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
email : kmb@kmb.cz, internet : www.kmbsystems.eu

KATKA

Thyristor Switching Modules

Application Manual

Applications

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 compensators of the NOVAR line. They can, of course, be also used in other applications where contactless 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.

11/2007

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

The benefits of contactless 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 overvoltage 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 curcuit condition of the module when control voltage is applied.

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

Wiring

The modules are compact switching modules that are currently manufactured in four models as further described:

- Katka 20-D – a module with natural cooling. It switches phases L1 and L3. Phase L2 passes through. It is designed for star- or delta-connected three-phase loads. Wiring diagram in Figure 1 (less the fan and auxiliary voltage).
- Katka 20-T – a module with natural cooling. It switches phases L1, L2, and L3. It is designed for star- or delta-connected three-phase loads. Wiring diagram in Figure 2a,b. It can be further wired as in Figure 3 (less the fan and auxiliary voltage).
- Katka 80-D – a module with forced cooling. It switches phases L1 and L3. Phase L2 passes through. It is designed for delta-connected three-phase loads. Wiring diagram in Figure 1.
- Katka 80-T – a module with forced cooling. It switches phases L1, L2, and L3. It is designed for star- or delta-connected three-phase loads. Wiring diagram in Figure 2a,b. It can be further wired as in Figure 3 .

The wirings in Figure 1 and 2 or 4 and 5, respectivelly, are traditional ones, wiring in Figure 3, resp. 6 is not so usual and therefore it is suitable to compare these wirings, mentioning their respective advantages and disadvantages, especially from fast reacive power compensation's point of view.

Fig. 1, 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 1.9 times the nominal voltage (820 V_{peak} for 400 V nominal, see Fig. 9) 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 (130 W for 20 kvar capacitor and 5 switching operations per seond).**Therefore, this connection is not recommended for fast compensation systems !**

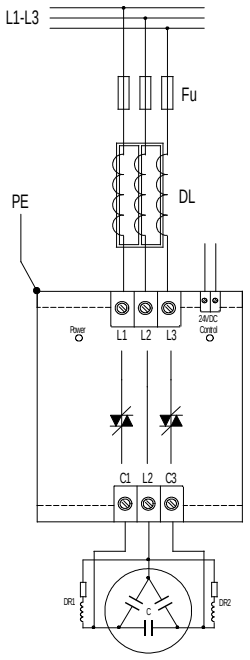


Fig. 1

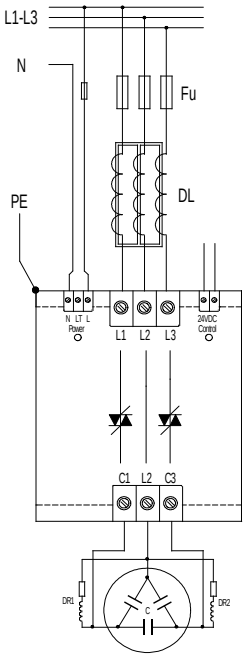
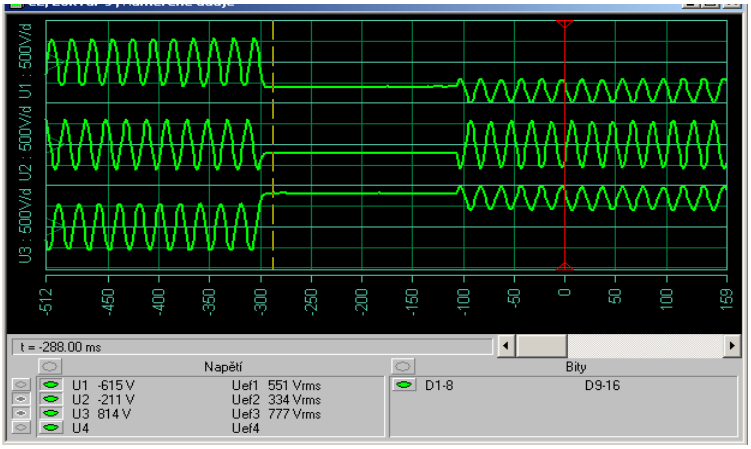


Fig. 4

Fig. 9 : 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 reswitching (t = -120 ms) is incorrect, because of capacitor between L2 and L3 only is switched-on ! Fast discharge cvircuits **DR** not installed.

