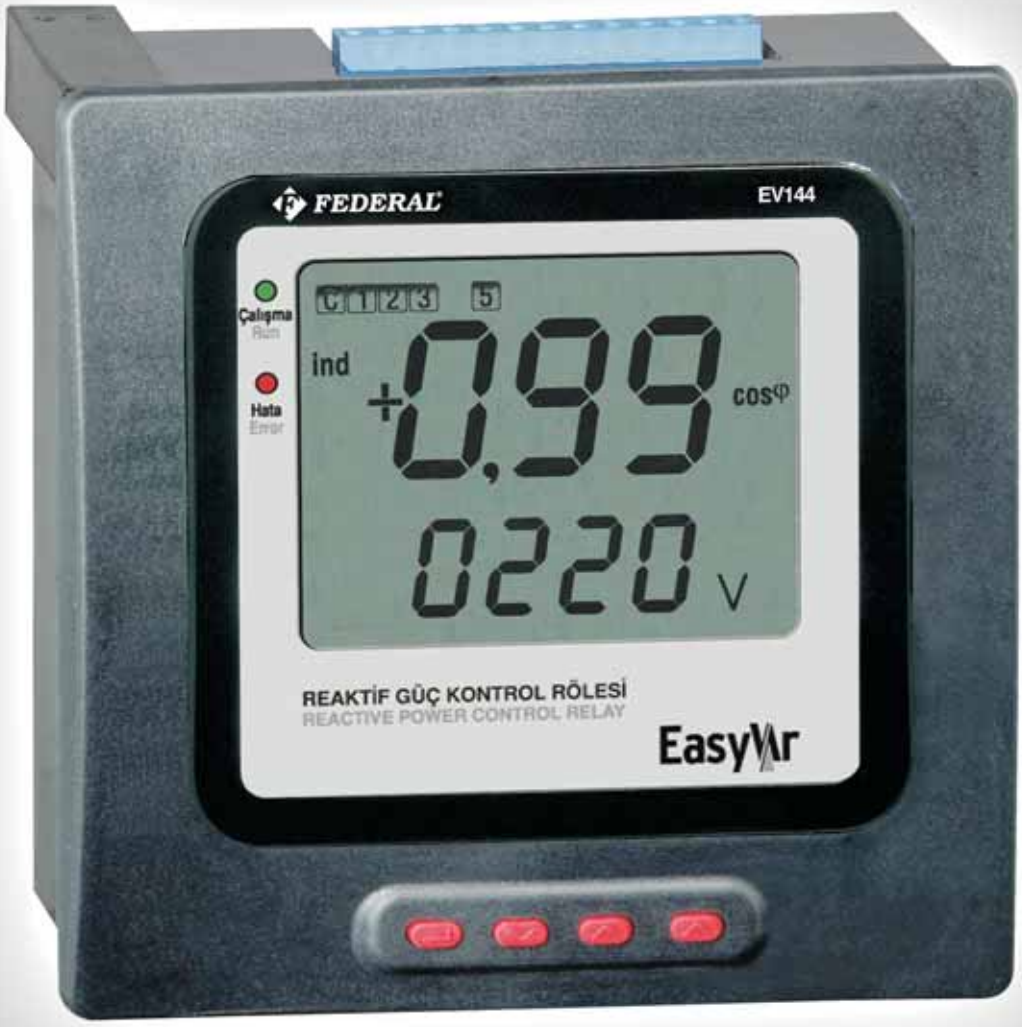
REACTIVE RELAYS



FX Series Reactive Power Control Relays

FX 5

FX 7

FX 12

EasyVAr Reactive Power Control Relays

EV96

EV144

FKR Series Reactive Power Control Relays

FKR240

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FX12 Reactive power control relay

FX series reactive power control relays, which are manufactured in accordance with CE, perceives the system current digitally and measures power factor of the facility sensitively. IN cases where estimated power factor is out of the desired values, capacitor is enabled or disabled. Capacitor contactors are driven by the relays in the device. These relays are resistant to temporary current regimes and opening-closing impact currents and arc has been minimized with filters used at contact ends.

Operating Characteristic :

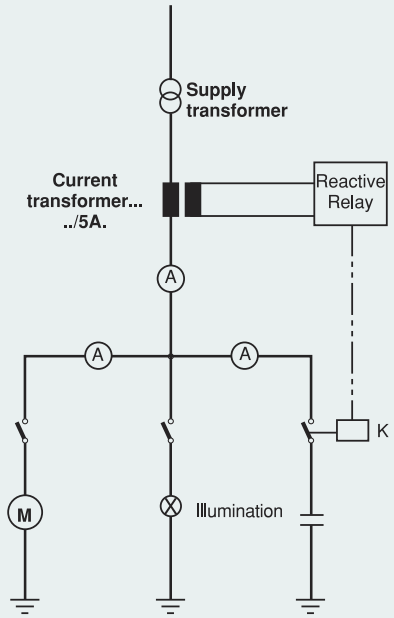
- Front panel consists of easy to use, 3 multi-functional buttons.
- Functions are selected with SET button. Changes in the selected function are made with up and down buttons.
- The relay is not affected from harmonic currents.
- Breakdown of capacitor or contactors in time, increase in reactive power consumed by the facility may avoid reaching the desired power factor. In this case, alarm contact is enabled to give warning. All the warning statuses can be monitored by the leds on the front panel. It is recommended to connect a remarkable warning lamp or audible warning to the alarm circuit.

