Smart Relay User Manual

WARNING

IN THIS MANUAL

SMART 12 - SMART 18
SMART 22-T
SMART OG1
SMART OG5

ADDRESS: İkitelli OSB Mah. Environment 14th Block Street. Telas Blok

Exterior Door No: 1 Floor: 1-2 Başakşehir/Istanbul

Phone: +90 212 438 80 24 **Fax: +90 212 438 80 25** **info@gruparge.com**

Versiyon 19-2

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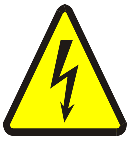
PROPER USE AND SAFETY REQUIREMENTS



Cut all the power when connecting and disconnecting the device to a panel.

Do not clean the device with a solvent or similar material. Only use a dry cloth!

Please do not intervene to the device when a technical problem is encountered and get in contact with a technical service within the shortest time.

If the warnings are not taken into account, our company or the authorized dealer shall not be held responsible for the negative consequences.

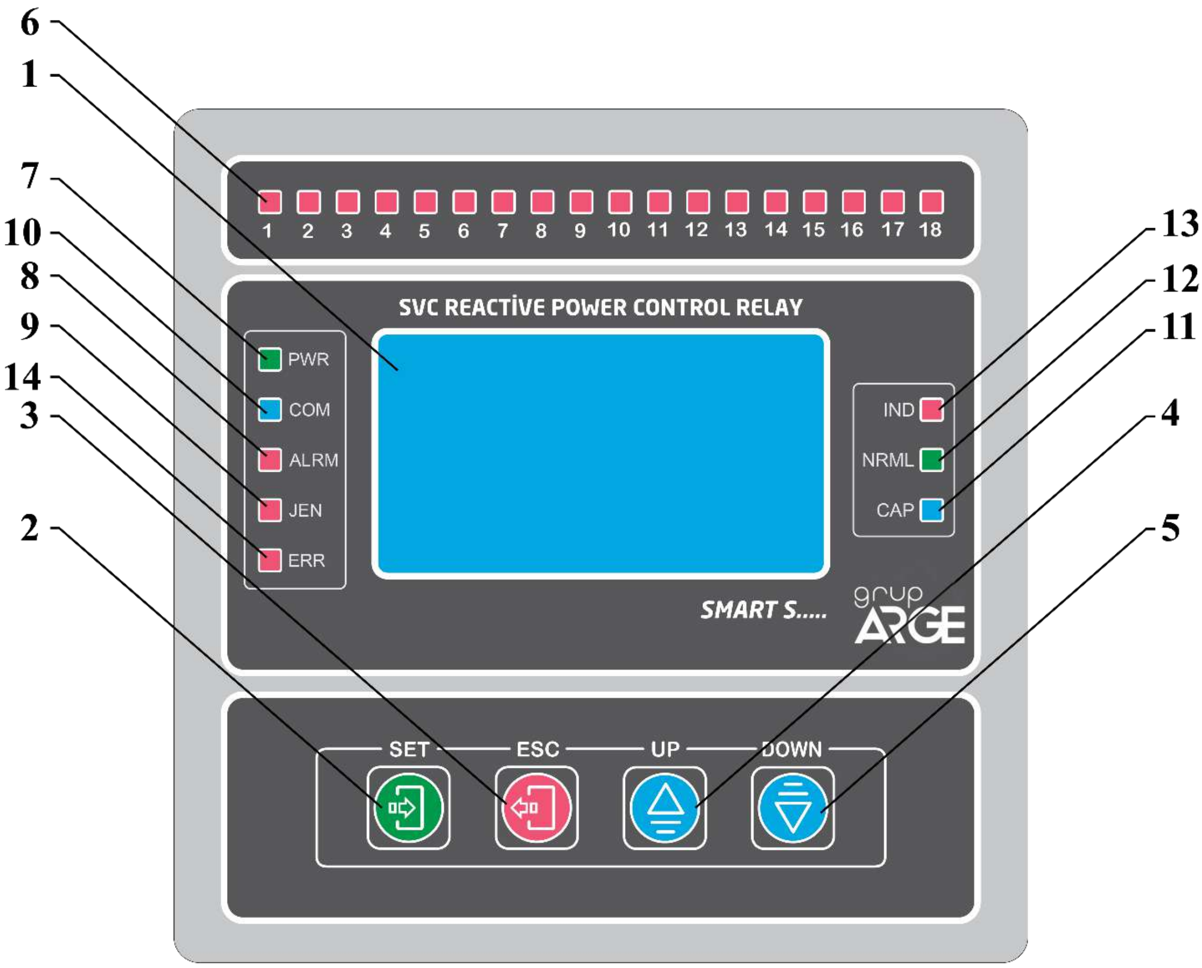
Do not dispose in the trash, the device must be delivered to the collection centers (electronic device recycling centers). It should be recycled or disposed of without harming human health and environment.

The installation, assembly, activation and operation of the device should be done and used by only expert professionals and in accordance with safety regulations and instructions.

The device operates with current transformers. Do not strictly leave current transformer tips unattached. Dangerous high voltage can occur.

1. INTRODUCTION

1.1 Front Panel View



1) LCD Screen: All powers, ratios, values, warnings and menu parameters are monitored on the screen. Screen lighting gets off automatically if no key is pressed for 2.5 minutes in operating mode. In this case it is sufficient for user to press a key to light the screen again.

2) Program (SET) Key: The key to enter the menu, switch to a submenu and keep the settings.

3) Exit (ESC) Key: It enables to return to the previous process in the menu and exit from the menu.

4) Up Key: It enables to move upward in measurement and menu position.

5) Down Key: It enables to move downward in measurement and menu position.

6) Stage LEDs: 12 pieces. (18 pieces in 18-stage relays. 22 pieces in 22-stage relays.) The stages are stated on each LED. When the LED is on, it is understood the relevant LED is activated.

7) Energy (Power) LED: The LED indicating as *PWR* on Leksan. When there is energy in the device, this green coloured LED gets on. If it does not get on, there is a problem in the supply.

8) Alert Led: It gets on when the system exceeds 15% cap and 20% end limits.

9) Gen Led (for SMART S18, SMART SOG1, SMART SOG5): It gets on when the system is supplied from the generator.

10) Communication Led: This led flashes during communication.

11) Capacitive Led: If total flowing capacitive reactive energy is above capacitive limit, this led gets on.

12) Normal Led: If total flowing reactive energy from all phases is below End/Cap limits in relays, normal led gets on.

13) Inductive Led: If total flowing inductive reactive energy is below inductive limit, this led gets on.

14) Error Led: When thermal input is opened, in the errors of connection and stage, no phase error, excessive inductive/capacitive errors, this led gets on. If the led gets on continuously, errors still exist. If error message is seen on the screen and alarm led is off, this means the errors occurred in the past and do not exist at the moment. In this case, the errors can be deleted by long press of ESC key.

1.2 Functions of Key

It is used to enter the menu and move to the next screen. Press this key for 3 sec to enter the menu. In order to store parameter which is set in the menu, press SET key and move to the next menu.

It enables to return to the previous process and exit from the menu.

It is used to change option and increase parameter value in the menu. Out of the menu, it ensures that the current display does not change for 1.5 minutes in operating time. The screens start to change automatically 1.5 minutes later. This key is used to enter stage values manually during stage test.

It is used to change option and decrease parameter value in the menu. Out of the menu, it is used to change screen from current to the next in operating time. The new screen stays unchanged for 1.5 minutes. The screens start to change automatically 1.5 minutes later. During the stage test, this key is used to pass the tested stage and proceed to the next stage test.

1.3 Relationship of Key

- If you hold down up key in the stage test, the manual login screen for that stage comes up.

- If you hold down down key in the stage test, the current stage test is passed by via its previous value.

- If you hold down ESC key in any test, the test is cancelled.

- In manual stage login, the value of each phase is entered separately. Transition between phases is done by pressing SET key. If you hold down ESC key during transition, the previous value of the phase is entered to another phase.

- FORMAT: Give energy to the device by holding down SET key and wait 5 sec in this position and press ESC key then leave firstly SET key and secondly ESC key; the format screen comes up.

If we cannot to use a stage to report a load that the relay does not see:

A load (capacitive effect of long OG cables or inductive loss of power transformer) that current transformer does not see can be defined to relay via ‘off set stage’. For this process; firstly one of the stages is defined as ‘off set’, then apply ‘stage test’ to this stage and enter the convenient value is entered from manual login menu.

EXAMPLE: *The OG cable distance between electric meter and power transformer = 500m*
The capacitive effect of the cable = 25 kVAr (for 34.500 V voltage and 95 mm2 XLPE cable)
In this case, even if the relay makes cosΦ as 1, the meter will write capacitive due to the capacitive effect of the cable. Reactive difference between the meter and the relay can be eliminated by making the necessary settings in the ‘off set’ stage menu of SMART SVC RELAY.

To activate a stage manually;
If you want to activate a stage manually, select the relevant stage as ‘off set’ stage. The relay will activate that stage manually after this process.

To take a stage as a load to the system;
Select the relevant stage as ‘off set’. Then select the value of off set from ‘off set’ login screen as 0 or test ‘off set’ stage by coming the stage test and enter the value as 0 for each phase. After this process, the relay will activate that stage as a load.

If we want to report a value that the relay does not see but the meter sees, we associate this value to a stage and report to the relay. We name this stage as ‘off set’ stage. This can be any idle stage. After we enter the number of this stage in ‘off set’ login in the menu, we come to stage test in the menu and test this stage then we enter the value of the stage for each phase as ‘off set’ value that the relay does not see in manual screen.

We can make ‘off set’ feature that is activated on any stage active or passive via an external signal. The generator input of relay can be used for this application by changing “off set” to “pin on” in the menu. When 220 Volt comes to generator input, ‘off set’ feature gets activated. Otherwise it gets passive.

EXAMPLE: *Assume that in our system we have a cogeneration that gives capacitive load of approximately 200 kVAr and it outputs to OG line via a step- up transformer. Let our compensation to be on AG side. We can use existing ‘off set pin’ feature to report to relay that there is a 200 kVAr capacitive load, that the relay does not see in the system when the cogeneration operates, and this load disappears when it is out of order. If a 220V output, that is taken when cogeneration is activated, is connected to this ‘off set pin’ input, the ‘off set’ value (200 kVAr), that we entered to the relay before, gets activated and the relay compensates according to this. When cogeneration is passive, the relay realizes this by pin login and makes ‘off set’ value, that is entered before, passive.*

In the case of alarm when the screen flashes (when it passes to 20% end or 15%kap), the alarm led gets on and the alarm contact outputs in the alarm output. When gen gets activated and 220 Volt entered to gen input, this led gets on.

NOTE: *The “Off set” stage must be idle or you should make it ineffective by cutting the stage energy. You can make it ineffective in the menu. (by making “off set out put” selection off).*

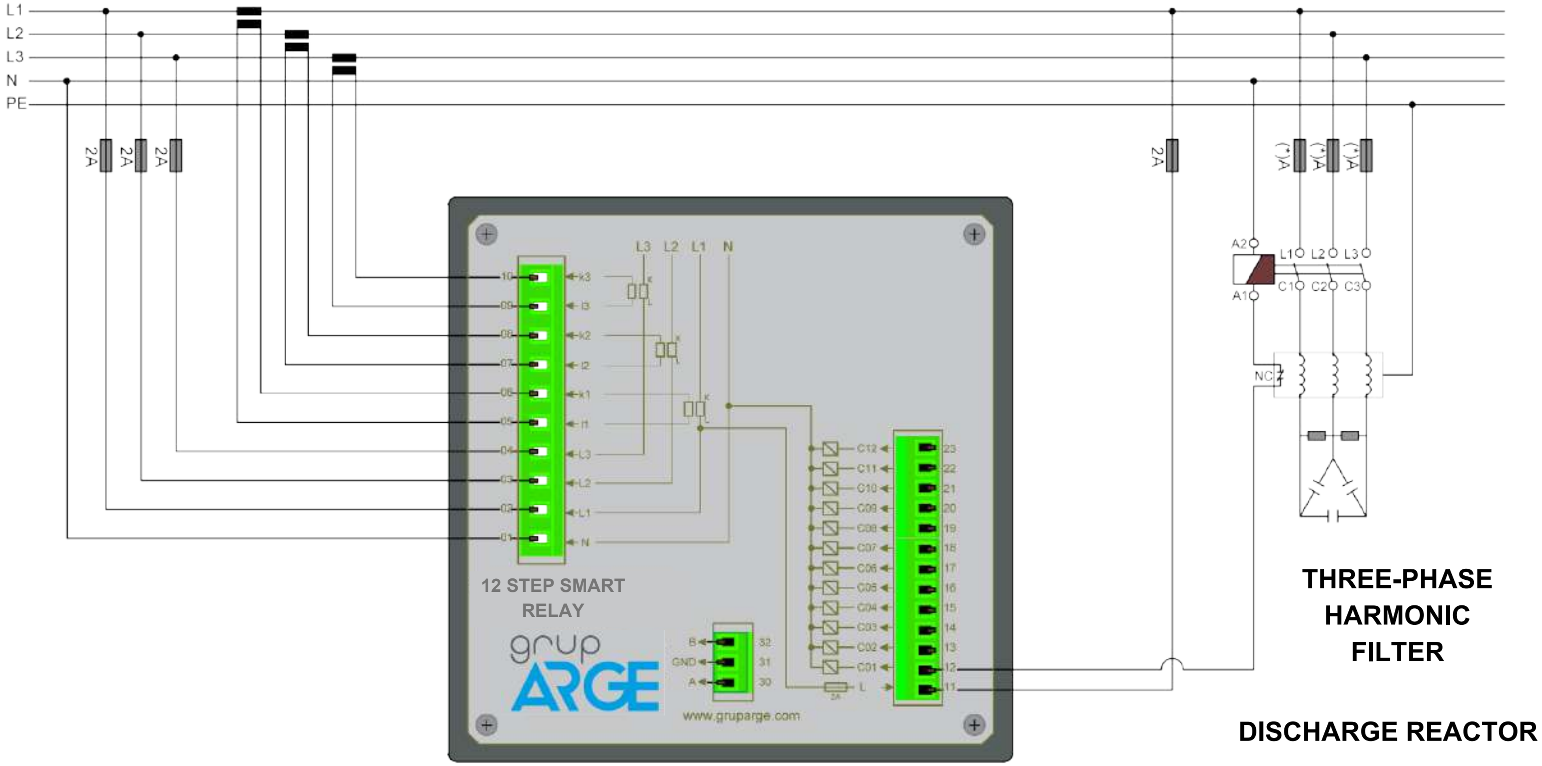
NOTE: *To get more information, you can call technical support numbers and get more detailed explanation.*

