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KATKA

Thyristor Switching Modules

5/2014

1. Description and Connection

1.1 A

Thyristor switching modules of the KATKA line have been designed especially for switching power factor correction capacitors in rapid reactive power compensation (up to 20 control interventions in one second) in conjunction with fast power factor controllers of the NOVAR line. They can, of course, be also used in other applications where contact-less load switching is required.

The modules are designed to switch a star- or delta-wired, symmetric or asymmetric, capacitive, resistive or inductive load in a 400/230-volt (440/250-volt) system - **option 400** and 690/400- volt system – **option 690V**.

Load is connected under near-zero voltage (typically 5 volts) across the switching device and disconnected on zero-cross current.

The benefits of contact-less switching are: switching device long life (high number of connections and disconnections), reduced current and voltage interference with the power system (connection and disconnection at near-zero power), and fast connection and disconnection.

The drawbacks are high initial cost and heat loss.

When using power factor correction capacitors, implementation of detuned power factor correction is highly recommended, otherwise an inductance of at least 12 µH must be wired in series with the switch to reduce speed of current rise. A detuning reactor also expands life of power factor correction capacitors and improves control accuracy.

The modules incorporate class C over-voltage protection varistors. It is further recommended that a class B, 50 kA, lightning current protection device should be installed in the power lead.

The control voltage is galvanically isolated from the other circuits.

The modules have a Power pilot light, to indicate voltage presence, and a Control pilot light to indicate closed circuit condition of the module when control voltage is applied.

KATKA 80 modules include thermostat-controlled fans for forced cooling and thermal protection.

1.2 Connection Description

The modules are compact switching modules that are currently manufactured in three models:

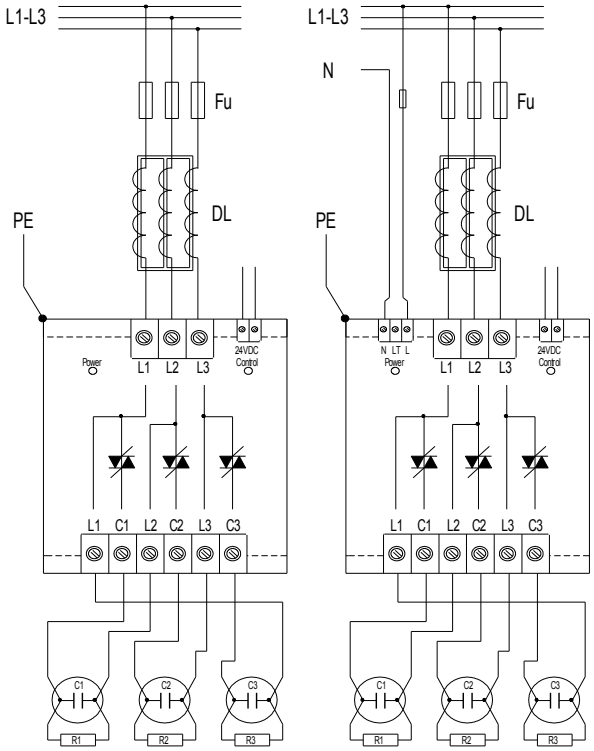
- **KATKA 20-T, KATKA 80-T** – 3 switches, . It switches L1, L2, and L3 at same time. It is designed for star- or delta-connected three-phase loads. Wiring diagram in fig 1, 2, 3.
- **KATKA 20-ST, KATKA 80-ST** – 3 switches, It switches individually L1, L2 and L3. It is designed for star- or delta-connected three-phase loads where it's possible to switch each phase individually. Wiring diagram in fig 1, 2, 3. Used mainly for PFC where asymetric load is present.
- **KATKA 20-D, KATKA 80-D** – 2 switches, It switches L1 and L3 at same time. Switch L2 passes through. It is designed for three-phase star-connected loads. Wiring diagram in Figure 4.

Below are mentioned individual connections and it's pros and cons from fast PFC side of view.

