KMB systems, s.r.o.
Dr. M. Horákové 559, 460 06 Liberec 7, Czech Republic
tel.: +420 485 130 314, fax.: +420 482 736 896
e-mail: kmb@kmb.cz, web: www.kmb.cz

Fast Power Factor Control Components

NOVAR 1312 controller + KATKA Thyristor Switching Modules

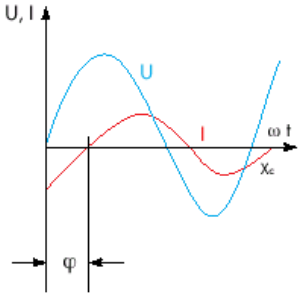
Novar 1312 - Description

Novar 1312 reactive power controllers or governors are designed for compensation systems where conventional governors with relay outputs to control circuit breakers do not meet requirements. They are especially systems where rapid frequent changes in reactive power take place (elevators, welding machines, etc.), but also for instance systems with strict requirements on electromagnetic noise suppression and power quality.

The governor has semiconductor switches to control thyristor switching modules and fast processor core that allows up to 10 control interventions in one second. Together with KATKA thyristor switching modules, it provides optimum control of reactive power compensation.

The instrument features precise voltage and current measurement circuits and digital processing of measurement values achieves high accuracy of rendering voltage, current, and power factor values. FFT algorithm is used to render harmonic components. This provides precise measurement and control even in conditions of harmonic distortion.

An inbuilt thermal sensor provides temperature measurement inside the switchboard cabinet. The two highest outputs can be used to switch on and off cooling or heating.



The governor allows building combined compensation systems utilizing both thyristor switching modules and circuit breakers.

The governor can be purchased with an optional galvanically isolated RS-232 or RS-485 communication port. It is thus possible to monitor all measurement values and set instrument's parameters using a remote computer.

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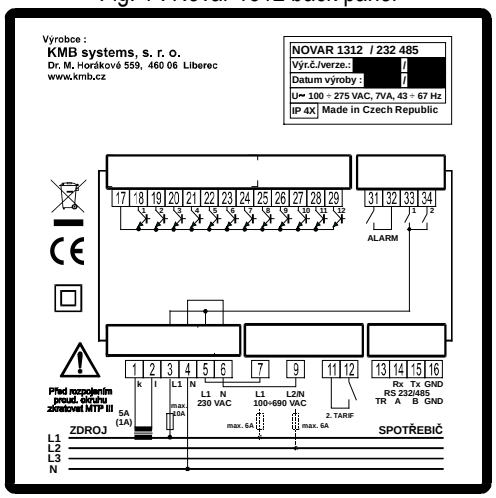
Control Principles

Fig. 1 : Novar 1312 back panel



Novar 1312 governor allows connecting both thyristor switching modules and circuit breakers. If such a combined compensation system is implemented, two control processes, which are relatively independent of each other, take place concurrently.

Semiconductor switches are controlled using **rapid control process**. There are a measurement stage, rendition stage and control intervention stage. Process rate can be set in the range from 1 to 10 Hz (1 to 10 control interventions per second). In rendering the optimum control intervention, only each control section's value is important and sections of the same values are switched in a rotating fashion. If low power discharging resistors are used, reconnection lockout time can be set between 0.1 and 10 seconds.

Slow control process controls conventional circuit breakers. It needs to respect the limitations from circuit breaker features and useful life. The measurement stage takes place once in a second. Depending on control deviation detected and preset control cycle, the control stage timing is controlled. The control stage can only repeat once every five seconds. In control intervention rendition, the reconnection lockout time setting has to be respected too. Optimum control intervention is chosen not only respecting compensation bank values, but also the number of connections of each bank, time since last disconnection, and the total number of switching operations within the control intervention.

Typically the rapid control process provides compensation, within fractions of a second, of power factor variations that correspond to the thyristor banks' instantaneous compensation capacity. If power factor variation exceeds certain limits, the slow control process renders the resulting control deviation and the slow control process control delay is counted down. When the countdown reaches zero, a control intervention, using circuit breaker banks, is carried out.