1.4 Smart Relay Features

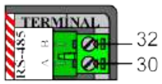
- It is microprocessor based.
- It provides easy compensation for the loads entering and exiting fast.
- As it is semiconductor controlled, the lifetime of power multiples is much longer than contactors.
- Since the sensing current is 3 mA, it can easily operate in small power plants or even in large power plants with high current transformer ratio.
- It provides full compensation even with aged or faulty capacitors.
- With the help of the power flow graph, the business can be easily analyzed. Maximum and minimum capacitor/reactor sizes required for each phase and phase imbalances can be determined.
- Detects faulty stage, excessive inductive/capacitive, phase error, connection error etc. and informs the user.
- With automatic stage test, stage values are continuously updated.
- It has automatic detection and correction of current transformer connection changes.
- While extending the compensation maintenance period, it also reduces maintenance costs.

1.5 Connection Diagrams

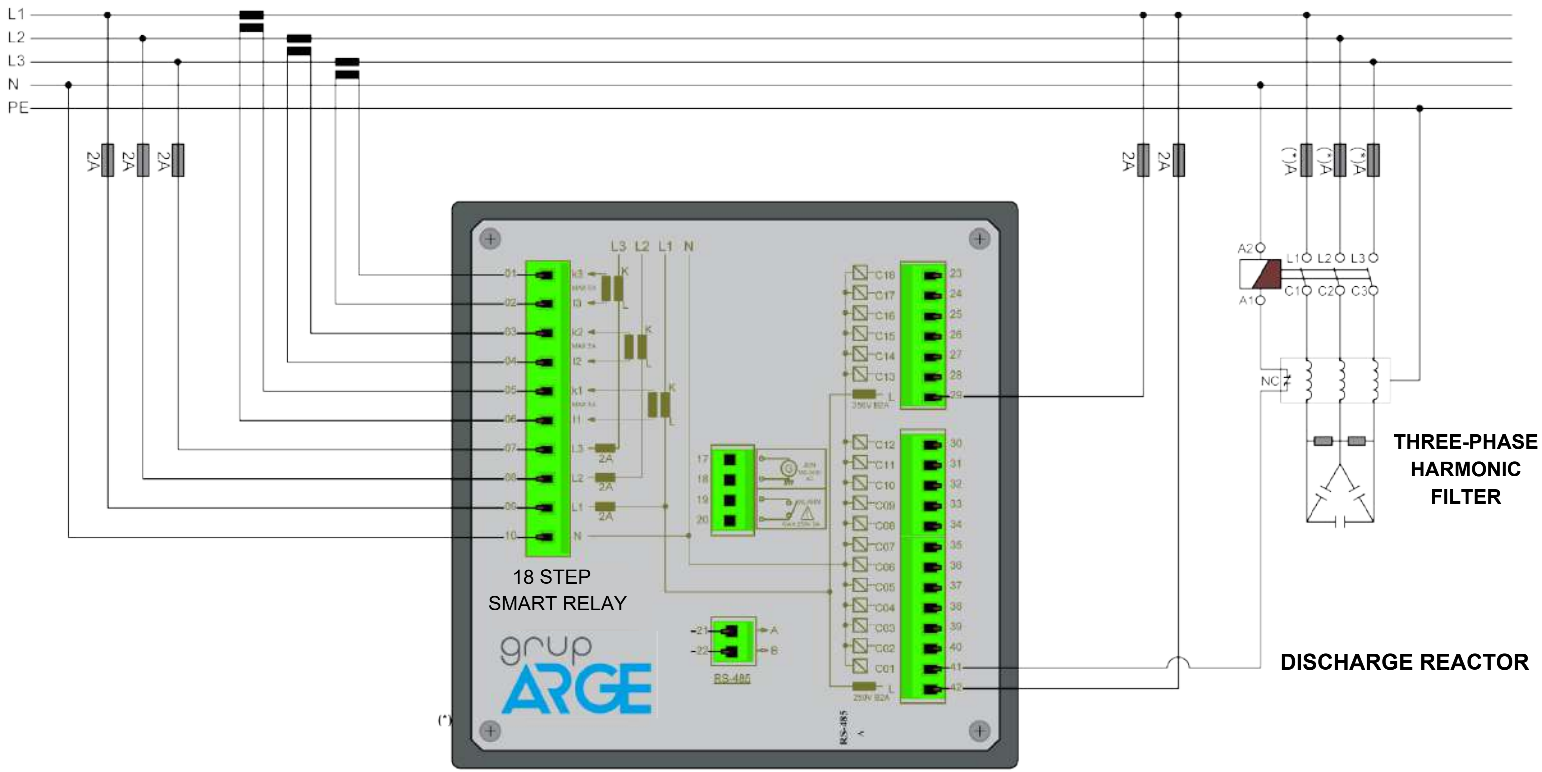
1.5.1 SMART 12



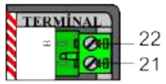
(*) For the recommended fuse current and cable cross-section, please refer to the rated operating current table in the section related to the product of your choice.



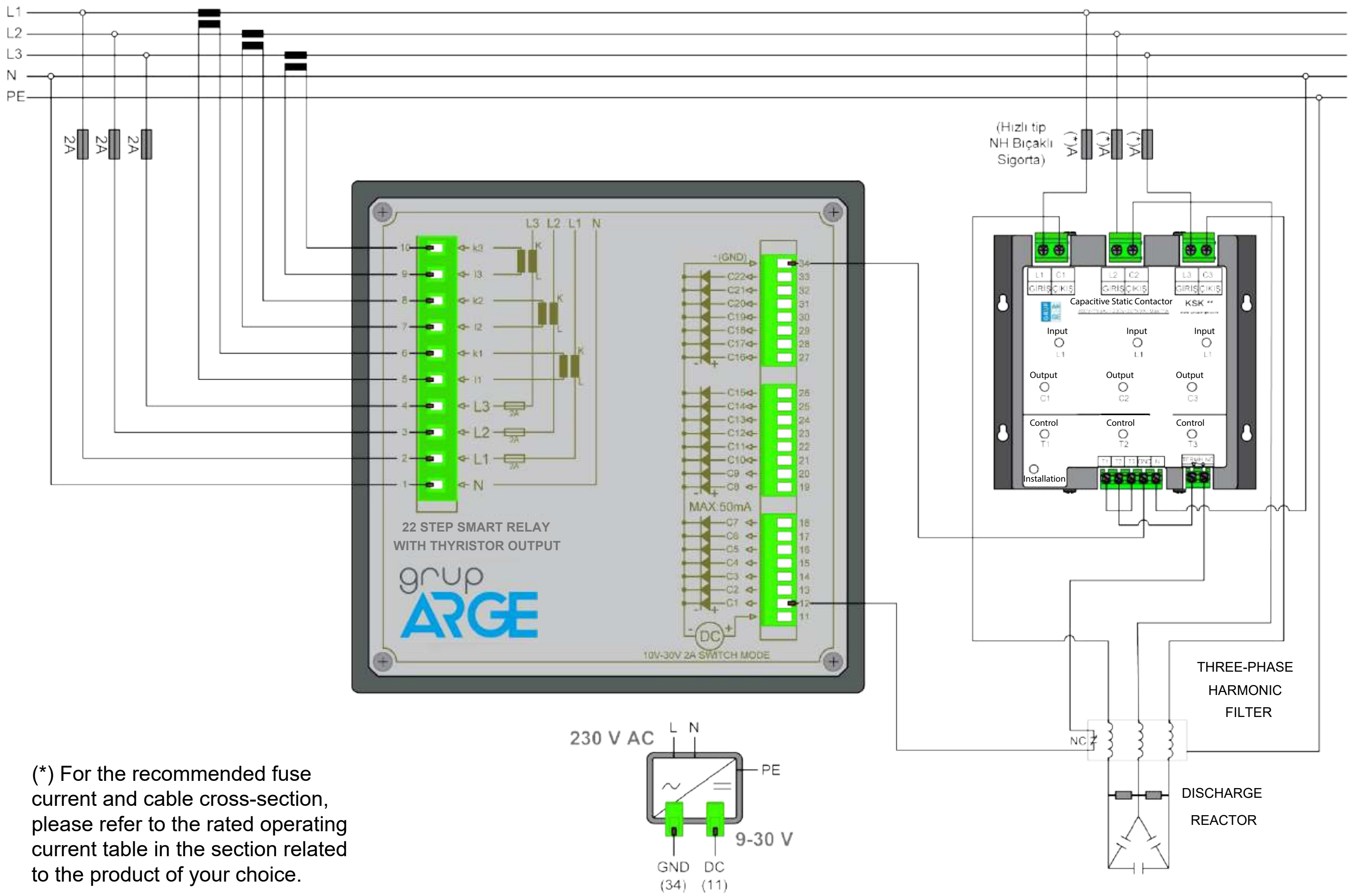
1.5.2 SMART 18



(*) For the recommended fuse current and cable cross-section, please refer to the rated operating current table in the section related to the product of your choice.

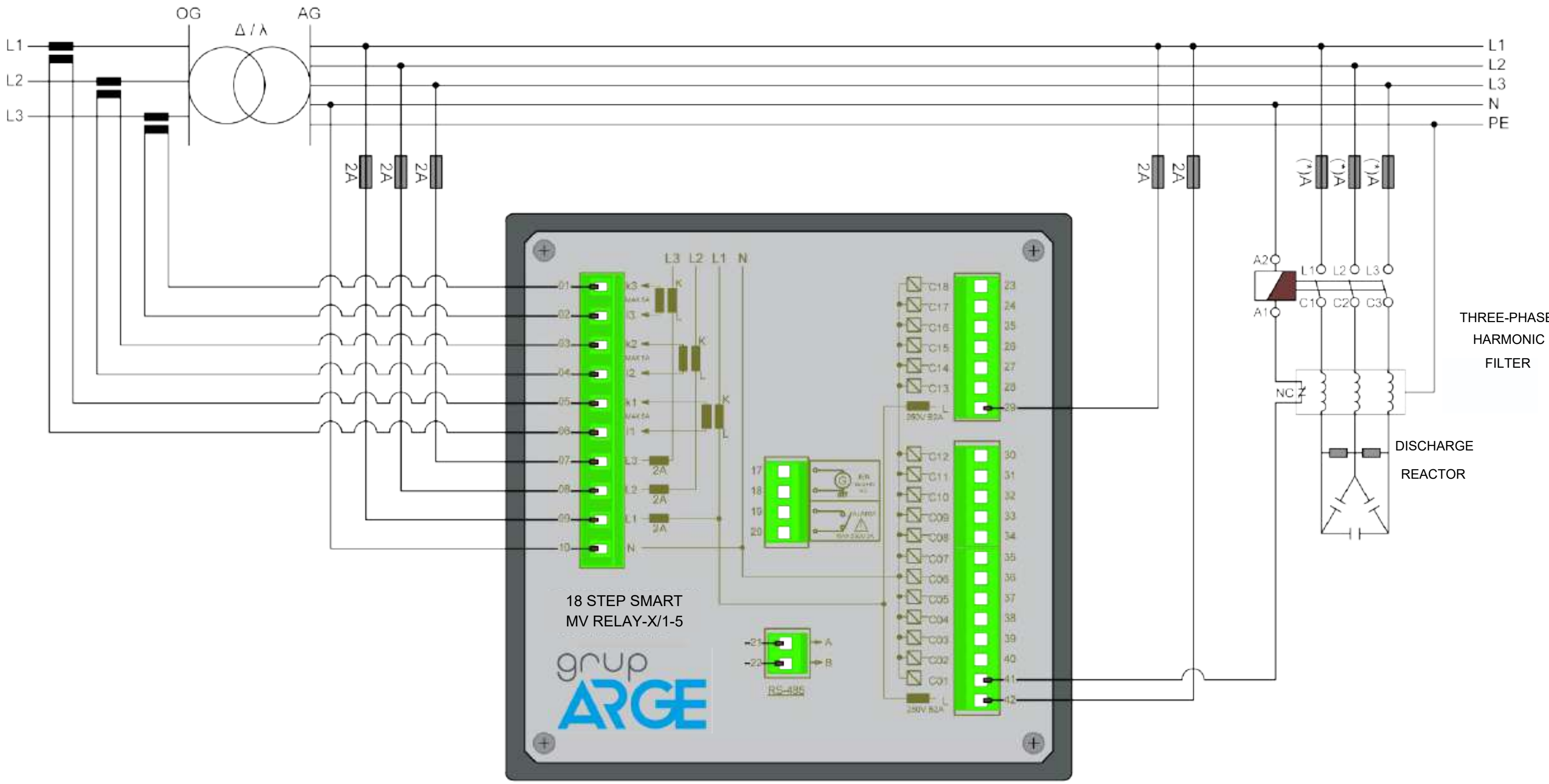


1.5.3 SMART 22-T

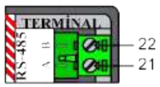


(*) For the recommended fuse current and cable cross-section, please refer to the rated operating current table in the section related to the product of your choice.