- **Fig. 1 – three switches in series with load**

Three switches, loaded with 1.7 times smaller current in compare with wiring nr. 5 for the same switched power. This wiring features the lowest heat loss of all the wirings, therefore higher loads can be switched. Load is distributed to three single-phase subloads and connected to phase-to-phase voltage. If used for reactive power compensation, the capacitors get charged to maximum 1.4 times the voltage and thus can be reconnected immediately. There is no fast discharge circuit, use of additional discharge resistors **R,** eliminating supply voltage fluctuations is recommended. Due to this, the wiring is often more economical to the wirings on fig . 4. Manily for „T“ and „ST“ modules and 400/230V systems.

This connection is most common for fast PFC and we recommend to use this connection.

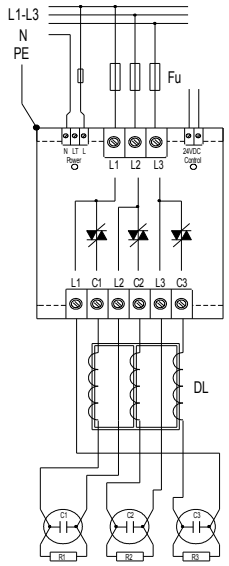


- **Fig. 2 – modification of connection on fig. 1**

Usually detuned filter reactor is connected in between fuse and module (fig. 1), but it's also possible to connecte reactor between module and capacitor (fig. 2)

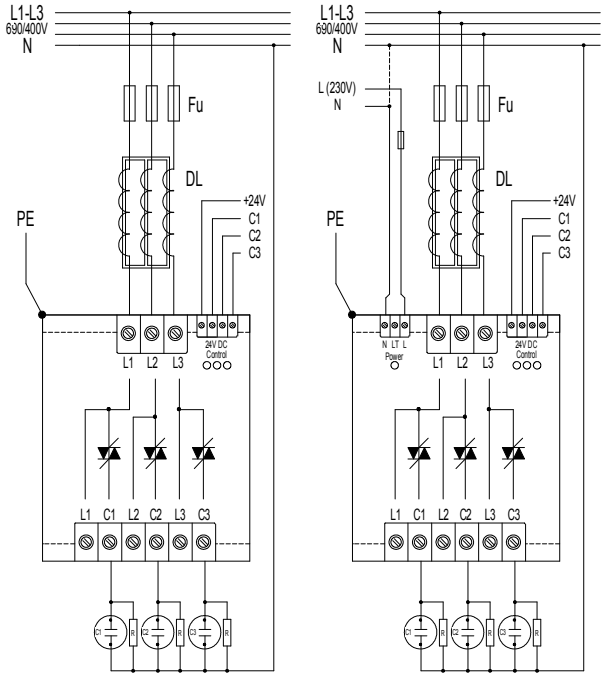
In this case it's necessary to use reacors with different inductance compared to previous connection, otherwise both connections are same. Sometimes reactors used with this connection are cheaper. Manily for „T“ and „ST“ modules and 400/230V systems.

Same benefits as with connection on fig. 1



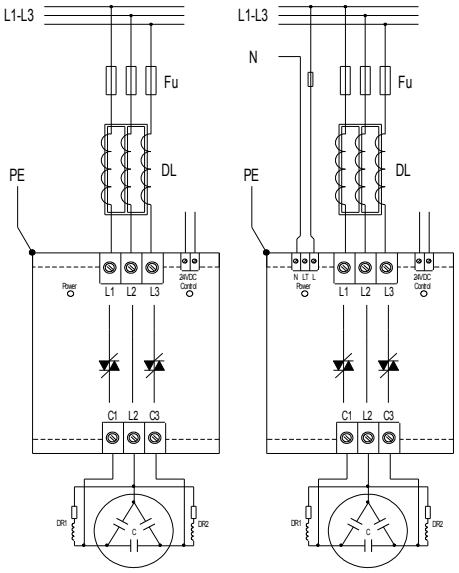
• **Fig. 3 – star connection.**
Capacitors or other load is star connected to the phase-to-neutral voltage. The **N** Neutral wire is connected for asymmetric or capacitive loads. Even ther is no fast discharge circuit, we recommend to use additional discharge resistor **R,** which eliminates fluctuation of suppy voltage. Manily for „T“ and „ST“ modules and 690/400V system.

