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MICROPROCESSOR-BASED RELAY FOR ELECTRIC ENGINES

E P S

INSTRUCTION FOR USE

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The notes concerning the relay's operational safety have been indicated with the following symbols. All information and recommendations labelled this way must be observed.

Electric shock hazard.

Potentially dangerous situation which may give rise to hazards for operators or cause damage to the relay.

Information concerning the structure, operation and service of the relay:

Important information or useful hint.

Practical advice or problem solution.

Exemplary application or function.

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APPLICATION

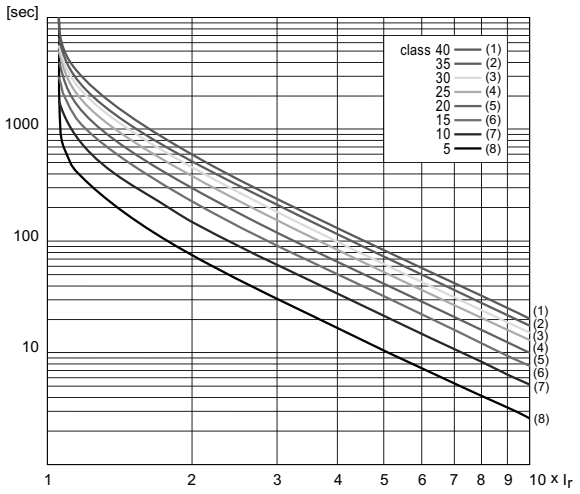
The EPS is intended for the protection of triple-phase electric engines of any power rating (for engines with power between several hundred watts and 55kW, direct connection may be used, whereas more powerful units require additional, external current transformers). The EPS secures the engine against thermal and current overloads, ground faults, faults leading to engine rotor stall, as well as against heavy start-up conditions, load unbalance and phase collapse. The EPS is also a perfect solution for engines used in expensive applications which require high reliability, like lifts, conveyors, elevators, fans, centrifuges, compressors, etc.

DESCRIPTION OF PROTECTION DEVICES

- thermal protection

The relay controls load imposed on each phase. Based on the set values selected by the operator, as well as on the actual current consumed by the engine, the microprocessor utilises one of the eight time-current characteristics of the relay in accordance with the IEC947 standard (see fig. 1). These characteristics are assigned with particular classes within the range from 5 to 40 (each class is a function which describes time in seconds after the lapse of which the relay will disconnect the current load at the multiplicity of 7,2×its set current Ir). The proper characteristics are selected depending on the start-up parameters and rated power of the engine. On the grounds of the protection characteristics selected, as well as the whole "history" of the engine's operations from the moment the relay was activated, the EPS calculates the maximum permissible engine overload time in order not to exceed the temperature rise threshold value, and disconnects the engine power supply once the value has been exceeded. Thanks to advanced processing algorithms applied, the EPS also correctly measures the actual effective value of currents deformed by higher harmonics (including the 7th harmonics), even with considerable overcurrents (up to 10 times).

Fig. 1



Time-current characteristics for "cold" status of thermal memory.

- protection against frequent start-ups

Thanks to the electronic "heat accumulation" feature, the device stores the temperature condition of the engine working in safe conditions. Frequent start-ups lead to extremely intensive heat generation in the engine, which in turn causes its overheating. In order to avoid this, after the set temperature rise has been achieved, the relay disables further start-ups until the temperature drops below the maximum permissible level.

- protection against load unbalance and phase decay

Independent current measurement for each phase enables the situation in which any phase collapse or operation with load unbalance exceeding 30% will be detected early enough, and the engine will be turned off with a 4-second delay. The delay is to avoid engine disconnection each time the voltage drops momentarily due to minor network fluctuations.

- protection against ground fault

Ageing electric cable insulation is one of the most common causes of punchthrough to the relay's case which may lead to ground faults dangerous for the engine and people in its proximity. In order to avoid this, the EPS relay has been equipped with a feature which selectively detects ground faults at the level predefined by the user and disconnects the engine after the lapse of a set time. This feature does not require any additional current transformer.

CAUTION!

The above function does not serve to protect operators against electric shock and is only intended as a fire-prevention measure!

OPERATION

On the basis of continuous load measurement made by internal current transformers, the EPS relay simulates the temperature status of the engine working in safe conditions and compares it to the set current-time protection characteristics. In addition, thanks to advanced processing algorithms applied, the EPS correctly measures the actual effective value of currents deformed by higher harmonics, even with considerable overcurrents (up to 10 times). Each time the set protection parameters are exceeded, e.g. in cases of engine overheating, phase collapse, voltage unbalance or ground fault, the 95-96 contact will be opened and the engine will be switched off. The relay will signal the cause of the disconnection. The engine can be restarted only after the cause of the defect has been rectified or proper power supply conditions reinstated. The operator must also unblock the relay manually (with the reset button). In the event of the thermal protection activated in the manual operation mode, the engine may be restarted after its temperature drops below 80% of the maximum permissible value. On the other hand, in the automatic mode, the engine will be restarted automatically after its temperature drops below the value stated above.

The EPS relay has a feature of electronic "heat accumulation", i.e. during the engine's continuous work, the device stores the temperature of the engine working in safe conditions, and once the relay is disconnected from the power supply or in the event of power voltage decay, its "thermal memory" is cleared and returns to the initial, "cold" status.

Due to the deformities in current flows caused by rotational speed inverters and the soft-starters included in the system, the EPS cannot be connected to such devices at the output side.

RELAY SELECTION

The EPS is available in seven current versions: 5A, 10A, 16A, 25A, 45A, 63A, and 100 A. The actual working current set value range for each version is from 62 to 100% of the relay's rated current (0,625÷1×In). Therefore, the selection of a proper relay depends on the power of the engine to be protected and its rated current. For engines with power between several hundred watts and 55kW, the EPS with a proper set current range can be used (see pt A), whereas more powerful units require the 5-A EPS version with additional external current transformers (see pt B).

A. Selection of relays for engines of rated power up to 55kW

The proper relay selection depends on the power of the engine to be protected and its rated current. Table 1 includes the range of working current set values for particular versions of the EPS relays, while Table 2 shows the relation between the engines' rated current and their power.

table 1

EPS VERSION	SETTING RANGE
5A	3,125÷5A
10A	6,25÷10A
16A	10÷16A
25A	15,625÷25A
40A	25÷40A
63A	39,375÷63A
100A	62,5÷100A

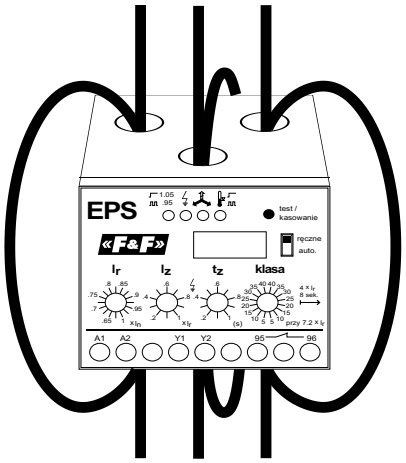
table 2

P [kW]	0,75	1,1	1,5	2,2	3,0	4,0	5,5	7,5
In [A]	1,8	2,7	3,5	5,0	6,5	8,0	11	15
P [kW]	11	15	18,5	22	30	37	45	55
In [A]	22	30	34	41	55	68	81	99

While selecting the proper EPS to protect the engine it is essential to remember that engines used in power transmission systems are selected in order to work at 80% of their rated parameters.

In the case of engines whose rated current is lower than the working current setting range for the relay or if the actual working current of the engine may fluctuate at the borderline between the limit settings for two relay versions, one may select a relay with a higher working current, simultaneously increasing the properly measured working current of the engine by running its power supply cables through the relay's transformers several times (see fig. 2).
***CAUTION!** The same number of wiring turns must run through each transformer!*

Fig. 2



EXAMPLE 1
A 3-kW engine with rated current of 6,5 A may be protected with a 25-A relay, whose setting value range is between 15 and 25A. Running three runs of the engine's power supply cables through the relay's transformers will increase the measured current to 19,5A, thus shifting it to the middle point of the setting range.

EXAMPLE 2
For a 5,5-kW engine with rated current at 11A, the working current setting may be at the borderline between the setting ranges of two relay versions, i.e. 10A (6,26÷10A) and 16A (10 ÷16A). By running the engine's power supply cables through the relay's transformers two times, the user may increase the measured current to 22A, which will enable the application of the 25-A relay version with the current setting range between 15 and

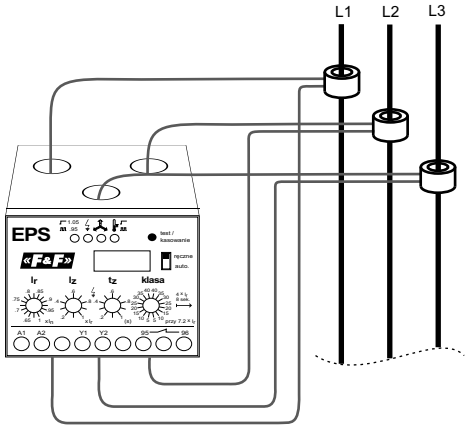
B. Selection of relays for engines of rated power exceeding 55kW

For engines with power exceeding 55kW (>100A) the 5-A version of the EPS relay should be applied with the additional current transformers whose secondary circuit cables are to be run through the relay's internal transformers (see fig. 3).

CAUTION!

The secondary rated current of the external transformers must amount to 5A.

Fig. 3



CAUTION!

To ensure proper operation of the relay, all current transformers must have identical rated values (i.e. be of the same type offered by the same producer).

The external transformers must be selected so that the rated current value of the engine to be protected remains within the actual range of settings for the current flowing in the main circuits (i.e. at the primary side of the transformer).
Table 3 below presents the relation between the engines' rated current and their power, while Table 4 includes the set value of the current depending on the transformer's rated current and ratio.

table 3

P [kW]	65	75	90	110	132
In [A]	115	135	160	195	230
P [kW]	160	200	250	315	355
In [A]	280	350	435	545	615

table 4

TRANSFORMER'S CURRENT	CURRENT RATIO	SETTING RANGE
100/5	20:1	63÷100A
150/5	30:1	94÷150A
200/5	40:1	125÷200A
250/5	50:1	157÷250A
300/5	60:1	188÷300A
350/5	70:1	219÷350A
400/5	80:1	250÷400A
500/5	100:1	313÷500A
600/5	120:1	375÷600A
700/5	140:1	438÷700A

EXAMPLE 3
A 160-kW engine with rated current at 280A may be protected with a 5-A relay with additional 300/5A current transformers connected (ratio: 60:1). The setting range for the actual working current Ir is between 188÷300A. This range is the product of the Ir current setting range and the current transformer ratio ([3,125÷5]A×60). The easiest way of specifying the engine's actual working current is to calculate the product of the Ir set value on the scale and the value of the transformer's rated primary current (e.g. 0,85 ×300A = 255A).

INSTALLATION

CAUTION!

The EPS relay should be assembled, operated and regulated only by personnel qualified in its structure, function and all related hazards.

CAUTION!

Do not install damaged or incomplete relays!

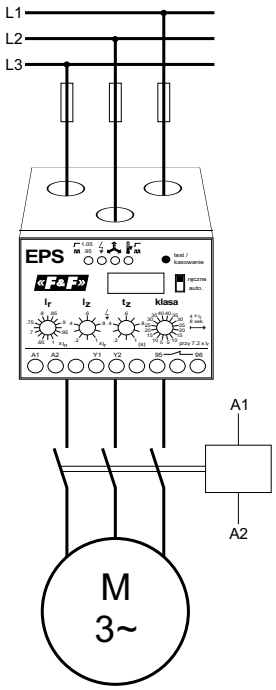
1. *Check if the engine works properly.*
2. *Disconnect the power supply.*
3. *Mount the EPS in the connecting box.*

CAUTION!

The EPS should be mounted in cases with IP42 protection level.

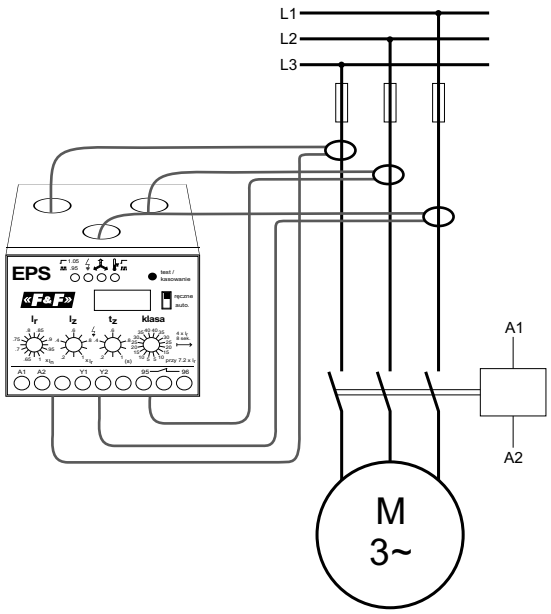
4. 1. Run the engine's power supply cables (see fig. 4) or the cables of the current transformers' secondary circuits (see fig. 5) through the apertures in the upper wall of the relay.

Fig. 4



Main circuits connection

Fig. 5



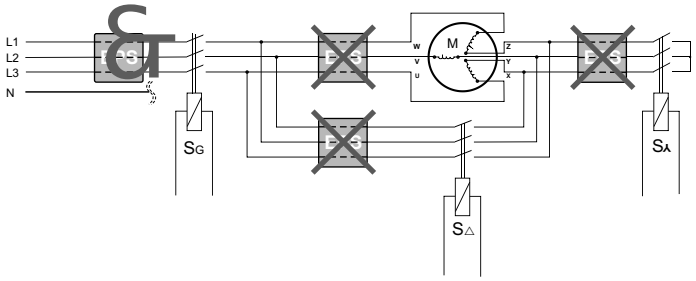
Connection to external current transformers

CAUTION!

Cables must be run and connected only after the user makes sure that the relay is disconnected from the power supply!

In the case of STAR-DELTA start-up systems, the relay must always be mounted (in terms of electrical connections) under the main connector (see fig. 6).

Fig. 6



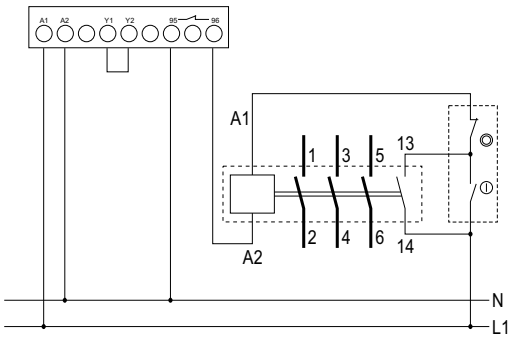
The location of the EPS connection within the connector-based Star-delta start-up system.

1. Connect the relay's power supply cables to terminals A1-A2. Apply protection level for the 2nd overvoltage category (load level). See fig. 7.
2. Include terminals 95-96 in serial connection into the circuit of the engine start-up connector's coil. See fig. 7.
3. Apply jumper to the terminals Y1-Y2. Otherwise, the 95-96 contact will remain open. See fig. 7.

CAUTION!

Do not connect any voltage to terminals Y1-Y2!

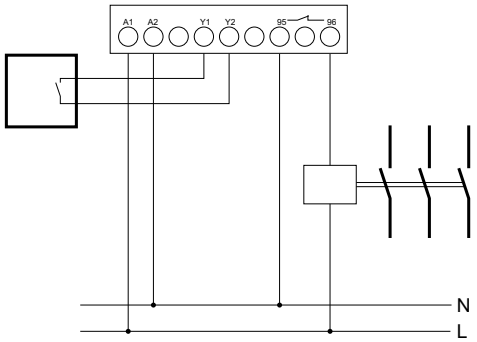
rys. 7



Connection of auxiliary circuits.

The Y1-Y2 input enables one to switch the engine on and off without any additional intermediate circuits. See fig. 8.

rys. 8

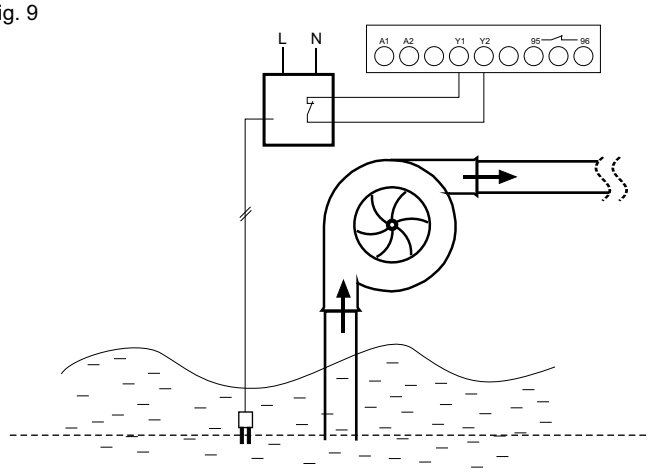


Connection with external controller.

By connecting the contact of the following devices: PLC, prioryty relay, fluent level controll relay, radio controller or other industrial controllers or supervision and control devices (e.g. phase sequence control relay) to terminals Y1-Y2, one can enable remote control of the engine by means of the EPS.

EXAMPLE 4
The contact of the fluent level controll relay (PZ-828) is connected to the terminals Y1-Y2, which additionally protects the pump against idle running. During the pump's normal operation (relay's probe submerged in liquid), the terminals Y1-Y2 are contact-closed. If the liquid level drops below the pump's suction point, and simultaneously below the relay's probe level (probe's electrodes open), the contact will open and the pump will stop working. See fig. 9.

Fig. 9



Pump protected against idle running

CAUTION!

Proper earthing system must be provided by the user, who is also responsible for correct selection, mounting and servicing of other protection devices.

PARAMETER SETTINGS

***Ir** - working current setting for the engine within the range of (0,625÷1)In and the pitch of 0,025.*
The engine is properly protected when its working current does not deviate from the value set on the relay's scale by more than ±5%. The correct setting is located by using the proper switch with the engine working. The current value within the range of (0,95÷1,05)Ir is signalled by a blinking LED, whereas any value exceeding 1,05 by constant lighting of the LED in question. When the LED remains blank, it means that the current setting value is below 0,95.

***Iz** - ground fault current setting within the range of (0,1÷1)Ir, with the pitch of 0,1.*

***tz** - relay activation delay setting for the ground fault current within the range of 400msec. + (0,1÷1)sec., with the pitch of 0,1 sec.*
CAUTION! The time of 400msec. is the shortest required switch-off time in the event of a ground fault.

***class** (klasa) - the relay offers the selection of one of eight thermal protection characteristics within the range of 5÷40. A class is a function which describes the time after the lapse of which the relay will disconnect the current load at the multiplicity of 7,2×its set current.CAUTION! If one of the characteristics located to the right of the switch is selected, an additional feature of the relay is activated which protects the device against the current flow exceeding 4xIr for the time of > 8 sec.*

The proper characteristics should be set on the basis of specifications provided by the engine producer. Should such data be missing, the user can use that from Tables 5 and 6 below which include approximate information on the protection class depending on the engine's start-up time.

table 5

DIRECT START-UPI	
start-up time	class
1÷2 sec	5, 10
3÷5 sec	10, 15
6÷8 sec	20, 25
9÷10 sec	30, 40
>10 sec	40

table 6

STAR-DELTA START-UP	
start-up time	class
5÷10 sec	5, 10
15 sec	15
20÷25 sec	20, 25
30 sec	30
30÷40 sec	35, 40

Each thermal protection class is selected for the normal working conditions for a given engine (ambient temperature at 20ºC).
In the case of high ambient temperature, caused for example by severe weather conditions or ventilation system failure, the engine will give up heat at a much slower rate. In such cases, a lower protection class must be selected in order to avoid superheating.

***manual/auto** (ręczne/auto) - two operation modes featured in the relay, which can be selected by moving the code switch to the proper position.*
In the auto mode, the relay is restarted automatically after overload, once the temperature of the protected engine drops below 80% of the maximum permissible value. In manual mode, the restart is achieved by pressing the reset button (N.B.: the engine's temperature must be below 80% of the maximum permissible value, since otherwise the relay cannot be restarted).

CAUTION!

In the auto mode, after the emergency stop, the engine will be automatically restarted. Should this pose a threat to the operators, and if switching to the manual mode is impossible, access to the protected engine should be disabled or the potentially dangerous location should be clearly marked with visible and easily comprehensible warning signs.

***test/reset** (test/kasowanie)*
- relay's test after the button is pushed, contacts 95-96 will be closed for a period of time (in seconds) equal to the number of the class selected (terminals Y1-Y2 must also be closed).

After the above test, the "thermal memory" of the relay is cleared and the device returns to the initial, "cold" status.

- failure reset engine restart after emergency stop.

START-UP

1. *Set the relay's parameters in accordance with this manual.*
2. *Switch on the power supply of the relay.*
3. *Start-up the engine.*

CAUTION! During the engine start-up, the relay switches to the status indicated as pos. 4 in Table 7. After the start-up, the status changes to the one described in pos. 2 or 3 (depending on the actual load).

4. *Adjust the Ir setting to the value between 0,95÷1,05.*

TECHNICAL DATA

Power supply	160÷253V, 50/60Hz
Main circuits' insulation voltage	690V~
Rated current (In)	see label on EPS case
Main circuits' frequency	50Hz
Main circuits' protection (2-A fuses, char. gG)	3×In,char. gG 2A at 400V~ DC-15 2A at 30V- DC-14
Insulation co-ordination type	2
Protection level	IP40
Material group	II
Surge voltage1,2/50	main circuit 8kV auxiliary circuit (96-96) 4kV control circuit (A1-A2) 2,5kV
Overvoltage category	- II (load level)
Effective current unbalance	>30%
Delay at phase decay and unbalance	4sec.
Pollution level	3
Rated duty type	class 30, rel. time 40%
Max. cable diameter	Ø14
Terminal	screw terminals 1×2,5 mm
Measurements	72×59×88 mm
Weight	385g
Fixing	on rail TH-35

STATUS INDICATION

table 7

Status	95–96	Y1–Y2	1.05 .95	⚡	Y	🌡	Status description
1. Relay inactive	open	open	○	○	○	○	no jumper on Y1-Y2
2. $I < 0,95 \cdot I_r$	closed	closed	○	○	○	●	wrong current setting
3. $0,95 \cdot I_r \le I \le 1,05 \cdot I_r$	closed	closed	☼	○	○	●	correct current setting
4. $I > 1,05 \cdot I_r$	closed	closed	●	○	○	●	wrong current setting
5. Thermal overload	open	closed	○	○	○	☼	FAILURE
6. Phase decay or load unbalance > 30%	open	closed	○	○	●	☼	FAILURE
7. Earth fault	open	closed	○	●	○	☼	FAILURE

○ - blank ☼ - blinking ● - continously lit

WARRANTY

1.The duration of the warranty is 24 months from the date of purchase.
2.The warranty is valid with the receipt only.
3.Complaints must be filed at the point of purchase or directly with the producer (tel. no. 42-2270971, e-mail: dztech@fif.com.pl).
4.Within the warranty period, the producer undertakes to repair or replace the relay within 14 days from the date the unit is delivered to the service point.
5.The purchaser has the right to have the relay replaced or to receive a refund if an indelible defect is revealed.
6.This warranty does not cover the following:
-mechanical or chemical defects,
-defects which stem from improper use contrary to the user's manual,
-defects which appear after the unit has been sold due to accidents or other events for which neither the producer nor the point of sale can be held responsible, e.g. transport damage, etc.
7.This warranty does not cover any operations which, according to the manual, should be done by the user, e.g. mounting of the relay, installation of the electrical system, installation of other required electrical protection devices, recommended inspections and tests, etc.

CAUTION!

No unauthorised modifications are to be made in the relay otherwise the device may be damaged or malfunction which in turn may lead to damage of the protected engine and jeopardise its operators. Should this warning be ignored, the producer cannot be held responsible for any related events and is entitled to deem this warranty invalid in the case of any complaint.