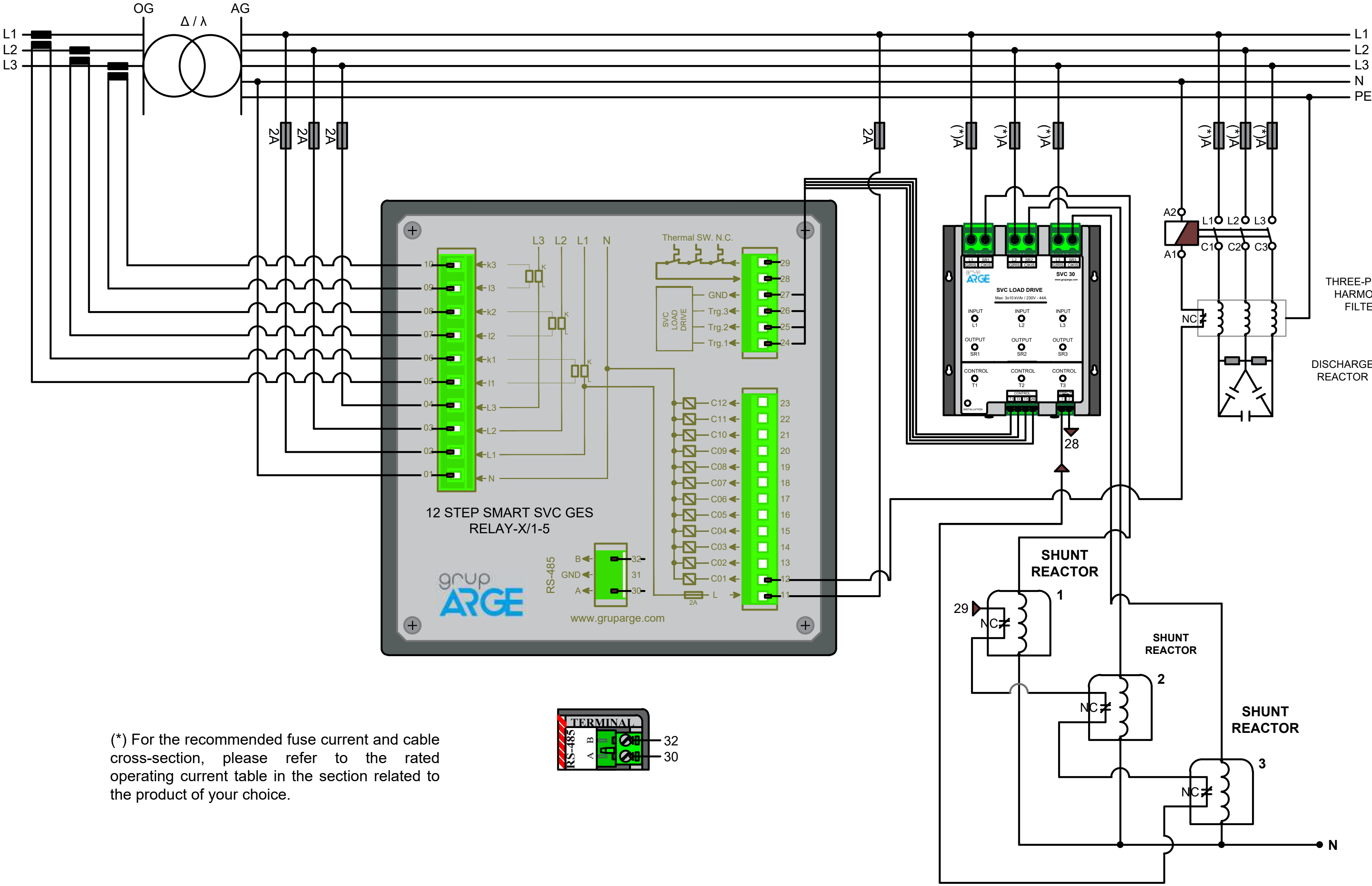
1.5.4 SMART OG1, OG5



(*) For the recommended fuse current and cable cross-section, please refer to the rated operating current table in the section related to the product of your choice.

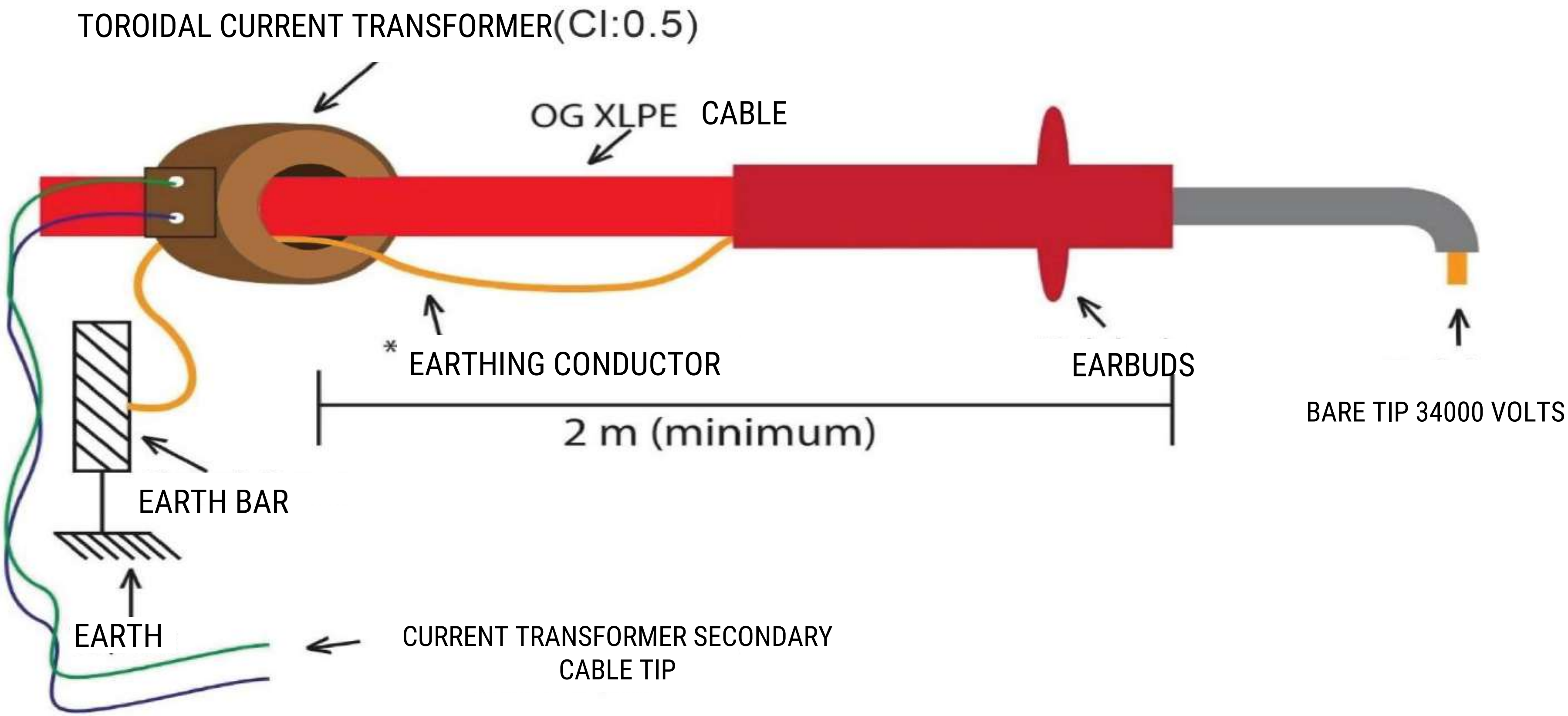


1.5.5 SMART GES1, GES5



(*) For the recommended fuse current and cable cross-section, please refer to the rated operating current table in the section related to the product of your choice.

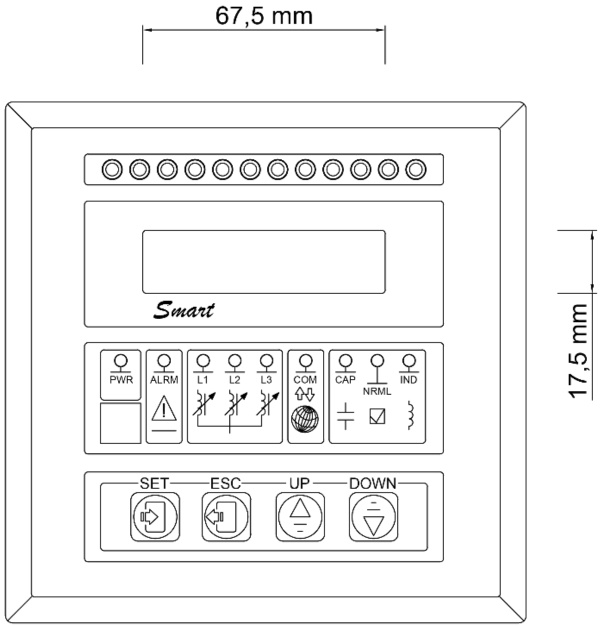
1.5.5 OG Toroidal Current Transformer



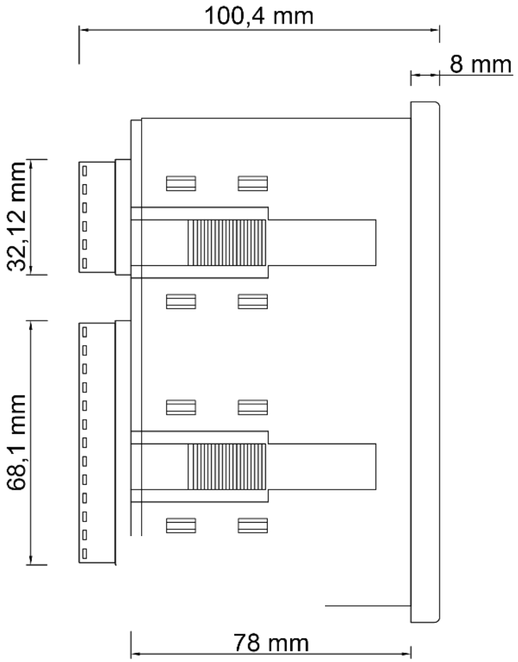
WARNING! Input phases of driver and relay must be definitely in the same order, so, L1 phase of relay and L1 phase of driver, L2 phase of relay and L2 phase of driver, L3 phase of relay and L3 phase of driver must be same. The TRG1-2-3 order of driver must be done correctly.