It's mainly used for simple single-phase power factor correction and for 690V/400V systems.



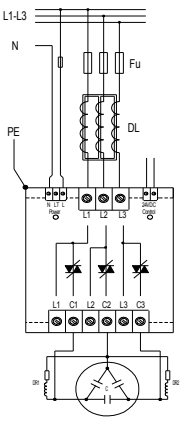
• **Fig. 4 – „economical“ wiring with only two switches.** Capacitors (or other load) are delta-connected to phase-to-phase voltage. If used in reactive power compensation, one of the capacitors gets charged to 2,1 times the nominal voltage (820 V_{peak} for 400 V nominal, see fig. 7) on disconnection. It must be partially discharged (to 1.4 times the nominal voltage, i.e. 560 V_{peak} for 400 V nominal) for reconnection. That is why a fast discharge circuit must be used (discharge power resistor in series with inductance DR) and a certain time waited, until partial capacitor discharge, before the section's reconnection. This substantially restricts speed of control and increases power dissipation (330W for 50kvar and 5 interventions per second). For „D“ modules and 400/230V system.

Therefore, this connection is not recommended for fast compensation systems !



• **Fig. 5 –** higher heat loss, three switches. Capacitors (or other load) are delta-connected to phase-to-phase voltage. – higher heat loss, three switches. Capacitors (or other load) are delta-connected to phase-to-phase voltage. It's modification of connection from fig 4, where all three phases are disconnected. Same rules as for connection of fig 4 are valid for this connection.

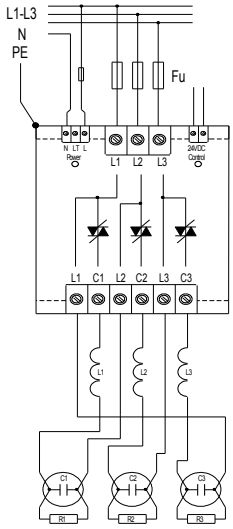
Therefore, this connection is not used for fast compensation systems !



- **Fig. 6 – PFC without harmonic filters**

di/dt protective chokes of inductance *dI/dt* min. 20uH have to be connected between switch and each capacitor. (see fig. 5b).