Factory Values of FX Series Reactive Power Control Relays:

- Cosφ : 0.99
- Stepping duration : 8 sec
- Program : 3

It is recommended to keep low stepping duration in facilities that require phase compensation (gas stations, welding houses, plastic coating etc.)! Please check accuracy of set values and health operation of compensation with regular intervals.! Current transformer of reactive relay must be placed on the phase of supply. For example, if the relay is supplied from R phase; transformer should be placed on R phase before loads and after main switch.! Fixed capacitor should be used at places with little illumination load at the end of working hours or at nights.

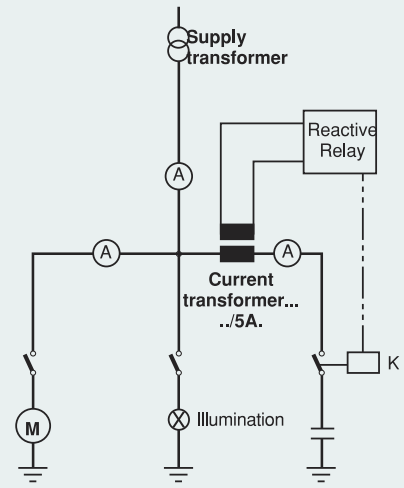
Right Connection Sample



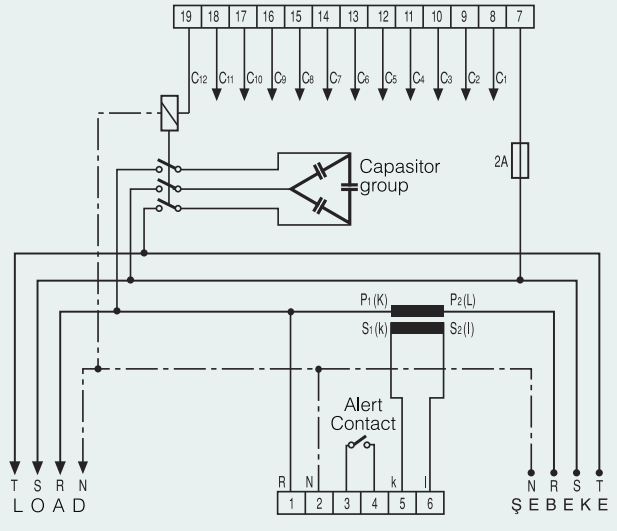
Technical Specifications:

Type	: FX5, FX7, FX12
Operating voltage	: 220 V (50/60Hz) ±20% (Other voltages are optional.)
Operating current	: 5A permanent
Operating method	: Can be selected from front panel as 1,2,2..; 1,2,4,4.. or 1,2,4,8,8.. 2 and later capacities are operated in 1,2,2... system; 3 and later capacities are operated in 1,2,4,4.. system and 4 and later capacities are operated in 1,2,4,8,8.. system.
Output contact capacity	: 1,5 A; permanent 10A
Cosφ adjustment	: 0,95 - 1.00 inductive
c / k adjustment	: between 0,00-1,00, with 0,05 interval
Stepping duration	: Can be adjusted with 1 second sensitivity between 7-99 seconds.
Power consumption	: 6VA max.
Weight	: 800 gr
Operating temperature	: -10°C, + 70°C
Storage Temperature	: -20°C, + 80°C
Order Code	: FX5 : 9HA-1000-X005 FX7 : 9HA-1000-X007 FX12 : 9HA-1000-X012

Wrong Correction Sample:



Connection Diagram of FX series ve EasyVAr:



EasyVAr Reactive Power Control Relays

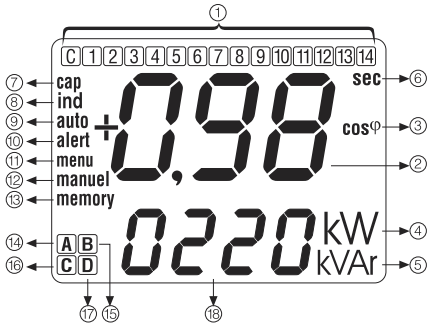
EasyVAr Reactive Power Control Relays

EV-96 and EV-144 LCD reactive relay measures voltage, current, active power and reactive power of the phase it is connected to and display it with coso. Current input is so sensitive to perceive a current of 10 mA and maximum input current value is 5.5 A. When a current transformer with a cycle ratio of 2000/5 is used, it can perceive a current of 4A on the phase it is connected to. As every value is displayed with units on wide LCD screen, it has a quite understandable and easy adjustable structure. Each value displayed out of inductive and capacitive cosφ limit adjustments is shown with current cosφ value. Moreoever, operating capacities are also displayed on the screen.

Technical Specifications:

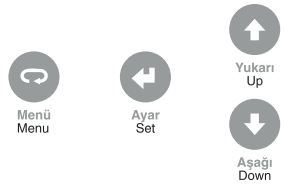
Type	: EasyVAr
Operating modes	: 1111-1222-1244-1248
Number of steps	: (EV-144) 4 -12 steps (EV-96) 4 - 6 steps
Operating voltage	: 220 V (50 Hz) , ±%20
Operating current	: 5A permanent
Output contact capacity	: Permanent 1,5 A Impact 10A
Stepping duration	: Between 1 - 30 sec.
Power consumption	: 6 VA max.
Weight	: 800 gr.
Cosφ adjustment :	
Inductive 0,95-0,96-0,97-0,98-0,99	
Capacitive f 0,98 - 0,99	
Order Codes:	
(EV-96)	9HA-DF000-C000
(EV-144)	9HA-DC000-B000

Screen Function :



1- Capacitor groups (*)
2- Power factor
3- cosφ symbol
4- Active power symbol (W, kW)
5- V, A, VAr, kVAr symbols
6- Stepping duration symbol
7- Capacitive cosφ
8- Inductive cosφ
9- Automatic operation
10- Warning symbol
11- Menu adjustment symbol
12- Manual operation
13- Memory operation symbol
14- Capacity number adjustment symbol
15- Switching mechanism adjustment symbol
16- Minimum capacity value symbol (**)
17- Current transformer primary current value symbol (**)
18- Variable values(area of displaying all information except cosφ)
(*)9 step selections between EV-144, 4-12
3 step selections between EV-96, 4-6
(**)There is no need for individual c/k adjustment as minimum capacity value and current transformer primary current value is entered separately.

Programming:
Reactive Relay programming is made with four buttons on the front panel.

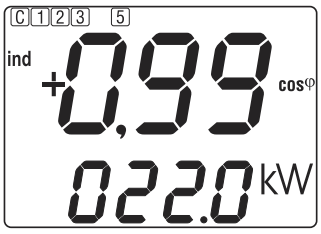


Menu button: It is possible to see current, voltage, active power and capacity values by pressing this button. Furthermore, this button should be used to make Reactive Relay adjustments.

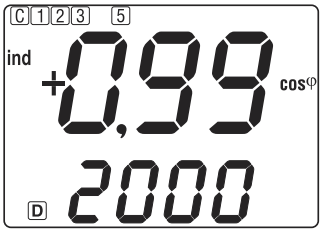
Adjustment button: You should press this button when you want to make a change in the values got by menu buttons.

Up - Down buttons: Are used to select the value to adjust.

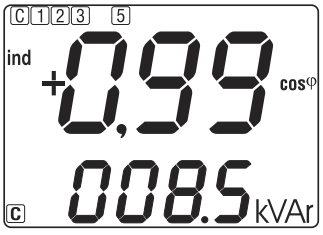
Programming Samples:
Active Power Display: On the screen where active power is displayed, active power amount passing through the phase connected to the reactive relay is shown under cos information with W or kW unit. If this value is shown as (-), this means ends of current transformer have been connected reverse. This case shall not affect compensation. In order to have correct values, primary current value of the current transformer should be entered correct.



Current Transformer Primary Current Value Adjustment Display:
This is the primary current value of the current transformer connected to the reactive relay. For example, value should be entered as 2000 for 2000/5 current transformer. The value is shown with "D" icon. In order to make adjustment, adjustment button should be pressed and desired value should be obtained by pressing increase and decrease buttons after menu icon is displayed. At each time these buttons are pressed, values are changed by fives and if you press and hold the button, increase and decrease amounts shall increase. In this way, value can be adjusted to 5000 easily.



Minimum Capacity Power Adjustment Display: Power of the capacitor connected to the circuit as the primary capacity should be notified to the reactive relay with kVar unit. Correct entry of this value is very important for an effective compensation operation. This value is displayed with C icon on LCD.

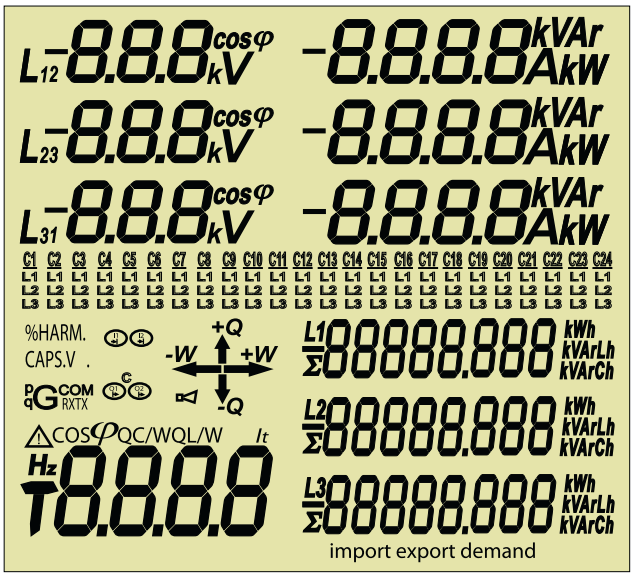


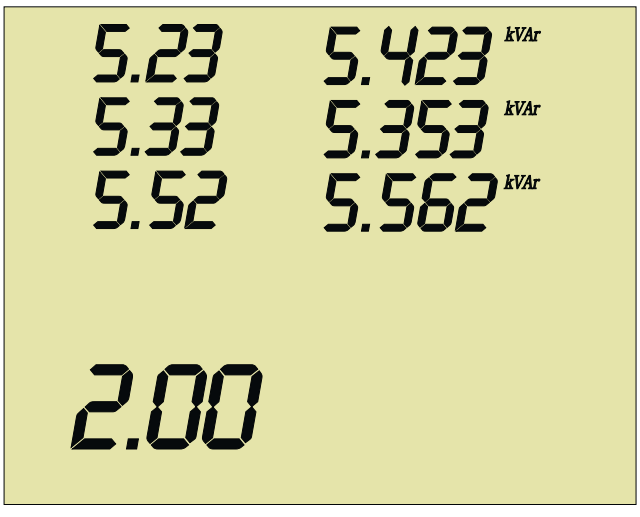
Note: EasyVAr Reactive Relay, as well as all these functions, allows us to see actual powers of the capacitors when we enable and disable capacitors one by one provided that manual position and capacity display is seen while system is in stable condition.

FKR Series Reactive Power Control Relays, which are manufactured with LCD display with 12, 18, 24 step options, have all the features of EA200 series Energy Analyzers and bear additional features to carry out compensation.
LCD display showing electrical values is the same with the Analyzer. In addition, status of capacitors on all the phases can be seen with the special symbols on the display.

Ideal Solution for Imbalanced Loads:
Reactive energy consumed by each phase is recorded separated in systems utilizing electronic meters. Therefore, phase balancing gains more importance. In this case, it is very important to evaluate each phase individually and ensure compensation. FKR Series Reactive Power Control Relay has been developed for this purpose and has the capability of both mono-phase and tri-phase compensation. Users may connect desired number of mono-phase capacitors to the system depending on load balance or variability. The relay evaluates each phase separately and compensates mono-phase capacitors and phases separately.

Calculation of Power Values:
Last 6 reactive power values caused by each step when the relay is enabled are kept in the memory for each capacity. According to first in first out principle, new readings are added to this group of six and oldest readings are disabled. In this way, average of reactive power changes as a result of enablement and disablement of last 6 is taken to find the capacitor value.





Display of Power Values: Current six step is shown in bottom left. For example, power statuses of second six group, that is 7...12 capacities are shown here.

General Adjustments
1- Adjustment of Step Number: The relay may be adjusted to desired step number. Mainly mono-phase step should be utilized in places with dense imbalance. Total number of steps can be adjusted as required. Desired number of mono-phase capacitors allowed by the relay step can be connected.

That is, connection to 24-step relay can be as follows;
3x1 mono-phase +21 tri-phase,
3x2 mono-phase +18 tri-phase,
3x3 mono-phase +15 tri-phase,
.....
3x8 mono-phase + 0 tri-phase.

2- COSφ operating intervals:
As it is known, reactive penalty rates reduced inductive rate is 0.20 and capacitive rate is 0.15.

If we calculate
For inductive:
If tan=0.20 (q/w), angle = 11.31°
Cosφ (11.31) = 0.980.
That is, inductive penalty is 0.979.
For capacitive :
If tan=0.15 (q/w), angle= 8.53o
Cosφ (8.53) = 0.989.
In normal conditions, we recommend 0.14 for inductive and 0.11 for capacitive.

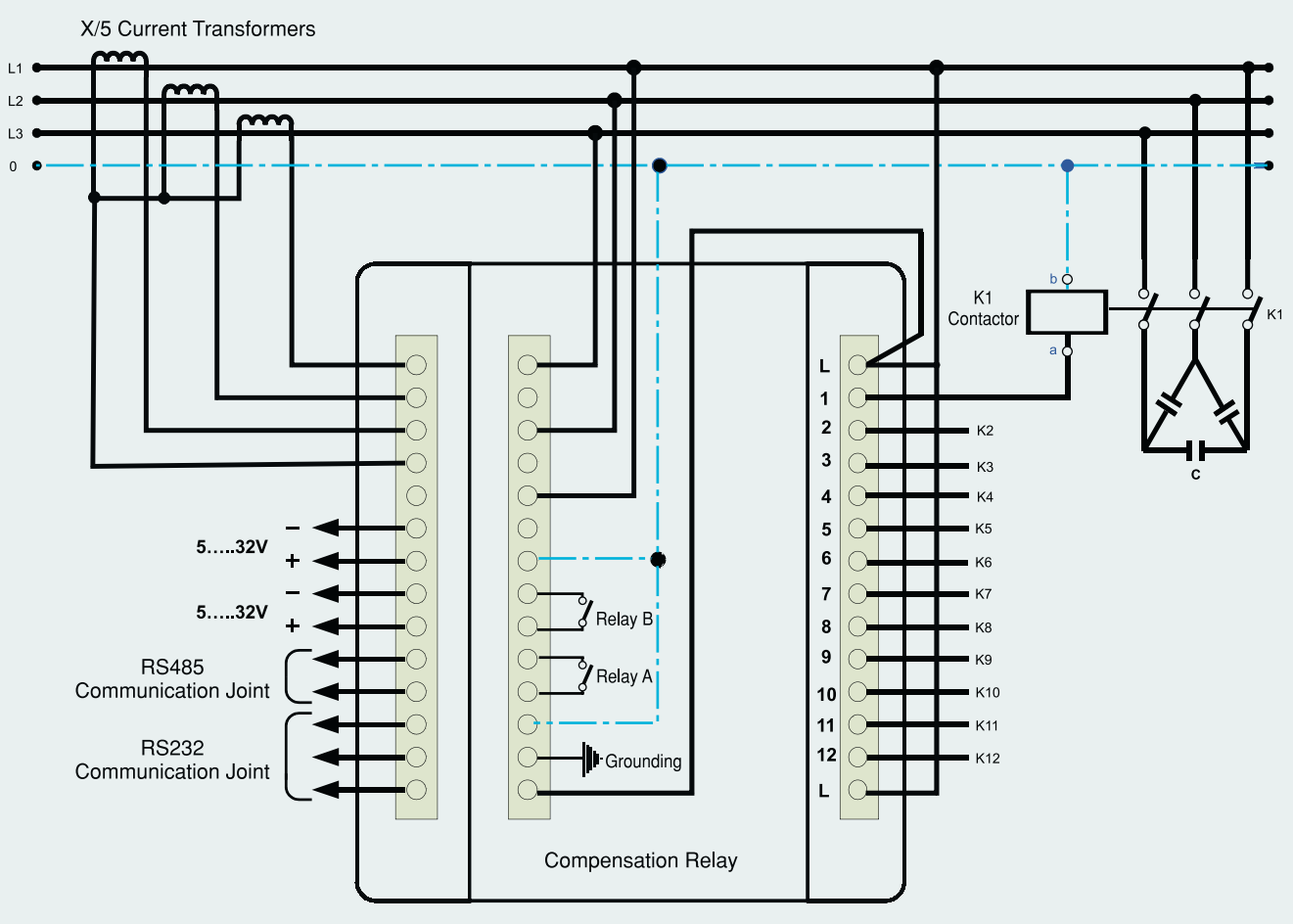
In this case, recommended operating intervals
For inductive:
If tan=0.14 (q/w), angle = 7.969°
Cosφ (7.969) = 0.990.
That is, inductive area adjustment should be entered as 0.990. (it is COS MIN in our relays.)
For capacitive:
If tan=0.11 (q/w), angle = 6.277°
Cosφ (6.277) = 0.994.
That is, capacitive area adjustment should be entered as 0.994. (it is COS MAX in our relays.)

3- Initial capacitor power:
It determines sensitivity of the system. This capacitor power has an impact to decide operating compensation functions of the relay or not. If drawn reactive power is lower than 66% of this initial capacitor power, the relay does not enable the capacitor.

4- Operating modes:
0- 11111: The system where each capacitor is at the same power. The relay enables and disables all the capacitors in order according to first in first out principle.
1-12222: The system where only first capacitor is at the half power of others. The relay first takes 1st step to make adjustment. Other capacitors are operated according to first in first out principles.
2-12444: The system where first capacitor is at the half power of the second, and the second is at the half power of others. The relay first tries combinations according to statuses of 1st and 2nd steps. Other capacitors are operated according to first in first out principles.
3-124888: This is similar to Mode 2, but it operates more sensitively. The relay first tries combinations according to statuses of 1st, 2nd and 3rd steps. Other capacitors are operated according to first in first out principles.
4-Otomatik: Capacitor steps may be different in this mode. When the relay is enabled for the first time, all the capacitors are enabled and disabled to calculate their powers. In each enablement and disablement of these steps, control continues to refresh power data. The relay enables or disables the capacitor closest to reactive need of the system.

5- Enablement disablement durations:
Entering enablement disablement durations completely depend on changing speed of the system load. Each enablement disablement operation reduces the system life. Therefore, since discharge duration is not provided to the capacitors in 1-second applications, zero-passing relays should be utilized in order to avoid impact currents and have long service life for capacitor and thyristor switching contactors.

6- Number of banks:
A compensation system, which is made with 20 pieces of 25 kVAr capacitors, is more sensitive than a compensation system made with 10 pieces of 50 kVAr capacitor. When it is considered as a facility, high steps and low capacitor power in enablement and disablement of the capacitors result in less impact current and interference. Therefore, we recommend high step numbers.



Technical Values:

Supply Voltage		: 220V o 20%, 50 Hz
Measurement Voltage Input		: 3x300V Phase-Neutral, 50 Hz
Measurement Current Input		: 3x5A, 50 Hz
Power Consumption		: <10VA
Operating Temperature		: -25°C, +65°C
Class		: <1%
Order Code	12 steps	: 9HF-DR00-0012
	18 steps	: 9HF-DR00-0018
	24 steps	: 9HF-DR00-0024

Gain Function:
Gain function may be used in system, where sensitive compensation is required for low loads in panels where big current transformers are utilized. In this way, system may be compensated even when 10A load is drawn at a facility using 2000/5 current transformer.

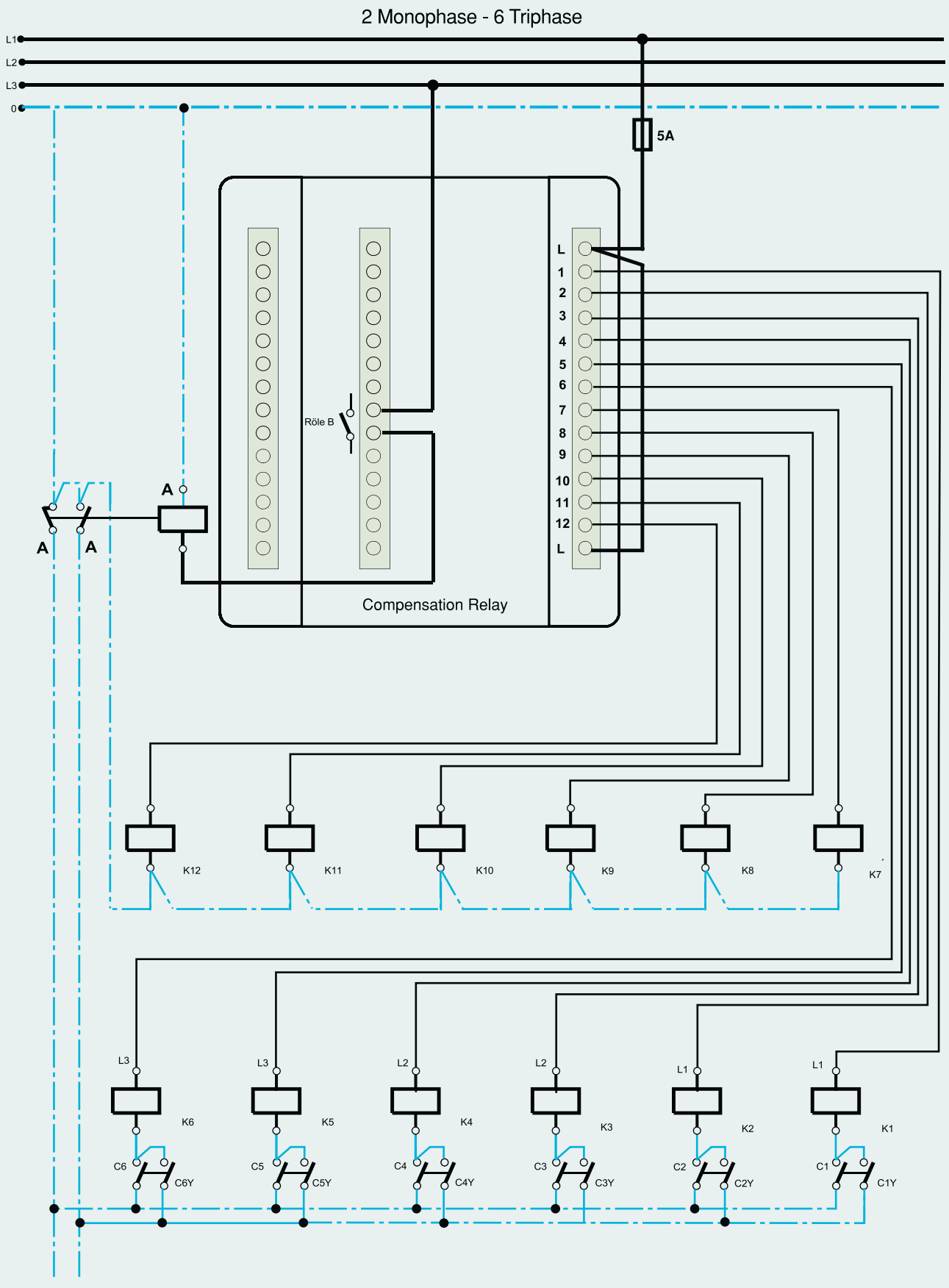
12 step capacitors total have been used, as 2 mono-phases to each phase and 6 tri-phases in the panel, gain connection diagram of which is given on the next page.

If the connection diagram is examined in detailed, it is seen that extra 6 mono-phase capacitors are used. Extra mono-phase capacitors have been selected at lower power when compared to first 6 capacitors. Now, let's explain what these additional capacitors are used for:

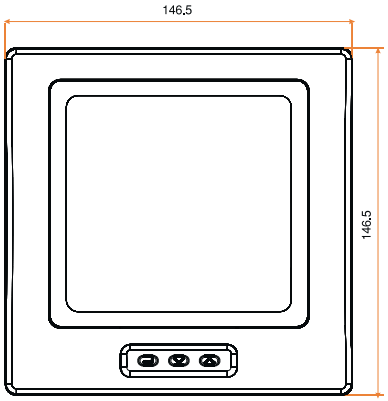
If the current passing through the system is in a measurement interval over 16% of the current transformer primary input (that is, if the current passing through the line in a system with 2000/5 current transformer is at 320 amperes and higher), the compensation relay shall enable and disable C1, C2, C3, ..., C7, C8, ..., C12 capacitors. If the current transformer is in a measurement interval below 16% of the current transformer primary input (that is, if the current passing through the line in a system with 2000/5 current transformer is below 320 amperes like 240 amperes), compensation relay shall enable and disable C1Y, C2Y, C3Y, ... and ... C7, C8, ..., C12 capacitors.

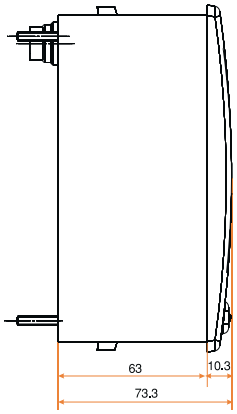
When the current passing through secondary of the current transformer goes below 16%, “Relay B” contact on FKR240 compensation relay shall be closed. When the relay B contact is closed, contactor A shall get energy. When contactor A gets energy, contacts shall be closed, neutral line of C1, C2, ... C6 capacitors shall be broken and neutral line of C1Y, C2Y, ... C6Y capacitors shall be connected to the circuit. In this way, when where is a current output below 16% at the current transformer secondary output, capacitors with lower power shall be exchanged with other capacitors until the current goes over 16% again.

Gain Connection Diagram

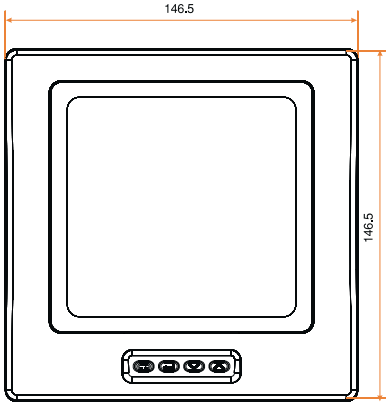


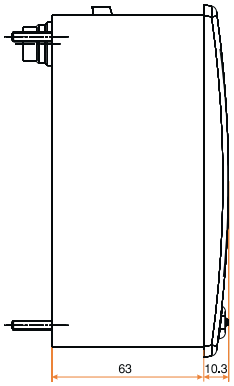
FX5 - FX7 - FX12



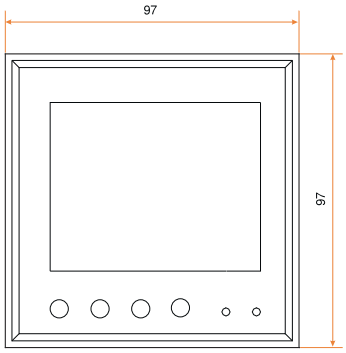


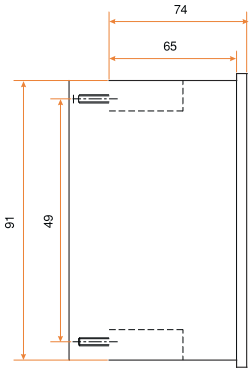
EV144:



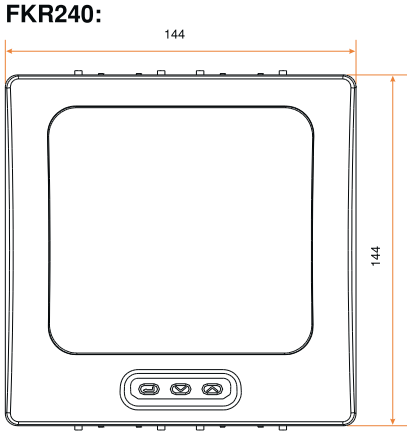


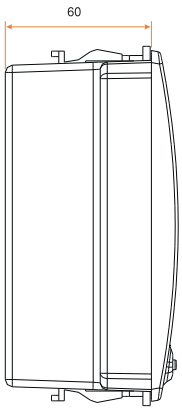
EV96:





FKR240:





Modbus Information for FPA50-FPA100-FPA120-FAA200-FKR240 Devices:
The device is generally established on floating point register system. Therefore, each register is 4 bytes. Since Modbus is established on 2 byte word, a float register is described as two modbus registers. Number 3 and 16 modbus reading and multi-writing functions can be applied to the device; since floating point is 2 registers long, 16 multi-writing functions have been utilized.

Reading Format

Request

Device No	Function	Starting Address HI	Starting Address LO	Number of Registers HI	Number of Registers LO	CRC HI	CRC LO

Response

Device No	Function	Number of Bytes	DATA HI	DATA LO	.. .	CRC HI	CRC LO

Sample: Read Phase 12 and Phase 23 voltages

Request

Device No	Function	Starting Address HI	Starting Address LO	Number of Registers HI	Number of Registers LO	CRC HI	CRC LO
1	3	0	3	0	4	180	9

Response

			U12 reg4				U23 reg5					
Device No	Function	Number of Bytes	DATA HI2	DATA LO2	DATA HI1	DATA LO1	DATA HI2	DATA LO2	DATA HI1	DATA LO1	CRC HI	CRC LO
1	3	8	0	0	0	0	0	0	0	0	149	215

Writing Format:

Request

Device No	Function	Starting Address HI	Starting Address LO	Number of Registers HI	Number of Registers LO	DATA HI	DATA LO	.. .	CRC HI	CRC LO

Response

Device No	Function	Starting Address HI	Number of Registers HI	Number of Registers LO	CRC HI	CRC LO

Sample: Let's change voltage and current transformer rates

Request

Device No	Function	Starting Address HI	Starting Address LO	Number of Registers HI	Number of Registers LO	DATA HI2	DATA LO2	DATA HI1	DATA LO1	CRC HI	CRC LO
1	16	0	100	0	2	0	0	0	0	180	9

Response

Device No	Function	Starting Address HI	Starting Address LO	Number of Registers HI	Number of Registers LO	CRC HI	CRC LO
1	3	0	100	0	2	149	215

Register Map for FPA50-FPA100-FPA120-FAA200-FKR240 Devices:
The device is designed in accordance with IEEE 754 standard, 32-bit floating, comma number standard. In this context, communication protocol has been arranged in compliance with 16-bit MODBUS structure. Curve information have different byte lengths and reading request should be made for bytes with similar lengths at the same time! Applicable MODBUS commands are 3 and 16. Orange areas are the registers used in compensation relay.

Reg. No:	Number of Bytes	Function	Description	W/R		Reg. No:	Number of Bytes	Function	Description	W/R
1	4	U1	Phase1 neutral voltage	R		53	4	BNK1	Hidden (compensation)	R
2	4	U2	Phase2 neutral voltage	R				BNK2	Hidden (compensation)	R
3	4	U3	Phase3 neutral voltage	R				BNK3	Hidden (compensation)	R
4	4	U12	Phase1, Phase2 voltage	R				BNK4	Hidden (compensation)	R
5	4	U23	Phase2, Phase3 voltage	R		54	4	KOND1	Hidden (compensation1 step power)	R
6	4	U31	Phase3, Phase1 voltage	R		55	4	KOND2	Hidden (compensation2 step power)	R
7	4	I1	Phase 1 Current	R		56	4	KOND3	Hidden (compensation3 step power)	R
8	4	I2	Phase 2 Current	R		57	4	KOND4	Hidden (compensation4 step power)	R
9	4	I3	Phase 3 Current	R		58	4	KOND5	Hidden (compensation5 step power)	R
10	4	kW1	Phase1 Active power	R		59	4	KOND6	Hidden (compensation6 step power)	R
11	4	kW2	Phase2 Active power	R		60	4	KOND7	Hidden (compensation7 step power)	R
12	4	kW3	Phase3 Active power	R		61	4	KOND8	Hidden (compensation8 step power)	R
13	4	kR1	Phase1 Reactive power	R		62	4	KOND9	Hidden (compensation9 step power)	R
14	4	kR2	Phase2 Reactive power	R		63	4	KOND10	Hidden (compensation10 step power)	R
15	4	kR3	Phase3 Reactive power	R		64	4	KOND11	Hidden (compensation11 step power)	R
16	4	cos 1	Phase1-I1 skip	R		65	4	KOND12	Hidden (compensation12 step power)	R
17	4	cos 2	Phase1-I2 skip	R		66	4	KOND13	Hidden (compensation13 step power)	R
18	4	cos 3	Phase1-I3 skip	R		67	4	KOND14	Hidden (compensation14 step power)	R
19	4	PF 1	Phase1 power factor	R		68	4	KOND15	Hidden (compensation15 step power)	R
20	4	PF 2	Phase2 power factor	R		69	4	KOND16	Hidden (compensation16 step power)	R
21	4	PF 3	Phase3 power factor	R		70	4	KOND17	Hidden (compensation17 step power)	R
22	4	kVA1	Phase1 apparent power	R		71	4	KOND18	Hidden (compensation18 step power)	R
23	4	kVA2	Phase2 apparent power	R		72	4	KOND19	Hidden (compensation19 step power)	R
24	4	kVA3	Phase3 apparent power	R		73	4	KOND20	Hidden (compensation20 step power)	R
25	4	kW1e	Phase1 export power	R		74	4	KOND21	Hidden (compensation21 step power)	R
26	4	kW2e	Phase2 export power	R		75	4	KOND22	Hidden (compensation22 step power)	R
27	4	kW3e	Phase3 export power	R		76	4	KOND23	Hidden (compensation23 step power)	R
28	4	EW	Total power	R		77	4	KOND24	Hidden (compensation24 step power)	R
29	4	EWi	Total import power	R						R
30	4	EWe	Total export power	R						R
31	4	ERl	Total inductive power	R		91	128	U1,I1	U1,I1,...U127,I127 signed char	R
32	4	ERc	Total capacitive power	R		92	128	U2,I2	U1,I1,...U127,I127 signed char	R
33	4	Er	Total reactive power	R		93	128	U3,I3	U1,I1,...U127,I127 signed char	R
34	4	Ecos	Average phase skip	R						
35	4	EPF	Average power factor	R						
36	4	F + İnp.	2 byte FRK/10+1 byte:128 inp1,32 inp2,1 byte hidden	R						
37	4	kWhi1	Phase1 energy import	R		101	4	VT+CT	Integer voltage transformer rate , integer current transformer rate	W/R
38	4	kWhi2	Phase2 energy import	R		102	4	SURE	Hidden (enablement duration 1.disablement 1.enablement duration 3.disablement duration)	W/R
39	4	kWhi3	Phase3 energy import	R		103	4	B.AD,MODE	Hidden (bank number 1. Bank number 3, model1)	W/R
40	4	kWhe1	Phase1 energy import	R		104	4	İLK KVAr	Hidden first capacitor power (Monophase)	W/R
41	4	kWhe2	Phase2 energy import	R		105	4	İLK KVAr	Hidden first capacitor power (Threephase)	W/R
42	4	kWhe3	Phase3 energy import	R		106	4	Min Cos 1	Hidden min. mono-phase cos value shall be divided into long 1000	W/R
43	4	kRLh1	Phase1 inductive energy	R		107	4	Max Cos 1	Hidden max. mono-phase cos value shall be divided into long 1000	W/R
44	4	kRLh2	Phase2 inductive energy	R		108	4	Min Cos 3	Hidden min. triphase cos value shall be divided into long 1000	W/R
45	4	kRLh3	Phase3 inductive energy	R		109	4	Max Cos 3	Hidden max. triphase cos value shall be divided into long 1000	W/R
46	4	kRCh1	Phase1 capacitive energy	R		110	4	P+R+G	integer PORT + Restart (komp!) + GPRS mode	W/R
47	4	kRCh2	Phase2 capacitive energy	R		111	4	IP	IP1 + IP2 + IP3 + IP4	W/R
48	4	kRCh3	Phase3 capacitive energy	R		112	4	T+B+Cn	Integer Timeout (x10ms) + BAUD + Device no (1-250)	W/R
49	4	EWhi	Total import energy	R						
50	4	EWhe	Total export energy	R		121	4	BANK on/off	Hidden each byte right 6 bit x 4 capacitor ON/OFF	W/R
51	4	ELh	Total inductive energy	R		122	4	OUTPUT	1. byte 3=1. relay on 4=2.relay on 5=1. and 2. relay on	W/R
52	4	ECh	Total capacitive energy	R						