1.6 Product Dimensions

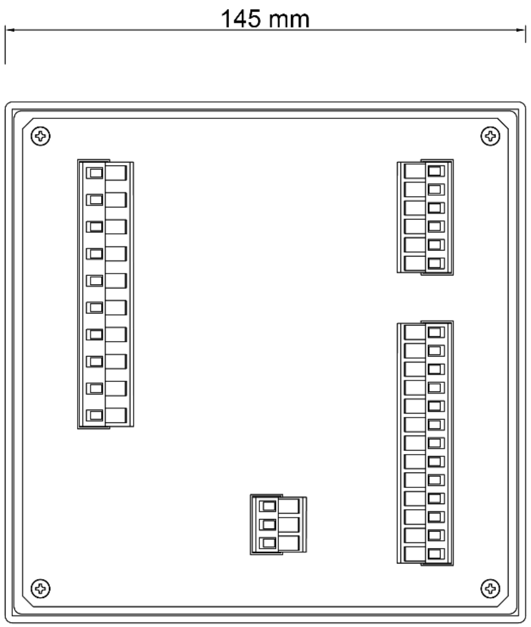
1.6.1 Small Screen Relay Technical Drawing



FRONT VIEW

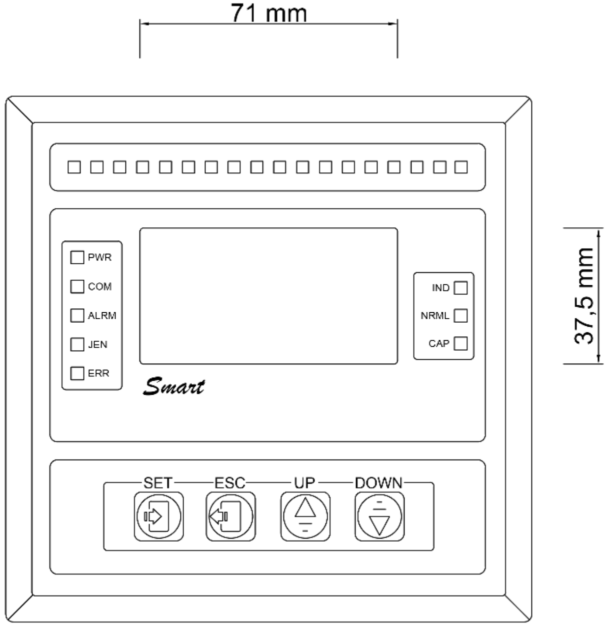


SIDE VIEW

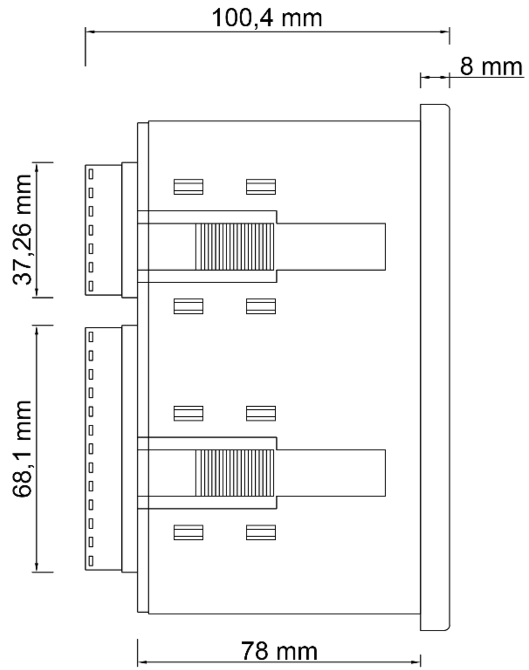


BACK VIEW

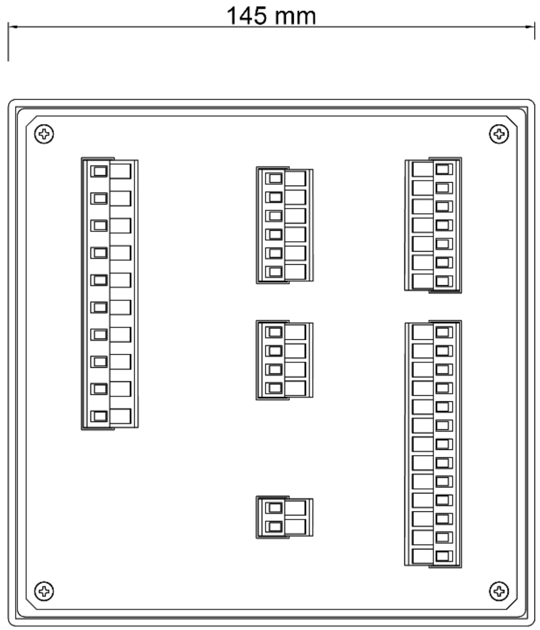
1.6.2 Large Screen Relay Technical Drawing



FRONT VIEW



SIDE VIEW



BACK VIEW

2.INSTALLATION

2.1 Installation and Activation

After giving energy to the device, the message in figure 2.1 will be encountered. After this message flashes on the screen for 3 sec., this standby can be skipped by SET key. Then, current transformer ratio message (Figure 2-2) will be displayed on the screen.

Smart BSC

Installation starts

Figure 2.1

After Figure 2.2 screen is displayed, the current transformer ratio of SMART RELAY can be set by up-down keys. After it is confirmed with SET key, SMART RELAY starts automatic transformer test.

Current Transformer Ratio

5/5 Ampere

Figure 2.2

In the transformer test, firstly the message (Figure 2.3) that the stages are being prepared is displayed.

Transformer Control

Load must be constant

Figure 2.3

The point to consider in current transformer test is; voltage and current tips of each phase must be matched. L1 voltage that comes to relay and current tips in L1 busbar, L2 voltage and current tips in L2 busbar, L3 voltage and current tips in L3 busbar must be matched. In case of a different situation, it warns the relay. SMART RELAY do transformer test for twice to eliminate the possibility of errors. The message below (Figure 2.4) will be displayed at the first transformer test.

Transformer Control 1

Load must be constant

Figure 2.4

In the transformer test, if the current drawn by activated stages are insufficient, a message like in Figure 2.5 will be displayed.

Low Current!

L1 L2 L3

Figure 2.5

In this case SMART RELAY continues the test by increasing the activated stages.

NOTE: Shunt reactors must be definitely connected to the last stages.

If the connections are correct, a message like in Figure 2.6 will be displayed. Thus, the first test is completed and the device passes to second control.

L1 - L2 - L3 -

Recheck

Figure 2.6

NOTE: In the message below (Figure 2.6), "-" value displaying on the right side of L1, L2, L3 indicates current transformer connection directions. In the example "-" displaying next to "L2" indicates that the current transformer connection direction that is attached to the relevant phase is reverse. SMART RELAY realizes this situation and fix the reverse connection automatically. Please look at the section of 'Transformer Test' for details of the message that indicates connection errors.

The message in Figure 2.7 displays at the second transformer test and the test starts.

Transformer Control 2
Load must be
constant

Figure 2.7

After the repeated test, current directions are displayed on the device screen. (Figure 2.8).

L1 + L2 - L3 +

L1 + L2 - L3 +

Figure 2.8

Transformer test is completed. (Figure 2.9).

Trafo Kontrol Islem

Tamamlandi Şekil

Figure 2.9

After completing the transformer test, the device starts stage test automatically by receiving the following message. (Figure 2.10) .

1st Stage Test

Load must be constant

Figure 2.10

The stages are measured automatically starting from first stage and value of the stage is recorded in SMART RELAY store. During measurement, the message below Figure 2.11 is displayed respectively for each stage. In the first row of this message indicates which stage is tested and in the second row the type and state information of the completed stage (single phase, two phase, three phase, cancelled) are displayed.

2.3rd Stage Measurement
3.2nd Three phase

Figure 2.11

If there is a load change during the test, the message in Figure 2.12 is displayed and the stage test is repeated.

3.Kademe Tekrar

Hazirlaniyor...

Figure 2.12

While the stage tests in progress, user can end the process by ESC key. After all the stage measurements are done, the message in Figure 2.13 is displayed and the stage test is completed.

Measurement completed.

Figure 2.13

After the stages above are completed, the installation of SMART RELAY is completed and the compensation starts to be controlled by SMART RELAY.

NOTE: It would be useful for whole compensation system to control the values and states of capacitors, shunt reactors and contactors connected to the stages from 'Stage Power' menu of Smart relay.

3. SETTINGS

3.1 Operating Screen

After the installation of SMART SVC RELAY, important parameters are displayed on the information screen. The device passes automatically from an information screen to another in 6-7 seconds. The values on the screen are updated in every 600 ms. and gives current information to the user. The up and down keys are used to move quickly between these information screens. In the screen displayed after pressing up and down key, the values are updated in every 600 ms and stand still for almost 1.5 minutes. After this, the screens are changed automatically 1.5 minutes later.

3.1.1 Instant Active/Reactive Powers and Percents

P1 = 12.6 kWatt Q/P

01 = +34 VAR %0.3

Figure 3.1

P2 = 154 Watt Q/P

Q2 = -4 VAR %2,5

Figure 3.2

P3 = 14,7 kWatt Q/P

03 = +132 VAR %0,9

Figure 3.3

In the screens above, respectively (Figure 3.1, Figure 3.2, Figure 3.3.) the active powers that flow from L1, L2, L3 phases in the 1st row; reactive powers and percents of these are displayed in the 2nd row. “P” represent active power, ” Q” represent reactive power and “Q/P” represents instant percents.

3.1.2 Achieved Inductive and Capacitive Ratios

In this screen (Figure 3.4), you can see in high resolution last 24 hours achieved inductive/ active and capacitive/active percents. In this way, you do not need to check the index from the meter. If ESC key is pressed more than 3 seconds in operating screen, the ratios that SMART SVC RELAY calculated are reset and starts to be calculated again.

End (%) Cap(%)

2.3 1.1

Figure 3.4

3.1.3 Currents

The instant current values belonging to L1, L2 and L3 phases can be displayed on the operating screen of SMART SVC RELAY. The current values belonging to L1, L2 and L3 phases are displayed like in Figure 3.5 .

Currents

0.0 0.0 0.0

Figure 3.5

3.1.4 Voltages

The instant voltage values belonging to L1, L2 and L3 phases can be displayed on the operating screen of SMART SVC RELAY. The voltage values belonging to L1, L2 and L3 phases are displayed like in Figure 3.6.

Voltages

213 213 214

Figure 3.6

3.1.5 Instant Cos φ Values

In this screen (Figure 3.7), instant coos φ values of each phase are displayed. The minus (-) values displays that Cos φ is in capacitive zone and (+) values displays it is in inductive zone.

Cos L1 L2 L3

-0.98 1.00 0.99

Figure 3.7

3.1.6 Instant Total Harmonic Distortion (THD %)

THD current values are displayed. In this screen, respectively, the current harmonics in L1, L2, L3 phases are displayed.

THD L1 L2 L3 % 1

1 1

Figure 3.8

3.1.7 Phase Sequence

It exists in every 18 stage relays. The phase sequence indicator is like below.

Phase sequence

_abc

Figure 3.9

3.1.8 Stage

It gives information about which stages are activated. The upper row indicates the stages between1 and 9 and bottom row indicates stages in 10 and after 10.

sta:0> …3.5

ge:1>……67

Figure 3.10

3.1.9 Active Energy +

If desired, Import (taken from the system) Active Energy + like Figure 3.11 is displayed on the operating screen of SMART RELAY.

Active Energy +

0000000043512 W.h

Figure 3.11

3.1.10 Active Energy-

If desired, Export (given to the system) Active Energy- like in Figure 3.12 is displayed on the operating screen of SMART RELAY.

Active Energy -

000000000000 W.h

Figure 3.12

3.1.11 Inductive Energy

If desired, the Inductive Energy that occurred in the system is displayed on the operating screen of SMART SVC RELAY like in Figure 3.13.

```
Inductive Energy
000000000341 V.h
```

Figure 3.13

3.1.12 Capacitive Energy

If desired, the Capacitive Energy that occurred in the system is displayed on the operating screen of SMART SVC RELAY like in Figure 3.14.

```
Capacitive Energy
000000000213 V.h
```

Figure 3.14

3.2 Main Menu and Sub-Menus of Smart Relay

To enter the menu when the device in on operating mode, press SET key for 3 sec. To stroll in main menu, SET key is used. After reaching to the desired menu option, the selection can be made with UP / DOWN keys. The selection is confirmed by pressing SET key again or reaches to sub-menus if they exist. If desired, ESC key is used for existing from menu. If user stays in the menu longer than 1.5 minutes, device exists from the menu automatically and returns to operating mode.

3.2.1 Stage Powers

It is the first menu option that is entered by pressing SET key in operating mode. A message like below (Figure 3.15) is encountered. It is stated that the values of stage powers per phase are displayed separately.

```
Stage Powers
L1  L2  L3
```

Figure 3.15

```
K#1  Single Phase
kVAr
0.0  2.0  0.0
```

Figure 3.16

In this menu, the type and states of the stages connected to the device can be seen. When the message above is displayed on the screen, you can switch between the stages with UP/ DOWN keys.

Displayed Stage Powers and Meanings

In the chart below (Figure 3.17), the message example, that is displayed when entering stage powers menu, is indicated and explained.