- **But this wiring is not recommended for fast compensation systems !**



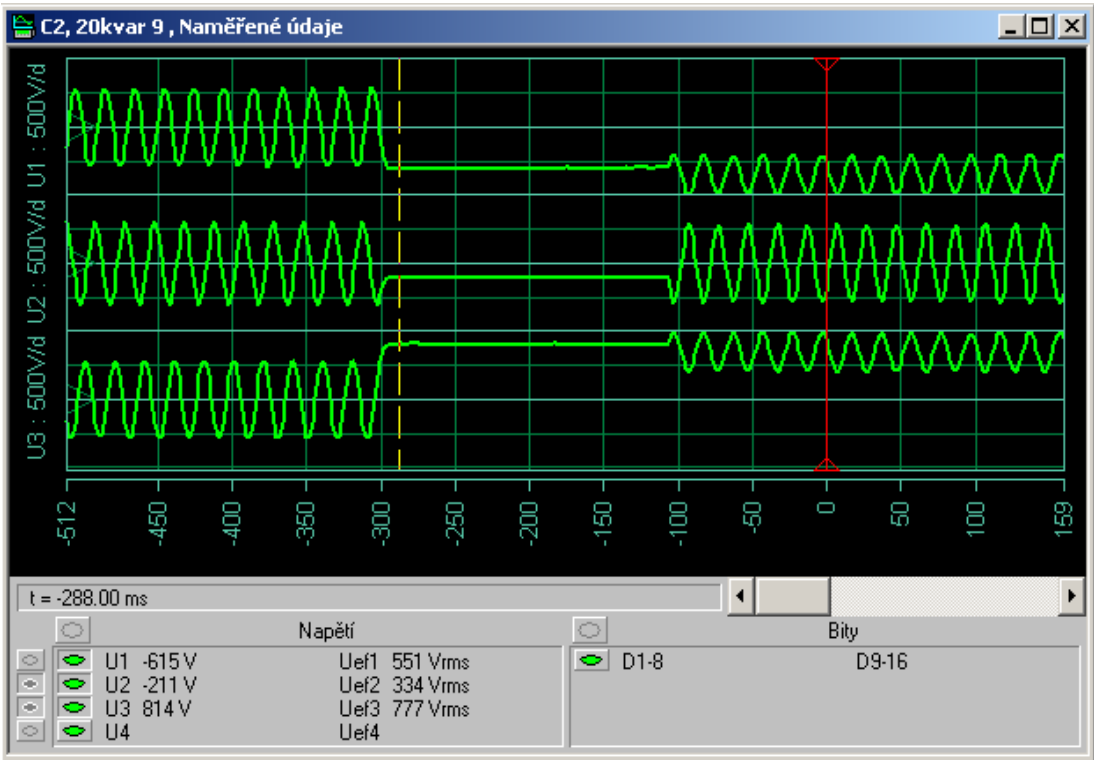
1.3 Wiring Notes

1) Auxiliary voltage for fan on modules with active cooling is connected to terminals L and N. Terminal LT is output of thermostat. Fan can be permanently turned on by connecting terminal L to LT (you can also check its status).

2) Connection of KATKA 20 ST and KATKA 80 ST is similar to connection of KATKA 20 T and KATKA 80T. Its only necessary to connect individual control signals for each switch. For this models its necessary to have corect polarity of control signals. See fig 3.

3) Recommended values for each component of detuned PFC are presented in table 2. Values are valid for connection according to fig 1.

Fig. 7 : 20 kvar Capacitor Voltage and Current Curves at Switching-Off and Following Switching/On



Capacitor between phases L3 and L1 overcharged to 814 V at switching-off (t = -300 ms); following re-switching (t = -120 ms) is incorrect, because of capacitor between L2 and L3 only is switched-on ! Fast discharge circuits **DR** not installed