KATKA Thyristor Switching Modules

KATKA thyristor switching modules allow switching compensation capacitors at up to 20 times a second. Load is connected at zero voltage across the switching device and disconnection takes place on zero-cross current. Thus, unlike conventional circuit breakers, these modules do not produce unwanted noise within the power system.

There are two basic models differing in maximum load rating:

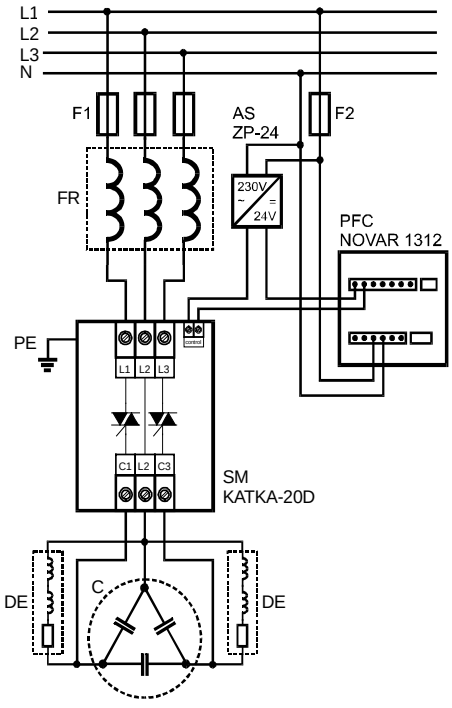
- Katka 20 … switched power maximum 19 to 27 kVAr (depends on wiring used), natural cooling
- Katka 80 … switched power maximum 40 to 87 kVAr (depends on wiring used), forced cooling by inbuilt fan

Either model is designed as two-phase (D) or three-phase (T).

Two principal wirings are used with the switching modules:

- wiring with a three-phase compensation capacitor (as in Figure 2)
  - benefits: two-phase switches can be used, only one, three-phase, capacitor – lower cost
  - drawbacks: overcharging takes place on disconnection – high power dischargers (DE) need to be installed for proper operation

Fig. 2 : Three-phase capacitor wiring



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- wiring with three single-phase capacitors (as in Figure 3)
  - benefits: no overcharging –ordinary bleeding resistor (DR) works all right, higher maximum switched power
  - drawbacks: three-phase switch required, three single-phase capacitors – higher cost

Fig. 3 : Single-phase capacitor wiring

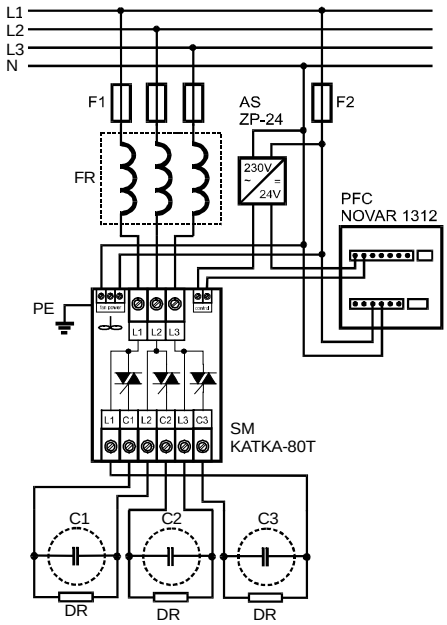


Table 1: maximum loads and recommended capacitors

module	wiring	voltage [V]	power [kVAr]	current [A]	recommended capacitors (ZEZ SILKO)
Katka 20-D	s 3-f. C	400	19	26.9	CSADP1-0.4 / 20 kVAr
Katka 20-T	s 1-f. C	400	22	18.6	3 x CVADP1-0.4 / 8 kVAr
		440	19	14.1	CZAKP6-0.44 / 20 kVAr
		440	27	20.5	maximum bank power at 440 V
Katka 80-D	s 3-f. C	400	47	67.1	CSAKP1-0.4 / 50 kVAr
Katka 80-T	s 1-f. C	400	70	58.1	3 x CVAKP1-0.4 / 25 kVAr
		440	37	28.2	CZAKP6-0.44 / 40 kVAr
		440	87	65.9	maximum bank power at 440 V

Note: values are shown for compensation with detuning reactor of detuning factor 7%.