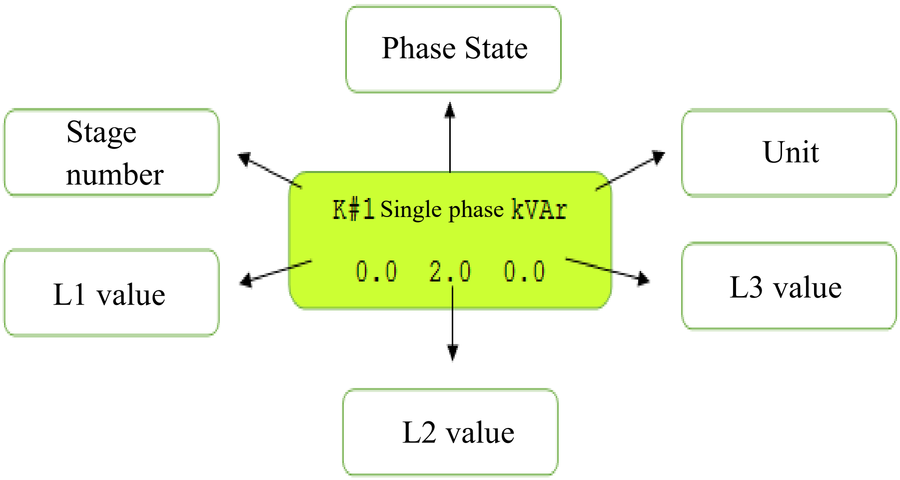


Figure 3.17

The following screens are examples indicating stages that have respectively (Figure 3.18, Figure 3.19, Figure 3.20) three phase, second phase and single phase capacitors.

K#1 three phase, kVAr

3.3 3.4 3.3

Figure 3.18

K#2 second phaseVAr

2.5 0.0 2.4

Figure 3.19

K#1 single phaseAr

0.0 2.0 0.0

Figure 3.20

Error Message

If there is 15% value difference between phases in a three phase capacitor that its value changed, user is informed with a message in the section of phase mode saying ‘Erroneous’. In this case, it is displayed like the following. (Figure 3.21)

K#4Erroneous kVAr

3.42.23.4

Figure 3.21

Cancellation Message

SMART SVC RELAY automatically cancels the stages that any capacitor or reactor does not connect a screen like following (Figure 3.22) informs user that this stage is cancelled.

K#12 cancel kVAr

0.00 0.00 0.00

Figure 3.22

Stage Error

SMART SVC RELAY informs user about an error that it discovers in any stage by flashing error LED in operating mode and by sending stage error message. In addition, in stage menu, in which stage the error occurs is displayed with "!" instead of "#" like in the screen below (Figure 3.23). For a healthy compensation, the problem of this stage must be fixed by the user.

K!1 Three phase kVAr

3.3 3.4 3.3

Figure 3.23

3.2.2 Stage Test

The Stage Test menu is displayed after the Stage Powers menu. (Figure 3.24).

Stage Test?

Yes ->No

Figure 3.24

When you want to do a stage test, you should bring the arrow to "Yes" with UP / DOWN keys and confirm it with SET key. A sub-menu like in below will display. (Figure 3.25).

Test Method?

->->All Single

Figure 3.25

With "All", the test is started for all steps (1-22). If "Single" option is selected, the desired stage is selected from the submenu below (Figure 3.26) with UP/DOWN buttons and the stage test is started..

Select Stage

1st Stage

Figure 3.26

Press SET key to start stage test. Stage test starts after informing user with the screen below. (Figure 3.27)

Stage Test

Load must be constant

Figure 3.27

***NOTE:* In order for stage test to be completed in a short time, the loads in the system must be constant if possible. The test can be done under a load but the test time may extend.**

In stage test, starting from the selected stage, the stages are automatically measured and stage values are saved to the storage of SMART RELAY. During measurement, the message in the Figure 3.28 displays on the screen for each stage. In the first row of this message which stage is tested, in the second row the type and state information of the completed stage is displayed. If a load change happens in the system during the test, the stage test is repeated after the message in Figure 3.29 is displayed.

σÒÄ ÓÔÁÇÅ
Í ÅÁÓÕÒÅ Í ÅÎÔ

&ÉÇÕÒÅ σ8çψ

σÒÄ ÓÔÁÇÅ ÔÅÓÔ
ÒÅÐÅÁÔÔ

Figure 3.29

The stage test is completed with the message below (Figure 3.30) after all the stage measurements are done.

- ÅÁÓÕÒÅ Í ÅÎÔ ÃÏ Í ÐÌÅÔÅÄ
ÒÌÅÁÓÅ ×ÁÉÔ8

Figure 3.30

NOTE: The user can cancel the test by holding down ESC key during the stage test. In this case, old values of completed stages are preserved. During the stage test, DOWN key is used to pass the tested stage and proceed to the next. To enter stage values manually, UP key is used.

3.2.3 Transformer Test

After Stage Test menu, Transformer Test menu is displayed on the screen. (Figure 3.31).

Transformer Test?

Yes ->No

Figure 3.31

When you want to do a transformer test, you should bring the arrow to “Yes” with UP / DOWN keys and confirm it with SET key, then the transformer test starts. The point to regard in current transformer rate; voltage tips and current tips of each phase must be matched. Thus; L1 voltage tip and kl-11 current tip, L2 voltage tip and k2-12 current tip, L3 voltage tip and k3-13 current tip must be matched to back input of Smart relay. Buzzing sound of current transformers indicates that there is a problem in matching or connection. In the transformer test, SMART SVC RELAY waits for preparation of stages by receiving the message below. (Figure 3.32)

Transformer Control

Load must be constant

Figure 3.32

With the message in Figure 3.33, the device starts current transformer test by activating the first three stages.

Transformer Control 1

Load must be constant

Figure 3.33

If the connections are correct, the information about completion of the first test is given to the user after the message in Figure 3.34.

L1 - L2 - L3 -

L1 + L2 - L3 +

Figure 3.34

NOTE: "+"and "-" values on the right side of L1, L2, L3 states current transformer connection directions. In the example, "-"displaying next to "L2" indicated the current transformer direction that is attached to the relevant phase is reversed. SMART SVC RELAY realizes this situation and fix the reverse connection automatically.

NOTE: If the current drawn by activated stages is insufficient, Smart relay increases the number of activated stages and continues the test.

NOTE: In order for SMART SVC RELAY to complete current transformer test in a short time, it is advised to place three-phase capacitors to the first stages from large to small. Connecting two-phase, single-phase capacitors and constant shunt reactors to the next stages enables transformer test to be completed in a short time. It is not compulsory to carry out this advice. Even though stage connections are not done like above, Smart relay will complete the test and start to operate correctly. In addition to this, it is recommended that the current transformer used in the system have a class of 0.5 for measurement accuracy.

After the first completed transformer test, the following message (Figure 3.35) will display on the screen and the current transformer test repeats for control.

Transformer Control 2

Load must be constant

Figure 3.35

After the repeated current transformer test, the message in Figure 3.36 informs the user about current transformer directions and the process completed by receiving the message in Figure 3.37.

L1 + L2 - L3 +

L1 + L2 - L3 +

Figure 3.36

Transformer Control

Process completed

Figure 3.37

NOTE: If SMART RELAY realizes any difference in current transformer connection with the previous ones, it automatically makes the stage test after the current transformer test.

If SMART SVC RELAY detects a change in any current transformer direction, it automatically makes a stage test. If the user wants to end current transformer test due to any reason, the user must press ESC key until the test is cancelled. The cancellation of the current transformer test is specialization-required subject. In the case of cancellation of this test, the user must consider connection directions and input/output. It is not recommended to cancel the current transformer test.

The Warning Messages Indicating Connection Errors in Transformer Test

Low Current!

L3

Figure 3.38

Possible causes and solutions according to Figure 3.38:

- Monophase capacitors may be connected to the first rows. The user must wait for relay to draw three-phase capacitors.

Low Current!

L2 L3

Figure 3.39

Possible causes and solutions according to Figure 3.39:

- There may be a problem in current transformer or connections of L2 and L3.
- The current transformer of L2 and L3 phases are connected to wrong point.
- The k-1 tips of k2-12 and k3-13 terminals current transformers, which are attached for measuring L2 and L3 phases, may be mixed with each other. In this case, the k2-13 tips must be relocated in the device input and the test must be repeated.
- There may be connection errors. The user must follow the connections and fix the errors.
- There is not sufficient current in L2 and L3 phases during the transformer test.

L1 L2 Preparing

Reverse...

Figure 3.40

Possible causes and solutions according to Figure 3.40:

- The current transformer tips of L1 phase to k2-12 inputs, the current transformer tips of L2 phase are connected incorrectly to k1-11 inputs. In this case, the voltage tips of L1 and L2 phases must be interchanged.

L1 L2 L3 Preparing

Reverse...

Figure 3.41

Possible causes and solutions according to Figure 3.41:

- The voltage tips and current transformer tips of phases are not matched. In this case, the voltage tips of any two phases must be interchanged and the test must be repeated. According to the new test result, the matching error in other phases must be fixed.

L1 Preparing

Reverse...

L2 Preparing

Reverse...

L3 Preparing

Reverse...

Figure 3.42

Possible causes and solutions according to Figure 3.43:

- This warning is not expected normally. Thus, unexpected powers are measured when we draw the stage. It means that the relay cannot detect transformer directions from these pointless powers. Generally, if stages that are activated for transformer test are left in two phases or there are powers in and out, these unexpected values occur. In this case, taking large powerful capacitors in the first stages and making the current, drawn by system, stable ease the transformer test.

3.2.4 Stage Control

The Stage Control menu comes after the Transformer Test (Figure 3.43) menu.

Stage Control

Yes ->No

Figure 3.43

When you want to enter the stage control menu, you should bring the arrow to "Yes" with UP / DOWN keys and confirm it with SET key, and then you can control stages via the screen below. (Figure 3.44).

K#1 State: Off

Usage: 20

Figure 3.44

NOTE: In the figure above, it is indicated with "Off" that the state of the first stage is deactivated and it is indicated to the user that this stage is activated for "20" times since the last operating of SMART SVC RELAY. .

If SET key is pressed in the screen above of stage control menu (Figure 3.45), the state of the selected stage can be changed manually.

1 Activate?

->Yes No

Figure 3.45

If the stage is deactivated, the user is directed with the screen in Figure 3.45 when pressed SET key. .

1 Deactivate?

->Yes No

Figure 3.46

If the stage is activated, the user is directed with the screen in Figure 3.46 when pressed SET key. .

NOTE: The user can control manually the relevant stage via SMART RELAY. In this way, it can test the contactor and the capacitor. If wanted, you can exist from this menu with ESC key. When SMART RELAY existing from this menu, the state of the stages returns to the old state.

3.2.5 Power Flow Chart

The feature of SMART RELAY that brings out power profile of the system and gives valuable information to the user as long as existing in synthesis of compensation system is named as "Power Flow Chart". When doing compensation process, SMART RELAY calculates the data in power flow chart as if there is no compensation in the system and saves reactive powers that the system draws. It states these powers and how much time flowed in total with their percentages.

Power Flow Chart

25 Sampl es, Difference% 3

Figure 3.47

The power flow chart firstly gives information to the user with the screen above. In the screen above (Figure 3.47), it is stated that there are 25 samples and the difference between the samples is 3%. This message disappears after 2-3 seconds.

SMART RELAY lines up power samples from the longest-term example to the shortest-term sample. The user can stroll between the next/previous samples with UP / DOWN keys. The percentage in there indicates the ratio of a sample time to the time of all samples. In other words, it gives percentage of power sample on periodic basis. This percentage informs the user about how much the relevant power sample must be regarded when creating the compensation system. The bigger the percentage is the more important power sample for compensation system.

1st sample 42% 123 mines

1.67 2.31 1.85

Figure 3.48

The positive values in the second row of power sample screen (Figure 3.48) in the above indicate inductive powers that the system draws and negative powers indicate capacitive powers. In the first row of the screen above;

the information is given about that the first sample is drawn by system for 123 minutes in total and the percentage in time of this sample is 42%. In the second row, it is seen that 1.67 kVAr inductive from L1 phase, 2.31 kVAr inductive from L2 phase and 1.85 kVAr inductive powers are drawn from L3 phase. This power profile information indicates that the user needs to add 7.5 kVAr three-phase capacitor to the stage in a SVC set of 1.5 kVAr. If all the large percent samples in the power flow chart are regarded, the number and power of capacitor and shunt reactors to be attached to stages in the compensation system can be easily determined.

3.2.6 Advanced Settings

The response of SMART SVC RELAY to the system can be set by some parameters. These parameters are presented as a whole to the user in the sub-menu of "Advanced Settings". (Figure 3.49).

Advanced Settings

Yes ->No

Figure 3.49

Bring the arrow to "Yes" with UP / DOWN keys and enter the advanced settings with SET key.