2. Technical specification

Table 1: Technical specifications of KATKA modules

Parameter	Unit	KATKA 20 D 400	KATKA 20 T 400, KATKA 20 ST 400	KATKA 20 T 690, KATKA 20 ST 690	KATKA 80 D 400	KATKA 80 T 400, KATKA 80 ST 400	KATKA 80 T 690, KATKA 80 ST 690
Nominal operating voltage	V	400/230±10%	400/230±10% 440/250±10%	690/400±10%	400/230±10%	400/230±10% 440/250±10%	690/400±10%
Blocking Voltage	V	1600	1600	1600	1600	1600	1600
Max. Operating Current	A	29	22	22	87	67	67
Max. Rate of Current Rise dI/dt	A/us	50	50	50	50	50	50
Conductors Cross-section	mm^2	10	10	10	25	25	25
Number of Switches	-	2	3	3	2	3	3
Load Character	-	C/R/L	C/R/L	C/R/L	C/R/L	C/R/L	C/R/L
Auxiliary voltage (for fan)	V	-	-	-	230±10%	230±10%	230±10%
Fan Power (temperature controlled)	VA	-	-	-	32	32	32
Conductor Cross-section	mm^2	-	-	-	2,5	2,5	2,5
Fan Threshold Temperature	°C	-	-	-	60±5	60±5	60±5
Control Voltage / current - DC [1)]	V / mA	24 / 10 [1)]	24 / 10 resp. 30 [1)]	24 / 10 resp. 30 [1)]	24 / 10 [1)]	24 / 10 resp. 30 [1)]	24 / 10 resp. 30 [1)]
Control Conductor Cross-section	mm^2	2,5	2,5	2,5	2,5	2,5	2,5
Temp. Protection (module switched off)	°C	-	-	-	100±5	100±5	100±5
Overovlt. Cath / Pollution Degree	-	3 / II	3 / II	3 / II	3 / II	3 / II	3 / II
Overvoltage Protection	-	„C“	„C“	„C“	„C“	„C“	„C“
Ingress Protection	IP	20	20	20	20	20	20
Temp. - operating (max. current) - operating (75% max. current) - storage	°C	-20 ÷ 45 -20 ÷ 60 -40 ÷ 100	-20 ÷ 45 -20 ÷ 60 -40 ÷ 100	-20 ÷ 45 -20 ÷ 60 -40 ÷ 100	-20 ÷ 45 -20 ÷ 60 -40 ÷ 100	-20 ÷ 45 -20 ÷ 60 -40 ÷ 100	-20 ÷ 45 -20 ÷ 60 -40 ÷ 100
Relative Humidity – non condensing	%	5 až 95	5 až 95	5 až 95	5 až 95	5 až 95	5 až 95
Dimmensions w x h x d	mm	122x192x117	122x192x117	122x192x117	122x245x157	122x245x157	122x245x157
Mass	kg	2,05	2,15	2,15	3,35	3,45	3,45

Note [1)] : Typy „D“ a „T“ - polarity-free, 230V / 50-60Hz / 5 mA or 24 V / 50-60 Hz / 10 mA on request.
Typy „ST“ - common positive pole, individual switches are activated by connection of $24V_{DC}$ control voltage, 10mA for 1 switch, 30mA per module

Tabulka 2: Components fore selected series of capacitors (for connection on fig. 1)

Detuned PFC (f =	189	Hz)			Uc/U = 107,5%	
Power of LC block (3-phase)	Power at 440V	Capacitor capacity	Reactor inductance	Current through thyristor	Current through fuse	Requested module
[kvar]	[kvar]	[uF]	[mH]	[A]	[A]	
2,7	1	16,4	14,376	2,2	3,8	Katka 20 T
5,3	2	32,9	7,188	4,4	7,7	Katka 20 T
6,7	2,5	41,1	5,751	5,6	9,6	Katka 20 T
10,7	4	65,8	3,594	8,9	15,4	Katka 20 T
13,3	5	82,2	2,875	11,1	19,2	Katka 20 T
21,3	8	131,5	1,797	17,8	30,8	Katka 20 T
26,7	10	164,4	1,438	22,2	38,5	Katka 20 T
40,0	15	246,6	0,958	33,3	57,7	Katka 80 T
53,3	20	328,8	0,719	44,4	77,0	Katka 80 T
66,6	25	411,0	0,575	55,5	96,2	Katka 80 T
80,0	30	493,2	0,479	66,6	115,4	Katka 80 T
106,6	40	657,7	0,359	88,9	153,9	-----
133,3	50	822,1	0,288	111,1	192,4	-----
160,0	60	986,5	0,240	133,3	230,9	-----

3. Vyráběné typy

KATKA 80 T 400

Instrument Model

KATKA = Thyristor Switching Module

Construction and Power

20 = passive cooling, upt to 22A (T, ST) / up to 29A (D)
80 = active cooling, up to 67A (T, ST) / up to 87A (D)

Switching Method

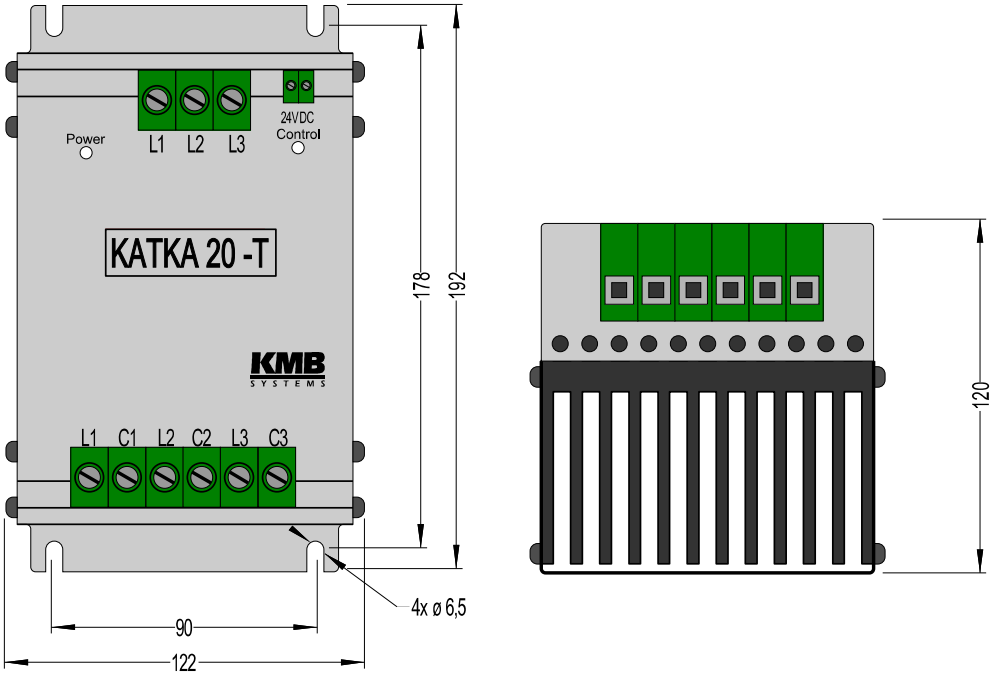
D = three-phase, two thyristors (fig. 4), only with option 400
T = three-phase, three thyristors (fig. 1, 2, 3)
ST = individual switching of each phase, three thyristors (fig. 1, 2, 3)

Voltage of the System

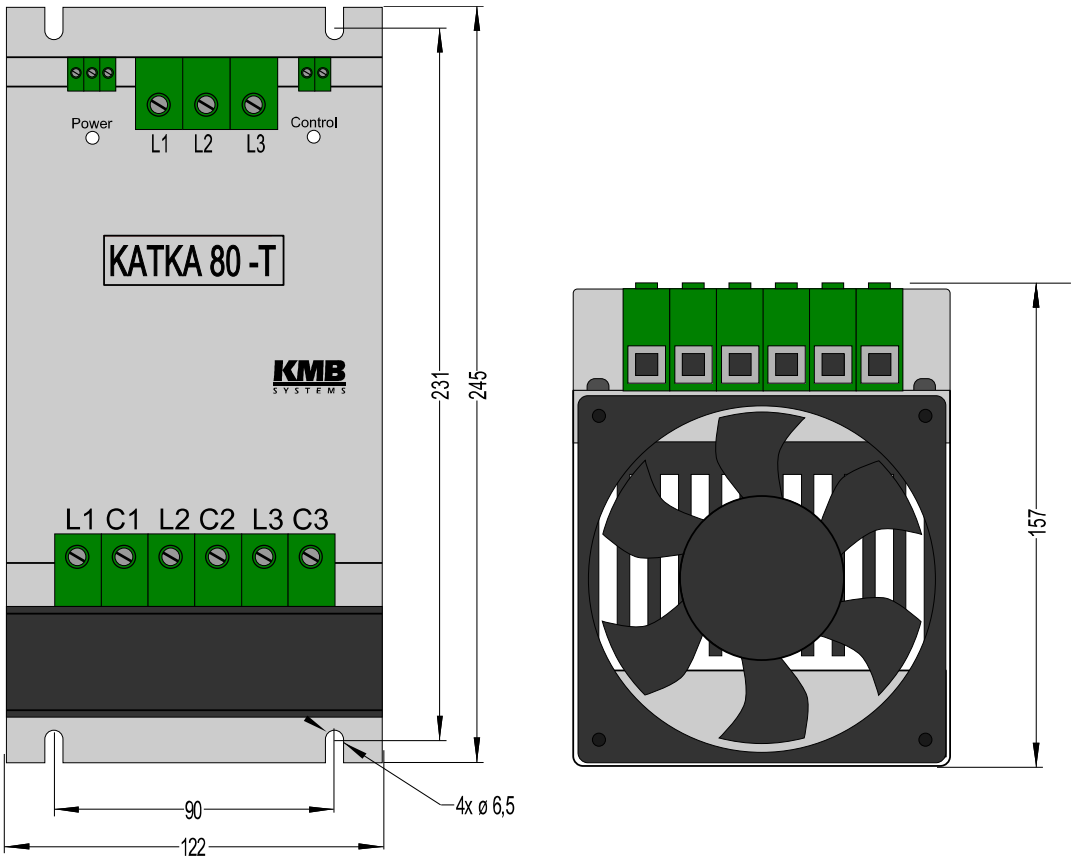
400 = 400/230V až 440/250V
690 = 690/400V (available only for option T and ST)

4.Mechanical Dimensions

KATKA 20-D / KATKA 20-T / KATKA 20-ST:



KATKA 80-D / KATKA 80-T / KATKA 80-ST:



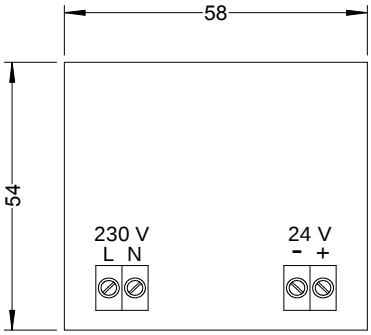
5. Accesories

5.1 Dis resist

3pcs of Auxiliary discharge resistors 33kΩ / 13W are delivered with thyristor modules. Resistors are designed to be used with connection on fig 3, 4. Its possible to connect resistors directly to terminals of capacitors.

5.2 ZP 24 auxiliary power supply

Auxiliary supply 24 Vss is necessary for thyristor switches modules or auxiliary relays excitation. Maximum load of the supply is 100 mA, that means up to 10 thyristor modules can be connected to a single supply. In case of higher load appropriate number of supplies is required.
The supply is without case, enclosure level IP 20, placed on mounting rail DIN 35 mm.
For connection example see chapter *„Compensation Switchgear Design Example“* .



6.Maintenance and Warranty

The KATKA modules do not require any maintenance in their operation. For reliable operation it is only necessary to meet operating conditions specified.
If the product has a breakdown, you need to complain to the supplier at their address:

Supplier: Manufacturer : KMB systems, s.r.o.
Dr. M. Horákové 559
460 06 LIBEREC 7
Czech Republic
telephone: +420 485 130 314
fax: +420 482 736 896
e–mail : kmb@kmb.cz
website : www.kmb.cz

The product must be in proper package to prevent damage in transit. Description of the problem or its symptoms must be delivered together with the product.
If a warranty repair is claimed, the warranty certificate must be sent in. In case of an out–of–warranty repair you must enclose an order for the repair.

Warranty Certificate

Warranty period of 12 months from the date of purchase is provided for the instrument. Problems in the warranty period, provably because of faulty workmanship, design or inconvenient material, will be repaired free of charge by the manufacturer or an authorized servicing organization.
The warranty ceases even within the warranty period if the user makes unauthorized modifications or changes to the instrument, connects it to out-of-range quantities, if the instrument got damaged in out-of-specs falls or by improper handling or if it has been operated in contradiction with the technical specifications presented.

type of product: **KATKA** ..... serial number .....
date of dispatch: ..... final quality inspection: .....

manufacturer's seal:

date of purchase: ..... supplier's seal: