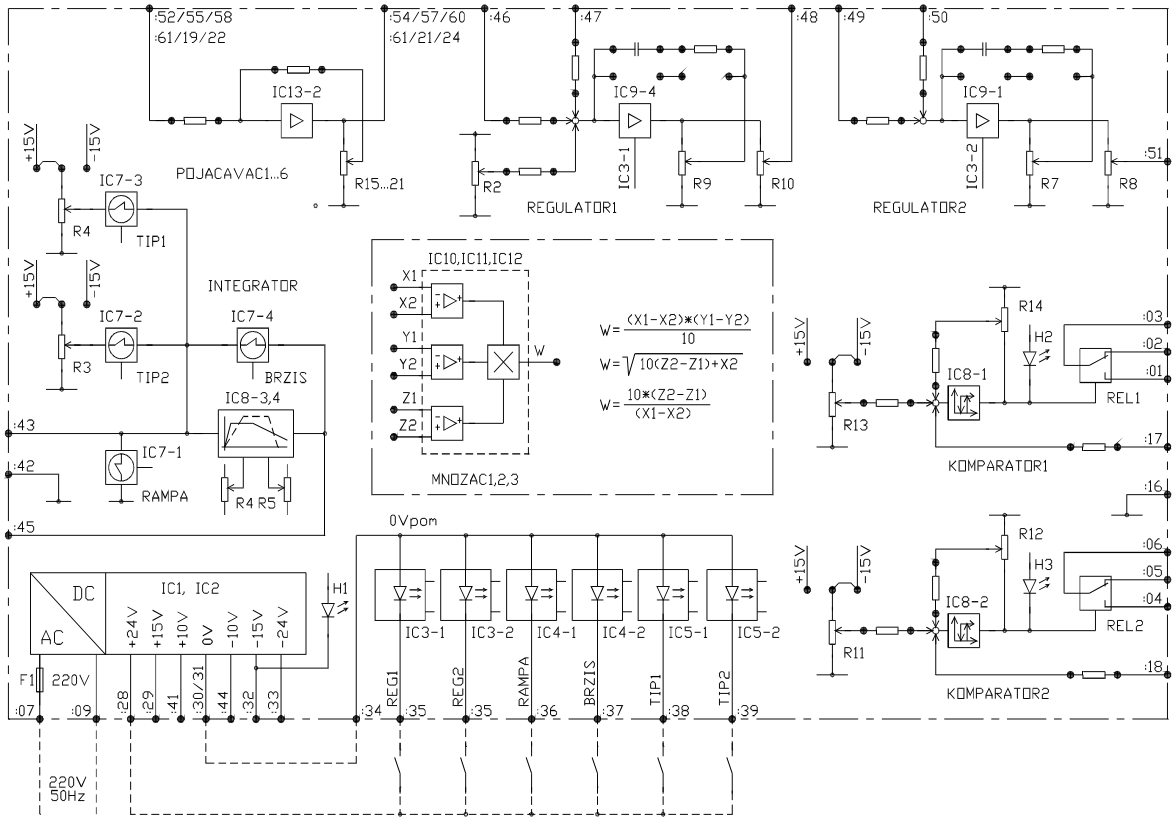
Block diagram units for three-phase TRI units for four-quadrant operation with standard controller



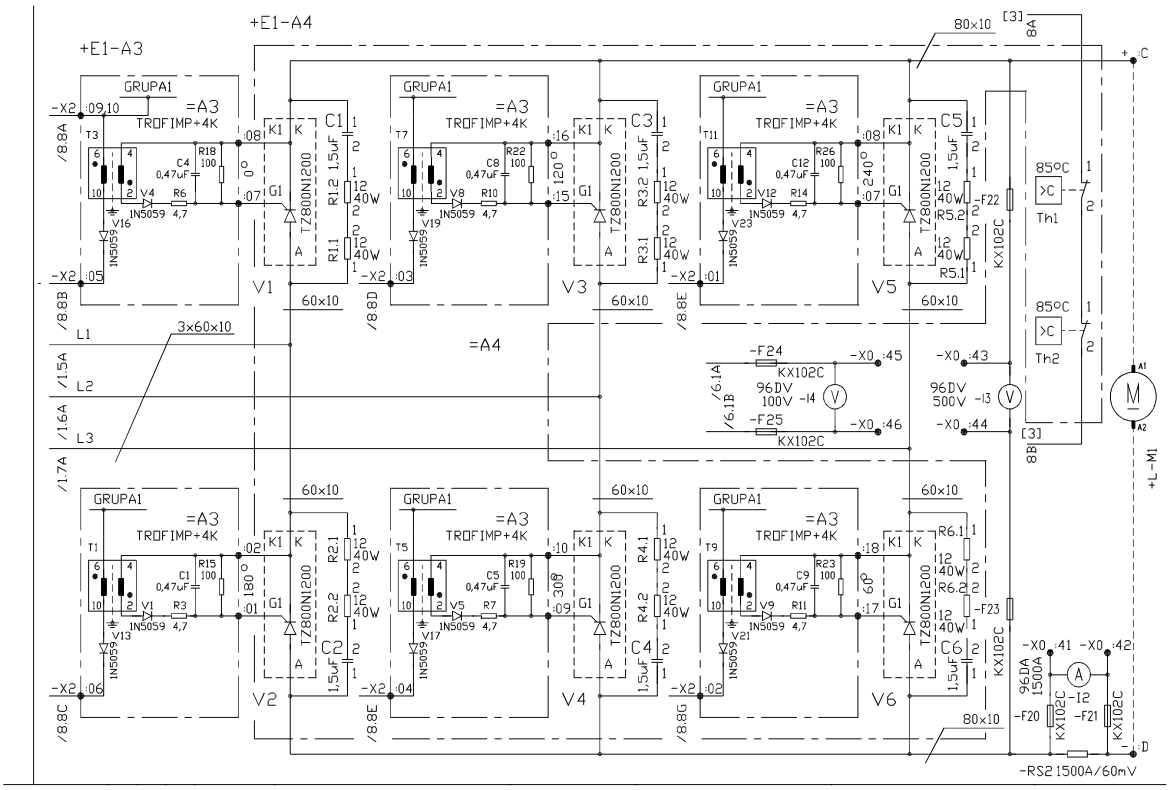
Block diagram units for three-phase TRI units with adaptive controller