Current Transformer Ratio

The Current Transformer Ratio message screen is like in Figure 3.50

Current Transformer Ratio
200/5 Ampere

Figure 3.50

The Current Transformer ratio can be set with UP / DOWN keys in this menu. When the current transformer ratio is changed, SMART SVC RELAY automatically makes the current transformer test and renews the stage test. If the current transformer ratio is entered incorrectly by the user and the active and reactive power values displaying on the screen of the device are seen as erroneous, it does not affect SMART SVC RELAY compensation process.

NOTE: The current transformer ratio can be set between 5/5 and 10000/5. When entering current transformer ratio in X1A relays, the primary value must be entered like in the tag but secondary value must be entered as 5.

Voltage Transformer Ratio

The voltage transformer ratio message screen is like in Figure 3.51. The values on the tag of power transformer are regarded. The first statement states the phase-phase primary input of the transformer (34200) and the second statement states the secondary phase-phase output. (380)

Voltage Tr Ratio
34200/380 Volt

Figure 3.51

Inductive Limit

The inductive limit menu enables to set necessary inductive limit for the system to operate correctly. If the set limit is exceeded, the device gets activated and the values are automatically lowered under this limit. If the inductive limit is set to 1%, the relay focuses on capacitive ratio when calculating reactive ratio.

Inductive Limit

%5

Figure 3.52

Capacitive Limit

The capacitive limit menu enables to set necessary capacitive limit for the system to operate correctly. If the set limit is exceeded, the device gets activated and the values are automatically lowered under this limit.

Capacitive Limit

%10

Figure 3.53

Reactive Response Time

The reactive response time message screen is like in Figure 3.54.

Reactive response

Time: 4.00 sec.

Figure 3.54

This value can be set with UP / DOWN keys. The value is confirmed with SET key and proceeds to the next menu. Reactive response time is the parameter that determines how much time later the reactive ratios, that SMART RELAY calculated, can response after limit value is exceeded. As this time shortens, the response time of SMART RELAY quickens. If there are not loads that change very quickly, increasing this time can be preferred.

NOTE: The factory output time for this parameter is 4 sec.

NOTE: The reactive response time can be set between 0 and 20 sec.

Capacitor Discharge Time

The capacitor discharge time message screen is like in Figure 3.55.

Capacitor Discharge

Time: 16.00 sec.

Figure 3.55

This value can be set with UP/ DOWN keys. The setting is confirmed with SET key and process to next menu. It is the time that determines how much time the device will wait after deactivating a capacitor. The manufacturers of capacitor do not recommend shortening this time!

NOTE: The factory output value for this parameter is 16 sec.
NOTE: The capacitor discharge time can be set between 0 and 600 sec.

3.2.7 Expert Settings

The response of SMART SVC RELAY to the system can be set via some parameters. These parameters are presented to the user in 'Expert Settings' sub-menu. (Figure3.56).

Expert Settings

Yes ->No

Figure 3.56

Energy Integral Time

The integral of power to a particular time gives energy as seen in the formula $W = \int_0^t Pdt$. "t" a.k.a time is designated with Energy Integral Time Menu. The energy occurred in the designated time is divided by the designated time and the avarage power is obtained. It is used for accurate measurement in low current.

Energy Integral

Time: 0.20 sec

Figure 3.57

Ade Gain (Opm) Multiplier

It indicates current multiplier coefficient for a high resolution measurement (accurate) in very low currents. The current is given to measurement channel by strengthening it up to opm multiplier. In this way, the high resolution is obtained.

ADE Opm Multiplier

1

Figure 3.58

NOTE: Ade Opamp (Gain) Multiplier can be set as 1, 2 and 4.

Ade Hw Opm Multiplier

It is the state when Ade Gain (Opm) Multiplier menu make a stage test. This means that the current in increased by the multiplier in the stage test at very high conversion ratios.

ADE Hw Opm Multiplier

1

Figure 3.59

Modbus Address

The MODBUS communication settings of device are done in Communication setting menu.

Modbus Address

1

Figure 3.60

With the menu above, a new MODBUS address different from other connected devices is assigned to the device. The values are changed between 0-254 with DOWN/UP keys and the wanted address can be given to the device with SET key.

Energy Reset

This menu enables to delete the energies that are saved to the device.

Energy Reset ?

Yes ->No

Figure 3.61

If you bring the arrow to Yes with the menu above and confirm with SET key, the saved energies are reset.

Deletion of Power Flow Chart

This menu enables to delete the Power Flow Chart that is saved to the device.

Delete Power Flow Chart

Yes ->No

Figure 3.62

If you bring the arrow to Yes with the menu above and confirm with SET key, the saved Power Flow Chart is deleted.

Stage Transition Time

The Stage Transition Time is set with this menu. This time is determined by the user according to groups of capacitor that are used.

Stage Transition Time

30x10ms

Figure 3.63

When this menu displays on the screen, the stage transition time is set with DOWN/UP keys.

NOTE: The stage transition time can be set between 0 and 255 x 10 ms.

Capacitive Delay Multiplier

It states the delay time of the capacitor when deactivating it in order for the capacitor and the contactors to be long-lasting.
The delay time of the capacitor when deactivating it = Reactive response time x capacitive delay multiplier.

Cap delay multiplier 1

Figure 3.64

NOTE: It should be regarded that if Inductive Power Multiplier and Capacitive Power Multiplier are set high, the reactive response of the relay will be delayed.

Inductive Delay Multiplier

It states the delay time of the capacitor when deactivating it in order for the capacitor and the contactors to be long-lasting.
The delay time of the capacitor when deactivating it = Reactive response time x capacitive delay multiplier

Inductive Delay Multiplier

1

Figure 3.65

NOTE: It should be regarded that if Inductive Power Multiplier and Capacitive Power Multiplier are set high, the reactive response of the relay will be delayed.

Off Set Stage

A load that current transformer does not see (the capacitive effect of long OG cables or inductive loss of power transformer) can be defined to the relay with 'off set stage'. For this process, firstly one of the stages are defined as off set then the convenient value is entered in manual login menu after make a stage test to the defined stage.

EXAMPLE: *The OG cable distance between electric meter and power transformer = 500m*
Capacitive effect of the cable = 25 kVAr

In this case, even if the relay makes cosΦ as 1, the meter will write capacitive due to capacitive effect of the cable. The reactive difference between meter and relay can be eliminated by making necessary settings in SMART RÖLE "Off set" stage menu.

Off Set Stage Setting

1. An idle stage is selected in off set stage menu.
2. The demanded value is defined to the selected stage in stage test menu with the help of manual login.

Off Set Stage

Off

Figure 3.66

NOTE: The value to be defined to the stage that is defined as "Off set" should be; (-) for capacitive loads and (+) for inductive loads.

Off Set Stage Extra Information

We can report a value to the relay that the relay does not see but the meter sees by associating this value with a stage. We name this stage as "off set". This can be any idle stage. After entering the number of this stage in 'off set' stage login in the menu, we come to the stage test in the menu and make a stage test to this stage and we enter the value of the stage as 'off set' value, that the relay does not see, for each phase in manual screen. We can make off set feature activated via any stage active and passive with a signal. The generator input of the relay can be used for this application by making off pin on in the menu. When 220 volt is given to the generator input, off set feature becomes active, otherwise it becomes passive. For example; in this way, we can make off set value active when cogeneration is deactivated and make passive when it is deactivated.

Rapid Off Set On

If you want this feature to be activated rapidly after choosing "Off Set" stage, you should make parameter 'on'.

Rapid Off Set On

On

Figure 3.67

Off Set Output

If you want "Off Set" stage to give input when this feature is activated, you should make it 'on'.

Off Set Output

On

Figure 3.68

Off Set Enter

The value of "Off Set" stage can be entered in this screen.

Off Set Enter

->Yes No

Figure 3.69

Off Set Reactive

"Off Set" stage value is entered 100 VAr for each phase.

Off Set Reactive

0

Figure 3.70

Off Set Pin

If you want to enable or disable generator input pin "Off set" stage, make the parameter 'on'. If 220 V is reached to the generator pin, the "Off set" state that is activated gets active. When it reaches to 0, the activated 'off set' state is made passive.

Off Set Pin

Off

Figure 3.71

Inductive Ratio Hysteresis

The system shows tolerance up to the inductive hysteresis value with Inductive Ratio Hysteresis Menu and the necessary capacitor is not done. It is used to extend the life of the board in situations that do not have trouble in terms of punishment. The relay intervenes in the system to reach inductive limit. If the obtained ratio after intervention is in hysteresis limits, it does not intervene anymore.

EXAMPLE: *In case of inductive limit is 5% inductive ratio is 5, if the values stay 5% and 10% after the intervention, the relay does not intervene anymore.*

End Ratio Hysteresis

8

Figure 3.72

NOTE: Inductive Ratio Hysteresis can be set between 0 and 20.

Capacitive Ratio Hysteresis

With Capacitive Ratio Hysteresis Menu, the system shows tolerance up to capacitive hysteresis value and the necessary compensation is not done.

It is used to extend the life of board in situations that do not have trouble in terms of punishment. The relay intervenes in the system to reach capacitive limit. If the obtained ratio after intervention is in hysteresis limits, it does not intervene anymore.

EXAMPLE: *In case of capacitive limit is 12%, capacitive ratio hysteresis 2, the relay will not intervene again if the values after intervention remain between 12% and 14%.*

Cap Ratio Hysteresis

3

Figure 3.73

NOTE: Capacitive Ratio Hysteresis can be set between 0 and 20.

Response Resolution

Response resolution menu enables to make compensation with the wanted accuracy. The higher response resolution, the higher accuracy is, the lower, the lower accuracy. It is not recommended for response resolution to be high in fast changing loads. In other words, as the response resolution decreases, we find an approximate solution by doing less switching and a definite solution by doing much switching.

Response Resolution

32

Figure 3.74

NOTE: Response resolution can be set between 1 and 60.

Auto Stage Test

It exists in 18-stage relays. The device makes a test automatically in every 15 days when the system is in 'stand by'. This feature is normally closed. Make on to activate it.

Auto Stage Test

Off

Figure 3.75

Gen End Limit

It exists in all 18-stage relays. It can have values up to 99. It determines inductive limit when generator is activated. If Gen End Limit and Gen Cap Limit are 99 together, compensation will be deactivated.

Gen End Limit

5

Figure 3.76

Gen Cap Limit

It exists in all 18-stage relays. It can have values up to 99. It determines capacitive limit when generator is activated. If Gen End Limit and Gen Cap Limit are 99 together, compensation will be deactivated.

Jen Kap Snr

10

Figure 3.77

Second Zone Bass

It exist in18-stage relays. It exists to use contactor and thyristor switched stages together. Thyristor switching is entered as the parameter to the screen below from which stage it starts.

Second Zone Bass

Off

Figure 3.78

Second Zone Multiplier

It exists in all18-stage relays. It determines thyristor stage activation pace when contactor and thyristor switched stages are used together.

EXAMPLE: *If second zone multiplier is 20, the activation pace of thyristor increases by 20 times compared to the contactor stage. So, if discharge time of contactor stage is 8 sec, it is 8/20= 400 msn in thyristor for stage.*

Second Zone Multiplier

Off

Figure 3.79

DYN Value

It indicates the connection diagram of power transformer. This value is written on tag of the transformer. DYN is the angle difference between the primary and the secondary voltage of the transformer. **EXAMPLE:** *If DYN=11, the angle between the primary and the secondary voltage is 11x30=330 degrees.*

DYN Value

11

Figure 3.80

Export Energy

It exists in all 18-stage relays. If you want to make a different compensation when the system is energised, make export energy ‘on’.

Export Energy

Off

Figure 3.81

In Expr Comp Off

It enables to deactivate compensation when the system is in export.

In Expr Comp Off

On

Figure 3.82

In Expr At Imprt

If a phase of the system is in import and the other phase is in export, it compensates the system as if it is in import mode. If you make it ‘off’, this feature is closed.

In Expr At Imprt

On

Figure 3.83

In Expr Comp Pass

If the system is in export mode, the feature is set to ‘on’ if you want to switch to stand by.

In Expr Comp Pass Off

Figure 3.84

Slayt On

If you want to make the screen stay on a page, make it off.

Slayt On

On

Figure 3.85

Power Off Set Fac

If you want to synchronize the relay with another device or you want to make the measured powers over or under % for any reason, this feature is activated.

Power Off Set Fac

Off

Figure 3.86

AC Off Set Fac L1, L2, L3

It determines the % multiplier of the measured active power to be added.

AC Off Set Fac L1,L2,L3

0

Figure 3.87

EXAMPLE: *If parameter is 10, the active power is accepted 10% more than the measured power. So, 80 kW power is accepted as 80 + 80 x 10%=88. If it is – 10, it is reversed.*
Thus, it is 80-80x1%0=72.

In Off Set Fac L1, L2, L3

It determines % multiplier of the measured inductive power to be added.