- **Fig. 2a, 5a** – higher heat loss, three switches. Capacitors (or other load) are delta-connected to phase-to-phase voltage. All of three phase voltages switched on/off. The same applies to reactive power compensation as in Fig. 1, 4. **Therefore, this connection is not recommended for fast compensation systems !**

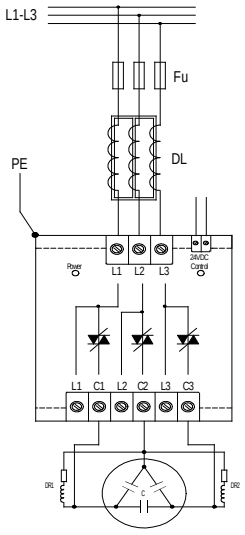


Fig. 2a

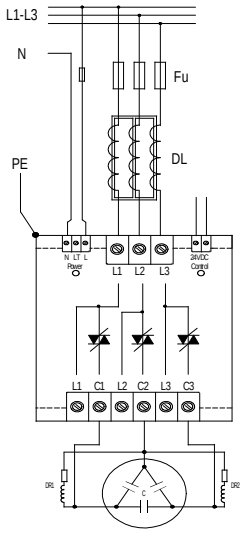


Fig. 5a

- **Fig. 2b, 5b** – Capacitors (or other load) are star-connected to the phase-to-neutral voltage. The **N** Neutral wire is connected for asymmetric or capacitive loads. It is however not used for reactive power compensation. There is no fast discharge circuit. **Not usable for compensation systems !**

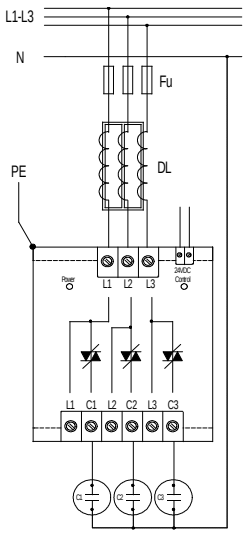


Fig. 2b

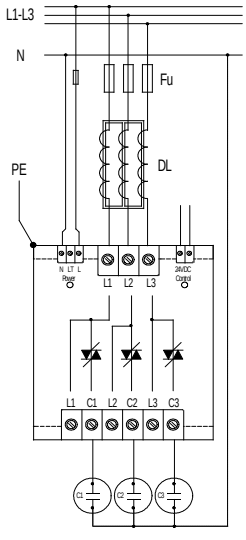


Fig. 5b

- **Fig. 3, 6** – Three switches, loaded with 1.7 times smaller current in compare with preceeding wirings 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** (33 kΩ / 13W) eliminating supply voltage fluctuations is recommended. Due to this, the wiring is often more economical to the wirings Fig 1, 4. **Therefore this wiring is recommended for fast compensation systems.**

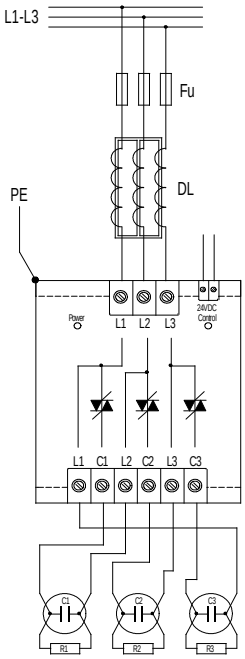


Fig. 3

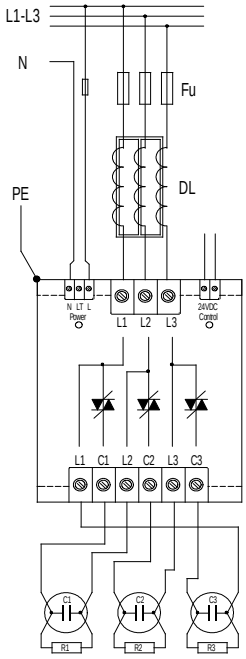


Fig. 6

- A choke, or inductance, is connected between the circuit breaker and the switching module with detuning reactors (see Fig. 1 through 6). It is also possible to connect it between the switching module and capacitors (see Fig. 7). **But chokes of different inductance must be used in such case.** Except of this the wirings have the same features.
- *di/dt* protective chokes of inductance 12 µH if not using detuning reactors are connected between the switch and each capacitor (see Fig. 8). **But this wiring is not recommended for fast compensation systems !**
- Auxiliary voltage for the fan goes to terminals L and N. The LT terminal is a line behind the thermostat. Short circuiting L and LT terminals turn on the fan on a fixed basis thus also allowing fan operation test.

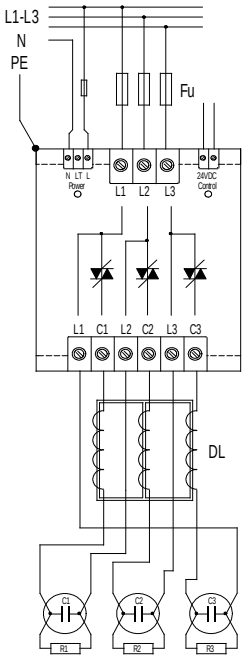


Fig. 7

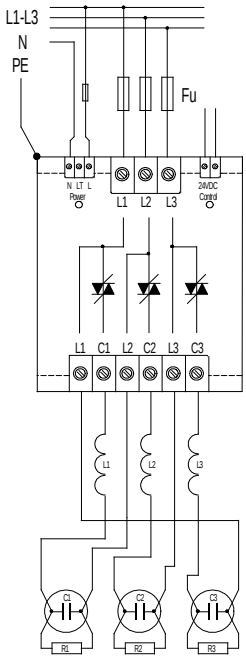


Fig. 8

- For recommended values of detuned compensation systems see Tab. 2; the vaules are valid for wirings Fig. 3 and 6. Program for compensation system design (*PFC_Design.xls*) available at manufacturer (see www.kmbsystems.eu).

Technical specifications

Tab. 1: Katka Modules Technical Parameters

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%
blocking voltage max.	V	1600	1600	1600	1600
operating current max.	A	29	22	87	67
rate of current rise dI/dt max.	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
aux. 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
temp. protection (module switched off)	°C	-	-	100±5	100±5
overvoltage cath. / 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 (max. 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
relative humidity – non condensing	%	5 ~ 95	5 ~ 95	5 ~ 95	5 ~ 95
dimensions w x h x d	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.

Tab. 2: Compensation System Components' Values for Standard Capacitor Value Line (valid for wirings Fig. 3, 6)