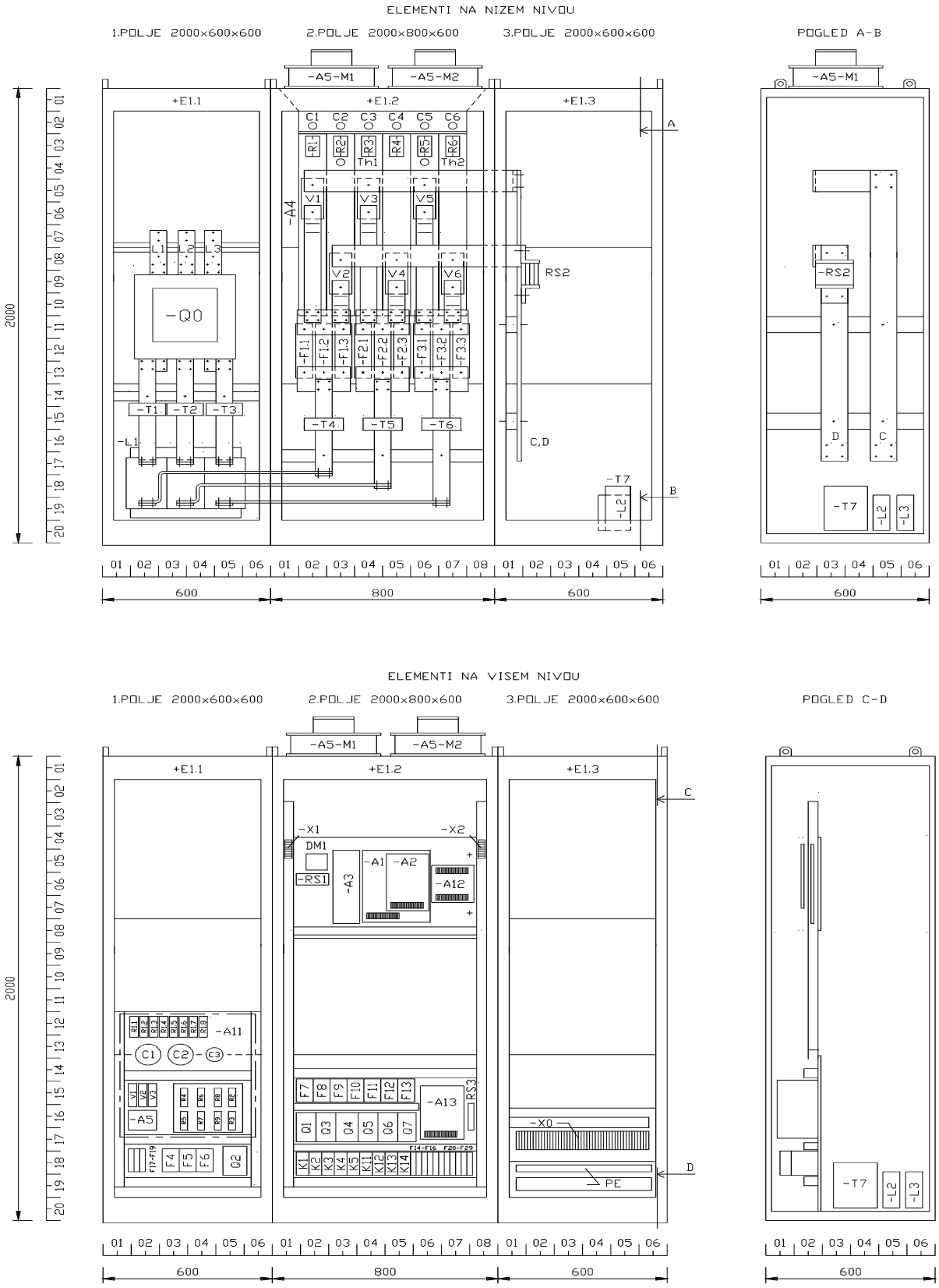
Block diagram units for three-phase TRI units for four-quadrant operation with adaptive controller



Block diagram additional analog calculator



One example of power rectifier for cabinet unit



One example of cabinet unit