Figure 4: installation wiring, combined system with switching modules and circuit breakers

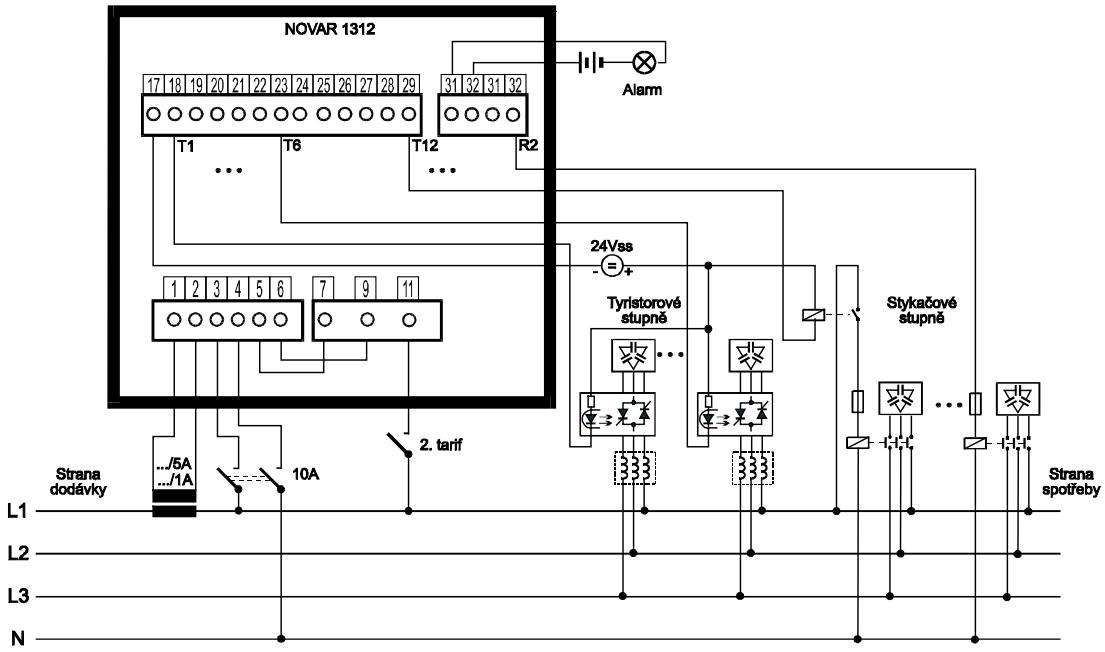


Figure 5: voltage on capacitors and current through switch (wiring with detuning inductance)