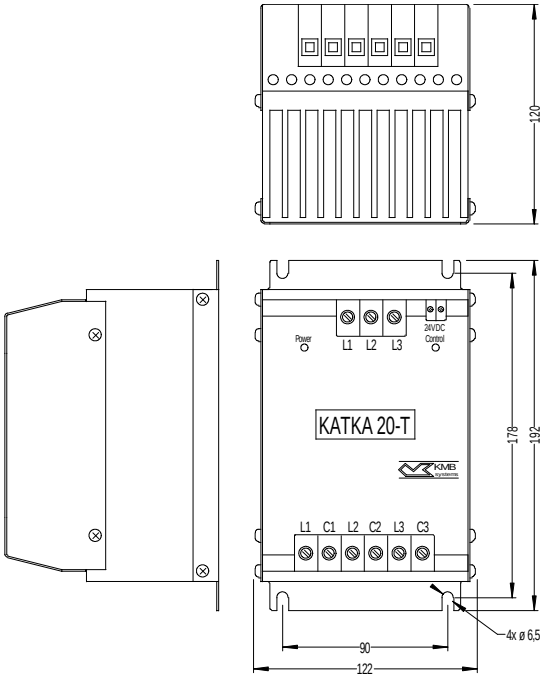
Detuned Power Factor Correction (f =	189	Hz)			Uc/U = 107,5%	
Power of capacitor-reactor block (3 phases)	Power of capacitor at 440V	Capacitance of capacitor	Inductance of reactor	Switching current	Rated current	Recommended modul
[kvar]	[kvar]	[uF]	[mH]	[A]	[A]	
2,7	1	16,4	14,376	2,2	3,8	Katka 20 T
4,0	1,5	24,7	9,584	3,3	5,8	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
8,4	3,15	51,8	4,564	7,0	12,1	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
16,7	6,25	102,8	2,300	13,9	24,0	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 80 T
33,3	12,5	205,5	1,150	27,8	48,1	Katka 80 T
40,0	15	246,6	0,958	33,3	57,7	Katka 80 T
44,5	16,7	274,6	0,861	37,1	64,3	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

Note : Program for components' values calculation (PFC_Design.xls)available at manufacturer (see www.kmbsystems.eu).

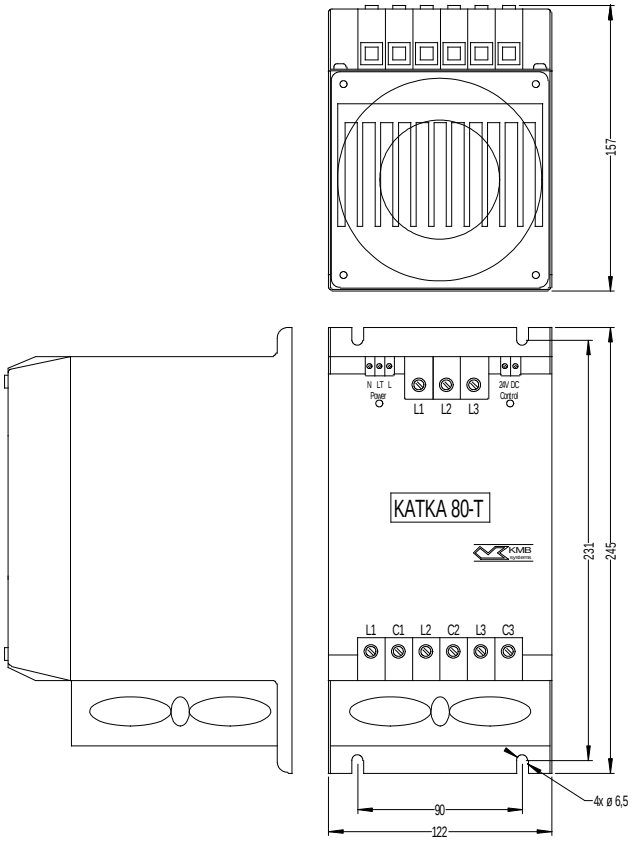
Mechanical dimensions

(values in milimeters)

KATKA 20-D / KATKA 20-T:



KATKA 80-D / KATKA 80-T:



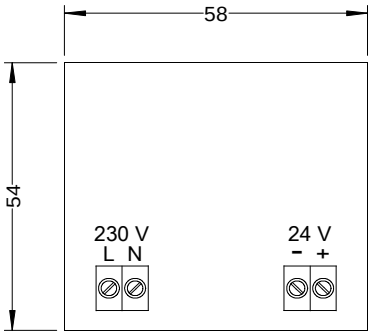
Accessories

Discharge resistors

3 pieces of discharge resistors 33 kΩ/13 W are delivered with each module as standard accessory. The resistors are suitable for use in wirings Fig. 3,6 (**R**). The resistors can be connected directly to the capacitors terminals.