In Off Set Fac L1,L2,L3

0

Figure 3.88

EXAMPLE: *If parameter is 10, the inductive power is accepted 10% more than the measured power. So, 80 kW power is accepted as 80 + 80 x 10%=88. If it is – 10, it is reversed.*
Thus, it is 80-80x1%0=72.

Cp Off Set Fac L1, L2, L3

It determines % multiplier of the measured capacitive power to be added.

Cp Off Set Fac L1,L2,L3

0

Figure 3.89

EXAMPLE: *If parameter is 10, the capacitive power is accepted 10% more than the measured power. So, 80 kW power is accepted as 80 + 80 x 10%=88. If it is – 10, it is reversed.*
Thus, it is 80-80x1%0=72.

Normal Effect

It stabilizes the solution found with SVC.

Normal Effect

Off

Figure 3.90

Ignore Mode

If one or two of the phases changed directions, it is used to bypass the compensation of the wanted direction.

Figure 3.91

Auto Tr Kont

It enables to start the current transformer test automatically if the current directions change.

Figure 3.92

Auto Opm Mode

It automatically switches opamps to increase resolution at small currents.

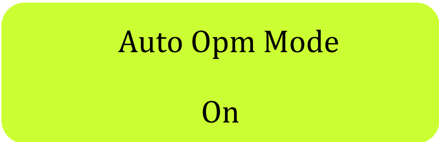


Figure 3.93

Sec Opm Mode

It keeps the multiplication coefficient of opamps in the safe zone.

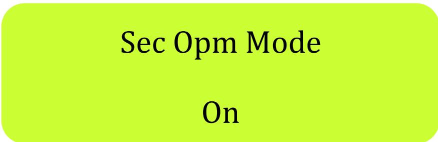


Figure3.94

Advanced Comp Mode

It activates the advanced compensation mode.

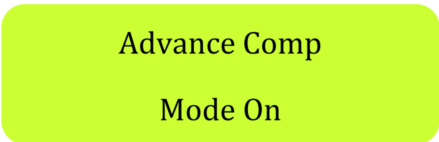


Figure 3.95

Prll Comp Mode

It enables two relays to work parallel.

Figure 3.96

Selc Comp Mode

It states parallel working relay to be master or slave. The phase is entered to alarm input of slave relay in relay operating mode. The alarm output is connected to master generator input.

Moreover, the neutral connection of generator input of master relay is done. The phase is connected to alarm input of master relay. The alarm output of master relay is connected to the generator input of slave relay. The neutral connection of the generator input of master relay is done.

Selc Comp Mode

Master

Figure 3.97

Ade Reset On

It is used to protect energy measurement units in harmonic places from incorrect measurement.

Ade Reset On

Off

Figure 3.98

Back Light

It exists in 18-stage relays. If you want the screen to never go off, you must make this feature ‘on’.

Back Light

Off

Figure 3.99

Default Values

All the parameters restored factory settings. except important ones such as Transformer ratio, DYN value.

Default Values

Yes ->No

Figure 3.100

4. COMMON ERRORS

4.1 Common Errors and Solution Suggestions

Error Description	Cause of Error	Resolution of Error
The energy is coming on but the device is not working.	The connection sockets are not fully engaged.	Check the connection sockets.
The energy is coming, but the lighting of the screen is flashing.	Relay's penalty limit (20% end when it exceeds 15% cap), it occurs for warning purposes.	It should be checked whether the stages remain adhered or whether the stages are suitable.
Compensation supply open current transformers are buzzing.	Current transformer output terminals are not matched or current transformer output terminals are left open.	Check the current transformer connections by measuring and/or checking by eye/hand. Match the outputs on the relay.
Although I have matched the current and voltage phases in the current transformer test It gives the warning message ”L<1,2,3>Reverse".	The first stage capacitors may be defective or two-phase. There are fast changing loads in the system.	Check the capacitor currents with a clamp meter. Move the two-phase or faulty capacitors installed in the first stages to the last stages. Turn off the loads that change suddenly during the test process.
Although I have energized the device, it cannot perform the current transformer test, it constantly gives the "Current Low" warning and activates and deactivates the stages.	The current transformer is not at the network input. There are no capacitors on the stages. Current transformer output terminals are not matched or current transformer output terminals are left open. Stage capacitor feeds are taken before the current transformer (current transformer does not see the stage purchases).	Turn off the fast in and out loads in the system. Check that the current transformers are connected to the first input. Make sure that there is a capacitor or reactor connected to the stages and that the fuse is open and that reactive energy is drawn from all 3 phases. Turn off fast loads in the system.
Current transformer test is finished but capacitor test takes a long time.	There are fast changing loads in the system. Current transformer class greater than 0.5.	Use current transformers with a class of 0.5.

The inductive LED is on, but the device is not activated.	The stages can be selected large. The relay may not have recognized the stages.	Analyze the circuit, check the stage values by observing the reactive energies flowing through the system from the power flow graph. Make a stage test.
The capacitive light is on even though none of the stages are activated. The meter says capacitive	There is capacitive power in the system. There is sticking in the stage contactors.	Analyze the system, capacitive load should not exceed the reactor power. Check the stage contactors and replace the stuck contactors.
The device activates and deactivates the stages quickly.	The intervention time is low. There are loads coming in and out fast.	If the intervention time is low, it intervenes quickly to the system changes and the intervention slows down as the intervention time increases. If there are loads entering and exiting fast, it responds to the system quickly, of course, it does not reactivate the stage without waiting for the discharge time entered from the menu.
The inductive and capacitive ratios shown by the device are incompatible with the ratios measured by the meter.	There may be a defect in the device or meter. Instant measurement was not taken. There may be a load (fixed capacitor, regulator, etc.) between the meter and compensation current transformers.	Device power measurement by meter with max there may be deviations of 2-3%. Check your meter. Reset the rates calculated by the device, 20 minutes after receiving the meter index. then compare the rates again.
GK 5.0/10.0/30.0 KVAr power floor gets too hot.	A reactor larger than the label value is connected. Panel ventilation is not done correctly.	Connect the reactor according to the label value. Make the panel ventilation well, ventilate the panel correctly by designing it to expel hot air out.
The reactors are getting too hot.	Panel ventilation is not done correctly.	Make the panel ventilation well. 70-80°C is normal for the reactor, please do not worry. You can reduce the heat by making good ventilation. Otherwise, the thermals inside the reactor will open and protect the system.
The “Reactors Are Hot” warning appears on the screen.	The reactors are overheating. Panel design is faulty. There is a fault in the connection.	Make reactor ventilation well. Check the thermal connection.

4.2 Operating the Device in the Inductive Zone

The inductive limit ratio of the device is brought to 1, the capacitive limit is set as required and the device then continues compensation by pulling the capacitor until the set capacitive ratio is reached.

4.3 Operating the Device in the Inductive Zone

The device already operates in the inductive region by default. It continues to compensate by pulling the minimum step (no more) to reach the set inductive limit.

4.4 Formatting the device (Reset)

If it is desired to format the device, after the device is de-energized, the device is energized by pressing and holding the menu button. After the production date of the device appears on the screen, press the ESC button in addition to the menu button, then release the menu button and then release the ESC button. After the format screen appears, select yes and press the menu button.

5. MODBUS

5.1 Communication Parameters

Baudrate	19200 bps
Data bits	8
Parity	None
Stop bits	1

5.2 Differences from Standard MODBUS

- Multiple register reading and writing cannot be done.

5.3 Sample Query and Answer

For a device with MODBUS address 5, Phase 1 Active Energy (Consumption) reading;

Query: 0x05 0x03 0x00 0x00 0x00 0x02 0xC5 0x8F

Answer: 0x05 0x03 0x04 0x00 0x00 0x02 0xA4 0xff 0xC5

For a device with MODBUS address 5, change (write) the Current Transformer Ratio to 30/5;

Query: 0x05 0x06 0x00 0xB4 0x00 0x06 0x48 0x6A

Answer: 0x05 0x06 0x00 0xB4 0x00 0x06 0x48 0x6A

5.4 Additional Explanations

Stage Test

The write function (0x06) is applied to the stage test address (185). When only one stage is to be tested, the low byte of the data to be written takes the value of the stage number. For example; In a device with MODBUS address 5, the query we will write to test the 1st stage is as follows.

Query:	0x05	0x06	0x00	0xB9	0x00	0x01	0x98	0x6B
Answer:	0x05	0x06	0x00	0xB9	0x00	0x01	0x98	0x6B

If all stages are to be tested, the low byte value is written as 255.
Query: 0x05 0x06 0x00 0xB9 0x00 0xFF 0x19 0xEB

Answer: 0x05 0x06 0x00 0xB9 0x00 0xFF 0x19 0xEB

If only SVC reactors are wanted to be tested; the low byte value is written to 254.

Query: 0x05 0x06 0x00 0xB9 0x00 0xFE 0xD8 0x2B

Answer: 0x05 0x06 0x00 0xB9 0x00 0xFE 0xD8 0x2B

Stage Test Cancellation

To cancel the stage test, the value 1 is written to address (100) with the write function. No response is received.

Query: 0x05 0x06 0x00 0x64 0x00 0x01 0x08 0x51

Transformer Test

To start the transformer test, the value 1 is written to address (186) with the write function.

Query: 0x05 0x06 0x00 0xBA 0x00 0x01 0x68 0x6B

Answer: 0x05 0x06 0x00 0xBA 0x00 0x01 0x68 0x6B

Transformer Test Cancellation

To cancel the transformer test, the value 1 is written to the address (101) with the write function.

Query: 0x05 0x06 0x00 0x65 0x00 0x01 0x59 0x91

Answer: 0x05 0x06 0x00 0x65 0x00 0x01 0x59 0x91

Stage Values

Register addresses between 256-380 give L1, L2, L3 loads for a stage in order. For example, for stage 1, registers 256-258-260 are queried with the 0x03 function.

Stage Conditions

Address 73 returns a 32-bit number. Starting from index 0, each bit indicates the state of the stage as the number of stages increases. If the bit value is 1, the stage is activated.

Stage Usage

Register addresses 768-785 give the number of switching for each stage.

SVC Readings

From the end of the step register addresses, 9 pieces of 4 each byte registers, that is, if the relay is 12 stages, the register addresses between 328-344, if it is 18 stages, the register addresses between 364-380 give the SVC values.

Power Flow Graph

Register addresses between 512-655 give L1, L2, L3 power samples, percentage and time values for a stage respectively.

For example, for stage 1, registers 512-514-516-518-519 are queried with the 0x03 function.

Parameter Name	Address	Data Type	Multiplier	Unit	Function
1. Phase Active Energy (Consumption)	0	Unsigned/32	1	Wh	R
2. Phase Active Energy (Consumption)	2	Unsigned/32	1	Wh	R
3. Phase Active Energy (Consumption)	4	Unsigned/32	1	Wh	R
1. Phase Active Energy (Production)	6	Unsigned/32	1	Wh	R
2. Phase Active Energy (Production)	8	Unsigned/32	1	Wh	R
3. Phase Active Energy (Production)	10	Unsigned/32	1	Wh	R
1. Phase Inductive Energy	12	Unsigned/32	1	VArh	R
2. Phase Inductive Energy	14	Unsigned/32	1	VArh	R
3. Phase Inductive Energy	16	Unsigned/32	1	VArh	R
1. Phase Capacitive Energy	18	Unsigned/32	1	VArh	R
2. Phase Capacitive Energy	20	Unsigned/32	1	VArh	R
3. Phase Capacitive Energy	22	Unsigned/32	1	VArh	R
1. Phase Active Power	24	Signed/32	1	W	R
2. Phase Active Power	26	Signed/32	1	W	R
3. Phase Active Power	28	Signed/32	1	W	R
1. Phase Inductive Power	30	Signed/32	1	VAr	R

2. Phase Inductive Power	32	Signed/32	1	VAr	R
3. Phase Inductive Power	34	Signed/32	1	VAr	R
1. Phase Capacitive Power	36	Signed/32	1	VAr	R
2. Phase Capacitive Power	38	Signed/32	1	VAr	R
3. Phase Capacitive Power	40	Signed/32	1	VAr	R
1. Phase Cos ϕ	42	Signed/16	100	%	R
2. Phase Cos ϕ	43	Signed/16	100	%	R
3. Phase Cos ϕ	44	Signed/16	100	%	R
Reached Inductive Percentage	45	Unsigned/16	10	%	R
Reached Inductive Percentage	46	Unsigned/16	10	%	R
1. Phase Frequency	47	Unsigned/16	1	Hz	R
2. Phase Frequency	48	Unsigned/16	1	Hz	R
3. Phase Frequency	49	Unsigned/16	1	Hz	R
1. Phase THDI	50	Unsigned/16	1	%	R
2. Phase THDI	51	Unsigned/16	1	%	R
3. Phase THDI	52	Unsigned/16	1	%	R
1. Phase SVC Opening Percentage	53	Unsigned/16	10	%	R
2. Phase SVC Opening Percentage	54	Unsigned/16	10	%	R
3. Phase SVC Opening Percentage	55	Unsigned/16	10	%	R

1. Phase Voltage	56	Unsigned/16	1	V	R
2. Phase Voltage	57	Unsigned/16	1	V	R
3. Phase Voltage	58	Unsigned/16	1	V	R
1. Phase Current	59	Unsigned/32	100	A	R
2. Phase Current	61	Unsigned/32	100	A	R
3. Phase Current	63	Unsigned/32	100	A	R
Serial Number	70	Char/48	1		R
Device Status	72	Byte/8	1		R
Stage Status	73	Unsigned/32	1		R
Stage Test Cancellation	100	Unsigned/16	1		W
Transformer Test Cancellation	101	Unsigned/16	1		W
Reactive Response Time	150	Unsigned/16	100	Sn	R/W
Normally Response Time	151	Unsigned/16	100	Sn	R/W
SVC Response Time	153	Unsigned/16	100	Sn	R/W
Cond. Discharge Time	154	Unsigned/16	100	Sn	R/W
Energy Integral Time	158	Unsigned/16	100	Sn	R/W
ADE Opamp Multiplier	159	Unsigned/16	1		R/W
ADE Hw Opamp Multiplier	161	Unsigned/16	1		R/W
Inductive Hysteresis	166	Unsigned/16	1		R/W

Capacitive Hysteresis	167	Unsigned/16	1		R/W
Response Resolution	168	Unsigned/16	1		R/W
Inductive Limit	169	Unsigned/16	1		R/W
Capacitive Limit	170	Unsigned/16	1		R/W
LC Offset L1	171	Signed/16	1		R/W
LC Offset L2	172	Signed/16	1		R/W
LC Offset L3	173	Signed/16	1		R/W
1. SVC Max Opening Percentage	177	Unsigned/16	1		R/W
2. SVC Max Opening Percentage	178	Unsigned/16	1		R/W
3. SVC Max Opening Percentage	179	Unsigned/16	1		R/W
Current Transformer Ratio	180	Unsigned/16	1		R/W
Voltage Transformer Ratio	181	Unsigned/16	1		R/W
Stage Test	185	Unsigned/16	1		W
Transformer Test	186	Unsigned/16	1		W
Stage Values					
1. Stage Q1	256	Signed/32	1		R
1. Stage Q2	258	Signed/32	1		R
1. Stage Q3	260	Signed/32	1		R

2. Stage Q1	262	Signed/32	1		R
2. Stage Q2	264	Signed/32	1		R
2. Stage Q3	266	Signed/32	1		R
3. Stage Q1	268	Signed/32	1		R
3. Stage Q2	270	Signed/32	1		R
3. Stage Q3	272	Signed/32	1		R
4. Stage Q1	274	Signed/32	1		R
4. Stage Q2	276	Signed/32	1		R
4. Stage Q3	278	Signed/32	1		R
5. Stage Q1	280	Signed/32	1		R
5. Stage Q2	282	Signed/32	1		R
5. Stage Q3	284	Signed/32	1		R
6. Stage Q1	286	Signed/32	1		R
6. Stage Q2	288	Signed/32	1		R
6. Stage Q3	290	Signed/32	1		R
7. Stage Q1	292	Signed/32	1		R
7. Stage Q2	294	Signed/32	1		R
7. Stage Q3	296	Signed/32	1		R
8. Stage Q1	298	Signed/32	1		R

8. Stage Q2	300	Signed/32	1		R
8. Stage Q3	302	Signed/32	1		R
9. Stage Q1	304	Signed/32	1		R
9. Stage Q2	306	Signed/32	1		R
9. Stage Q3	308	Signed/32	1		R
10. Stage Q1	310	Signed/32	1		R
10. Stage Q2	312	Signed/32	1		R
10. Stage Q3	314	Signed/32	1		R
11. Stage Q1	316	Signed/32	1		R
11. Stage Q2	318	Signed/32	1		R
11. Stage Q3	320	Signed/32	1		R
12. Stage Q1	322	Signed/32	1		R
12. Stage Q2	324	Signed/32	1		R
12. Stage Q3	326	Signed/32	1		R
13. Stage Q1	328	Signed/32	1		R
13. Stage Q2	330	Signed/32	1		R
13. Stage Q3	332	Signed/32	1		R
14. Stage Q1	334	Signed/32	1		R
14. Stage Q2	336	Signed/32	1		R

14. Stage Q3	338	Signed/32	1		R
15. Stage Q1	340	Signed/32	1		R
15. Stage Q2	342	Signed/32	1		R
15. Stage Q3	344	Signed/32	1		R
16. Stage Q1	346	Signed/32	1		R
16. Stage Q2	348	Signed/32	1		R
16. Stage Q3	350	Signed/32	1		R
17. Stage Q1	352	Signed/32	1		R
17. Stage Q2	354	Signed/32	1		R
17. Stage Q3	356	Signed/32	1		R
18. Stage Q1	358	Signed/32	1		R
18. Stage Q2	360	Signed/32	1		R
18. Stage Q3	362	Signed/32	1		R
1. SVC Q1	364	Signed/32	1		R
1. SVC Q2	366	Signed/32	1		R
1. SVC Q3	368	Signed/32	1		R
2. SVC Q1	370	Signed/32	1		R
2. SVC Q2	372	Signed/32	1		R
2. SVC Q3	374	Signed/32	1		R

3. SVC Q1	376	Signed/32	1		R
3. SVC Q2	378	Signed/32	1		R
3. SVC Q3	380	Signed/32	1		R
Power Flow Graph Examples					
1. Example Q1	512	Signed/32	1		R
1. Example Q2	514	Signed/32	1		R
1. Example Q3	516	Signed/32	1		R
1. Sample Percentage	518	Unsigned/16	1		R
1. Sample Time	519	Unsigned/16	1		R
2. ExampleQ1	520	Signed/32	1		R
2. Example Q2	522	Signed/32	1		R
2. Example Q3	524	Signed/32	1		R
2. Sample Percentage	526	Unsigned/16	1		R
2. Sample Time	527	Unsigned/16	1		R
3. Example Q1	528	Signed/32	1		R
3. Example Q2	530	Signed/32	1		R
3. Example Q3	532	Signed/32	1		R
3. Sample Percentage	534	Unsigned/16	1		R
3. Sample Time	535	Unsigned/16	1		R

4. Example Q1	536	Signed/32	1		R
4. Example Q2	538	Signed/32	1		R
4. Example Q3	540	Signed/32	1		R
4. Sample Percentage	542	Unsigned/16	1		R
4. Sample Time	543	Unsigned/16	1		R
5. Example Q1	544	Signed/32	1		R
5. Example Q2	546	Signed/32	1		R
5. Example Q3	548	Signed/32	1		R
5. Sample Percentage	550	Unsigned/16	1		R
5. Sample Time	551	Unsigned/16	1		R
6. Example Q1	552	Signed/32	1		R
6. Example Q2	554	Signed/32	1		R
6. Example Q3	556	Signed/32	1		R
6. Sample Percentage	558	Unsigned/16	1		R
6. Sample Time	559	Unsigned/16	1		R
7. Example Q1	560	Signed/32	1		R
7. Example Q2	562	Signed/32	1		
7. Example Q3	564	Signed/32	1		
7. Sample Percentage	566	Unsigned/16	1		

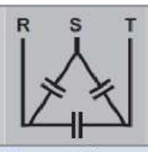
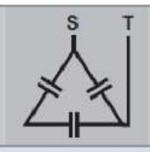
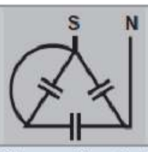
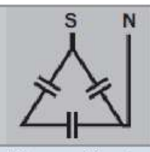
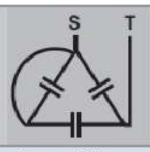
7. Sample Time	567	Unsigned/16	1		
8. Example Q1	568	Signed/32	1		
8. Example Q2	570	Signed/32	1		
8. Example Q3	572	Signed/32	1		
8. Sample Percentage	574	Unsigned/16	1		
8. Sample Time	575	Unsigned/16	1		
9. Example Q1	576	Signed/32	1		
9. Example Q2	578	Signed/32	1		
9. Example Q3	580	Signed/32	1		
9. Sample Percentage	582	Unsigned/16	1		
9. Sample Time	583	Unsigned/16	1		
10. Example Q1	584	Signed/32	1		
10. Example Q2	586	Signed/32	1		
10. Example Q3	588	Signed/32	1		
10. Sample Percentage	590	Unsigned/16	1		
10. Sample Time	591	Unsigned/16	1		
11. Example Q1	592	Signed/32	1		
11. Example Q2	594	Signed/32	1		
11. Example Q3	596	Signed/32	1		

11. Sample Percentage	598	Unsigned/16	1		
11. Sample Time	599	Unsigned/16	1		
12. Example Q1	600	Signed/32	1		
12. Example Q2	602	Signed/32	1		
12. Example Q3	604	Signed/32	1		
12. Sample Percentage	606	Unsigned/16	1		
12. Sample Time	607	Unsigned/16	1		
13. Example Q1	608	Signed/32	1		
13. Example Q2	610	Signed/32	1		
13. Example Q3	612	Signed/32	1		
13. Sample Percentage	614	Unsigned/16	1		
13. Sample Time	615	Unsigned/16	1		
14. Example Q1	616	Signed/32	1		
14. Example Q2	618	Signed/32	1		
14. Example Q3	620	Signed/32	1		
14. Sample Percentage	622	Unsigned/16	1		
14. Sample Time	623	Unsigned/16	1		
15. Example Q1	624	Signed/32	1		
15. Example Q2	626	Signed/32	1		

15. Example Q3	628	Signed/32	1		
15. Sample Percentage	630	Unsigned/16	1		
15. Sample Time	631	Unsigned/16	1		
16. Example Q1	632	Signed/32	1		
16. Example Q2	634	Signed/32	1		
16. Example Q3	636	Signed/32	1		
16. Example Percentage	638	Unsigned/16	1		
16. Sample Time	639	Unsigned/16	1		
17. Example Q1	640	Signed/32	1		
17. Example Q2	642	Signed/32	1		
17. Example Q3	644	Signed/32	1		
17. Sample Percentage	646	Unsigned/16	1		
17. Sample Time	647	Unsigned/16	1		
18. Example Q1	648	Signed/32	1		
18. Example Q2	650	Signed/32	1		
18. Example Q3	652	Signed/32	1		
18. Sample Percentage	654	Unsigned/16	1		
18. Sample Time	655	Unsigned/16	1		
Stage Usage					

1. Step Usage	768	Unsigned/16	1		
2. Step Usage	769	Unsigned/16	1		
3. Step Usage	770	Unsigned/16	1		
4. Step Usage	771	Unsigned/16	1		
5. Step Usage	772	Unsigned/16	1		
6. Step Usage	773	Unsigned/16	1		
7. Step Usage	774	Unsigned/16	1		
8. Step Usage	775	Unsigned/16	1		
9. Step Usage	776	Unsigned/16	1		
10. Step Usage	777	Unsigned/16	1		
11. Step Usage	778	Unsigned/16	1		
12. Step Usage	779	Unsigned/16	1		
13. Step Usage	780	Unsigned/16	1		
14. Step Usage	781	Unsigned/16	1		
15. Step Usage	782	Unsigned/16	1		
16. Step Usage	783	Unsigned/16	1		
17. Step Usage	784	Unsigned/16	1		
18. Step Usage	785	Unsigned/16	1		

7.CAPACITOR TRANSFORMATION TABLE

					
Total Capacitor Power (kVAr) Q	Three-Phase Connection (Q)	Two-Phase Connection (Q/2)	Phase-Neutral Bridge Connection (2xQ/9)	Phase-Neutral Connection (Q/6)	Two-Phase Bridge Connection (2xQ/3)
0,5	3 x 0,17	2 x 0,13	1 x 0,11	1 x 0,08	2 x 0,17
1,0	3 x 0,33	2 x 0,25	1 x 0,22	1 x 0,17	2 x 0,33
1,5	3 x 0,5	2 x 0,37	1 x 0,33	1 x 0,25	2 x 0,5
2,5	3 x 0,83	2 x 0,63	1 x 0,55	1 x 0,41	2 x 0,83
5,0	3 x 1,67	2 x 1,25	1 x 1,11	1 x 0,83	2 x 1,67
7,5	3 x 2,5	2 x 1,87	1 x 1,67	1 x 1,25	2 x 2,5
10	3 x 3,33	2 x 2,5	1 x 2,22	1 x 1,67	2 x 3,33
15	3 x 5	2 x 3,75	1 x 3,33	1 x 2,5	2 x 5
20	3 x 6,67	2 x 5	1 x 4,44	1 x 3,33	2 x 6,67
25	3 x 8,33	2 x 6,25	1 x 5,56	1 x 4,17	2 x 8,33
30	3 x 10	2 x 7,5	1 x 6,67	1 x 5	2 x 10