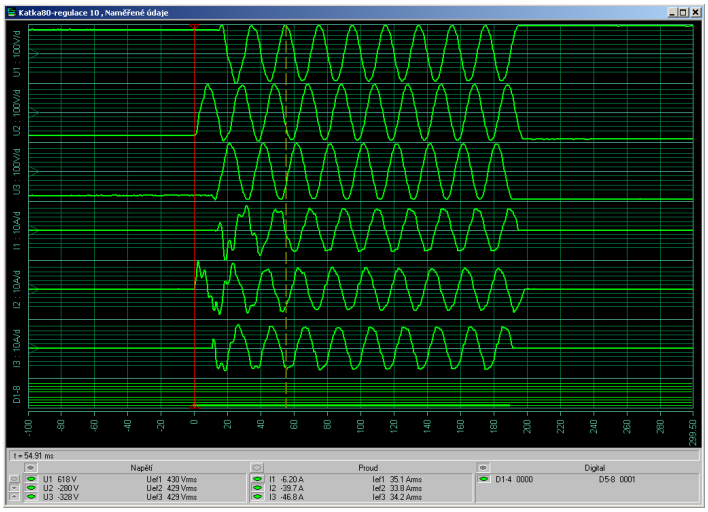
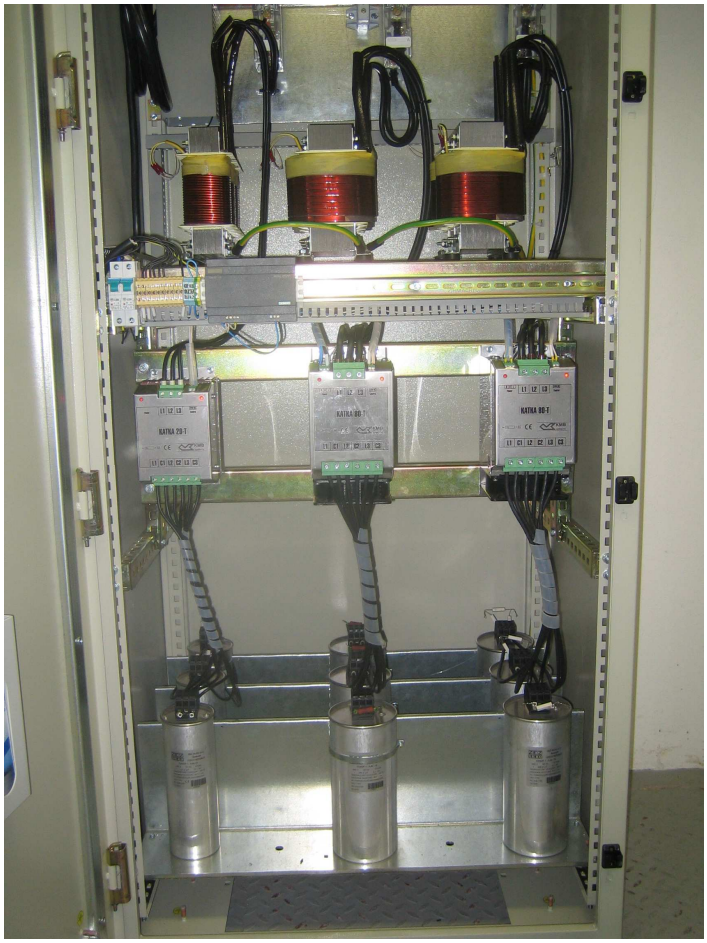


Figure 6: example of three-bank compensation, one KATKA 20T 25 kVAr + two KATKAs 80T, 45 kVAr



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Novar 1312 Power Factor Controller – Specifications

Technical parameters

Adjustable parameters

power factor desired	0.80 ind. through 0.80 cap.
control speed	1 to 10 control interventions in one second
reconnection lock–out time	0.1 to 10 seconds
smallest capacitor current (C/k value converted to CMT primary side)	(0.002 ÷ 2 A) x CMT ratio
choke control limit power factor	0.80 ind. through 0.80 cap.
setting compensation section values	automatic or manual
setting connection mode	automatic or manual

Inputs–Outputs

power supply	100 ÷ 275 V AC, 43÷ 67 Hz, max. 7 VA
measuring voltage	57.7 ÷ 690 V AC +10/-20%, 43÷ 67 Hz
voltage measurement accuracy (RMS value and 1st harmonic)	+/-1% +/-1 digit
voltage input impedance	> 800 kOhm
measuring current (galvanically isolated)	0,002 to 7 A
current input serial impedance	< 10 mOhm
current measurement accuracy (RMS value and 1st harmonic)	+/-1% +/- 1 digit
harmonic component and THD measurement accuracy	+/-5% +/- 1 digit (for U,I > 10% of range)
temperature measurement range / accuracy	-30 až 60 °C, ± 5 °C
number of outputs in transistor section	12
output transistor load capacity	maximum 100V / 100 mA
number of output relays	2
output relay load rating	250 V AC / 4 A
"alarm" relay load rating	250 V AC / 4 A
second metering rate input (galvanically connected, for connection of insulated contact optron	30 Vss / 5 mA
installation overvoltage class / pollution degree • for measuring voltage up to 300 V AC • for measuring voltage over 300 V AC	 III-2 in compliance with EN 61010-1 II-2 in compliance with EN 61010-1

Telecommunication

interface	RS 232 / RS 485, galvanically isolated
transmission rate	4800 ÷ 19200 Baud
maximum number of instrument on one communication line	1/32
maximum node–to–node distance	30 m / 1 200 m
protocoll	KMB / Modbus RTU

Operating conditions

working environment	class C1 in compliance with IEC 654-1
operating temperature	-40° ÷ +60°C
relative humidity	5 to 100 %

EMC

noise suppression level	in compliance with EN 50081-2, EN 55011 , class A, EN 55022 , class A
immunity	in compliance with EN 61000-6-2

Mechanical

enclosure - front panel - back panel	 IP40 (or IP54) IP20
dimensions - front panel - built-in depth - cutout	 144 x 144 mm 80 mm 138 x 138 mm
mass	max. 0.7 kg

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KATKA thyristor switching modules – technical data

Parameter	Unit	Katka 20-D	Katka 20-T	Katka 80-D	Katka 80-T
nominal operating voltage	V	400/230±10% 440/250±10%	400/230±10% 440/250±10%	400/230±10% 440/250±10%	400/230±10% 440/250±10%
maximum blocking voltage	V	1600	1600	1600	1600
maximum operating current	A	29	22	87	67
maximum rate of current rise dI/dt	A/us	50	50	50	50
conductor cross-section	mm^2	10	10	25	25
number of switches	-	2	3	2	3
load character	-	C/R/L	C/R/L	C/R/L	C/R/L
auxiliary voltage (for fan)	V	-	-	230±10%	230±10%
fan power (temperature controlled)	VA	-	-	32	32
auxiliary conductor cross-section	mm^2	-	-	2.5	2.5
fan threshold temperature	°C	-	-	60±5	60±5
control voltage / current - DC [1)]	V / mA	24 / 10	24 / 10	24 / 10	24 / 10
control conductor cross-section	mm^2	2.5	2.5	2.5	2.5
thermal protection (module switched off)	°C	—	—	100±5	100±5
overvoltage class / pollution degree	-	3 / II	3 / II	3 / II	3 / II
overvoltage protection	-	C	C	C	C
mechanical protection	IP	20	20	20	20
temperature - operating (maximum load) - operating (75% load) - 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
operating humidity – non condensing	%	5 ~ 95	5 ~ 95	5 ~ 95	5 ~ 95
dimensions WxHxD	mm	122x192x117	122x192x117	122x245x157	122x245x157
mass	kg	2.05	2.15	3.35	3.45

Comment: [1)] polarity-free, 230 V / 50-60 Hz / 5 mA or 24 V / 50-60 Hz / 10 mA on request

Fig. 2 : KATKA 20 – physical dimensions

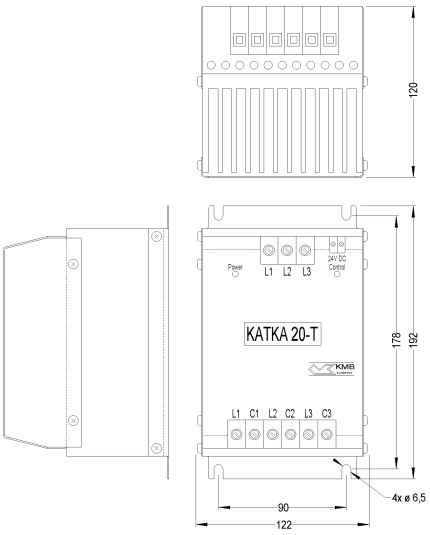

Fig. 2 : KATKA 80 – physical dimensions