Auxiliary supply ZP 24

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“* .

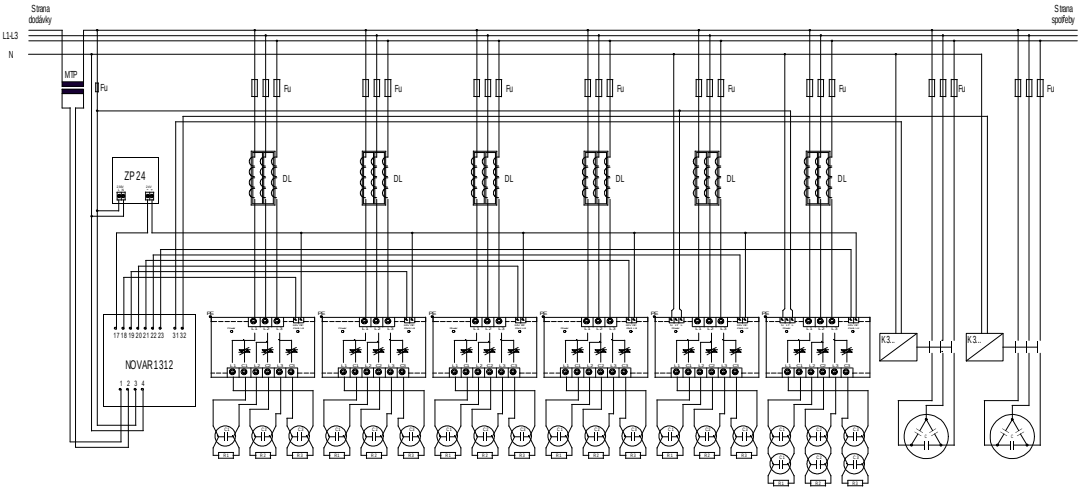


Compensation Switchgear Design Example

Task : Total compensation power is 250 kvar, from this 150 kvar for fast compensation. Fast compensation blocks detuned (res. frequency 189 Hz), slow blocks not detuned.
With „PFC_Design.xls“ program, next compensation blocks were chosen (discrete components of companies KMB systems and ZEZ SILKO):

Block No.	Block Type (freq)	Nominal Power at 440 V	Choke	Capacitor	Thyristor Switch / Contactor	Block Power	Cross Section / Fuse
		[kvar]				[kvar]	[mm² / A]
1	fast, fr = 194Hz	3,15	ZEZ 3,15-189/400/440	CVADP 1-0,44/1	Katka 20 T	2,65	2,5 / 8
2	fast, fr = 189Hz	6	ZEZ 6-189/400/440	CVADP 1-0,44/2	Katka 20 T	5,33	2,5 / 16
3	fast, fr = 189Hz	12	ZEZ 12-189/400/440	CVADP 1-0,44/4	Katka 20 T	10,67	4 / 25
4	fast, fr = 193Hz	25	ZEZ 25-189/400/440	CVADP 1-0,44/8	Katka 20 T	21,26	10 / 50
5	fast, fr = 189Hz	45	ZEZ 45-189/400/440	CVADP 1-0,44/15	Katka 80 T	39,99	25 / 100
6	fast, fr = 189Hz	80	ZEZ 80-189/400/440	2x CVADP 1-0,44/13,3+13,3	Katka 80 T	70,91	2x 25 / 200
7	slow, not-detuned	50	---	CSADP 3−0,4/50	K3-62K00 230	50	25 / 125
8	slow, not-detuned	50	---	CSADP 3−0,4/50	K3-62K00 230	50	25 / 125

Simplified switchgear wiring diagram :



Service

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.kmbsystems.eu

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: