Smart SVC Relay Instruction Manual

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WARNING: THIS INSTRUCTION MANUAL IS USED FOR RELAYS NAMED

"SMART S12" "SMART S18",

"SMART S18-T ",

"SMART SOG1", "SMART SOG5",

"SMART GES1", "SMART GES5"

Version 19-2

CONTENTS

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.

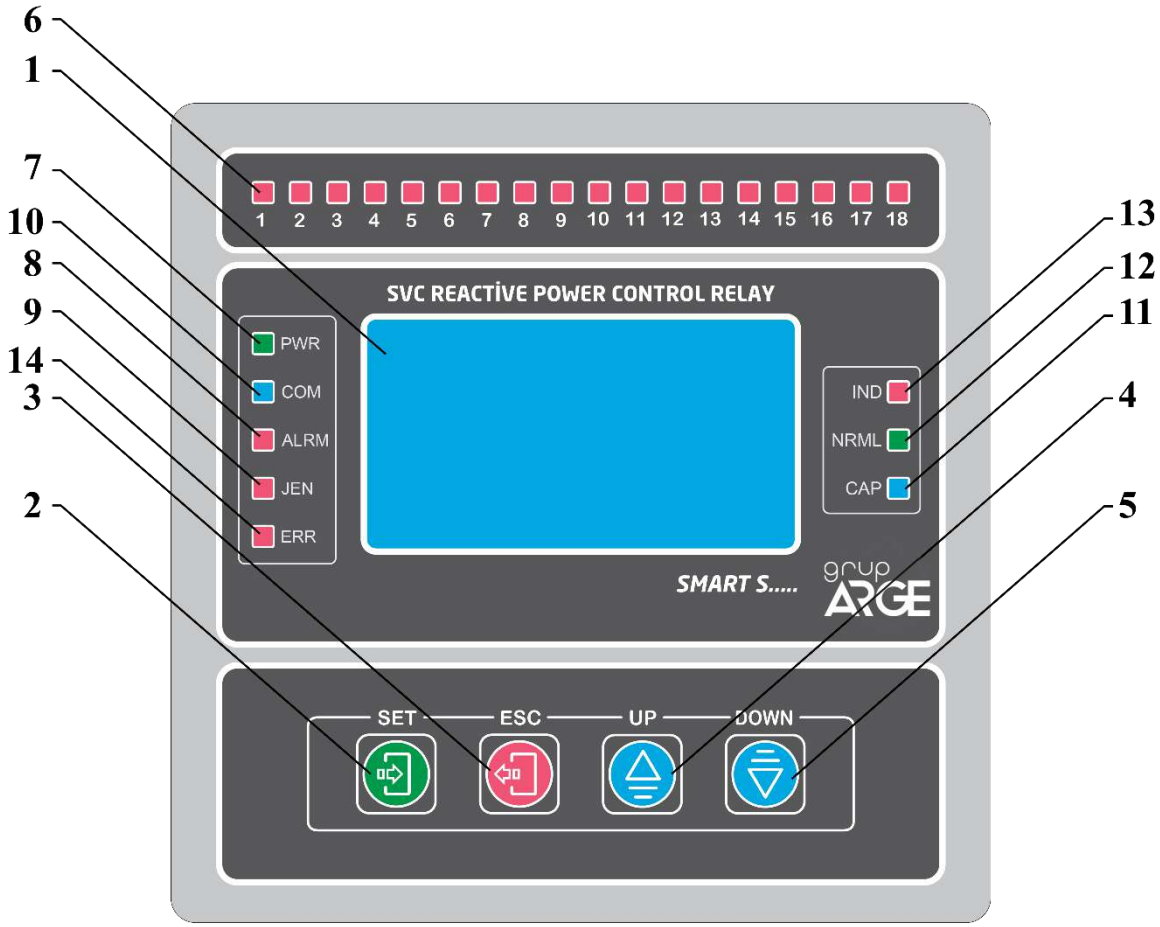
Do not dispose in the trash, the device must be delivered to the collection centers (electronic device recycling centers). It should be recycled or disposed of without harming human health and environment.

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.

Reactor Leds: Opening ratios of reactors are monitored by flashing leds. If reactors are %100 open, the led is on continuously. If it is %50 open, it is on for 0.5 sec. And off for 0.5 sec. If the leds are off, the reactors are close.

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.

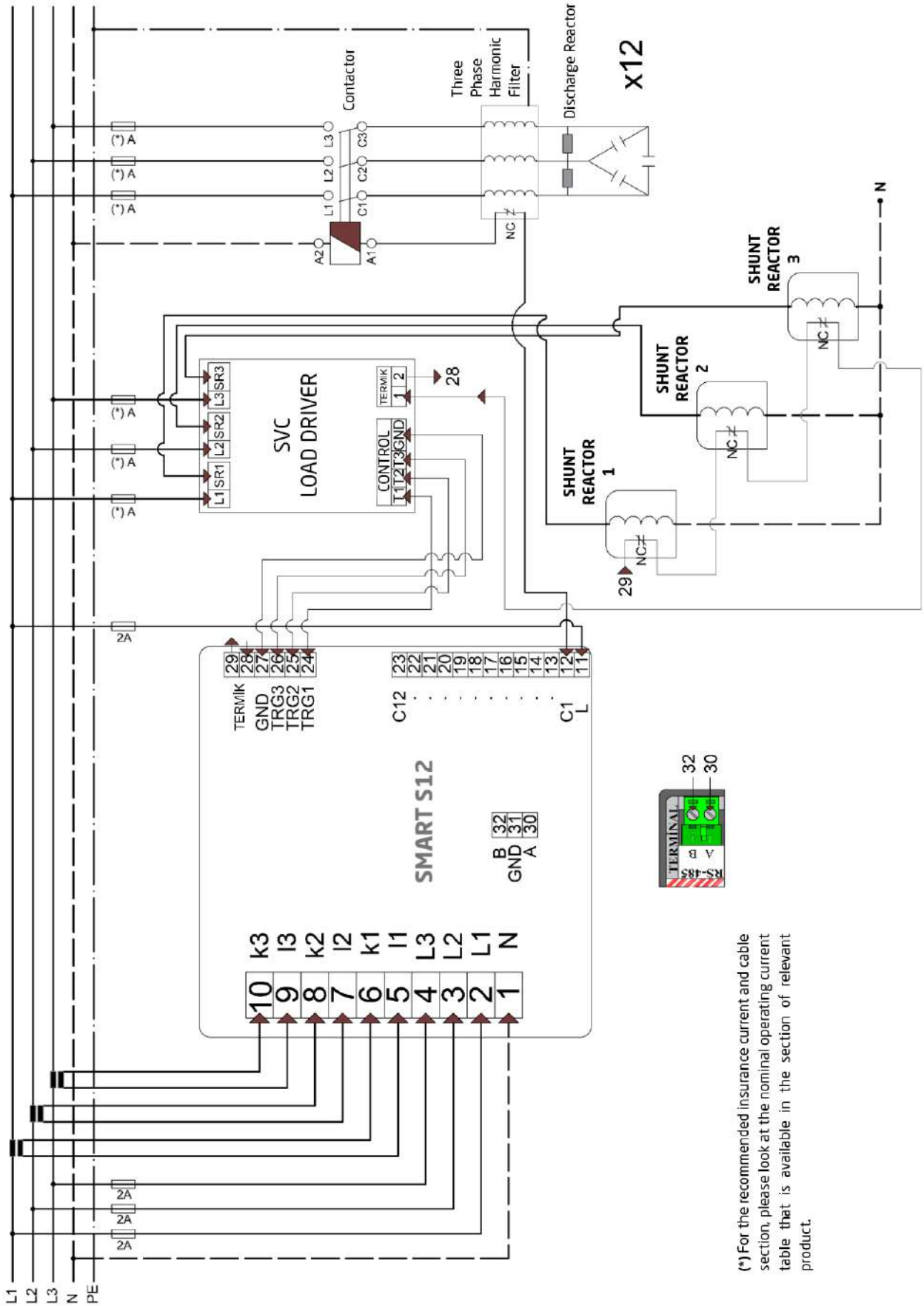
EXAMPLE: *Assume that in our system we have a cogeneration that gives capacitive load of approximately 200 kVAr and it outputs to OG line via a step- up transformer. Let our compensation to be on AG side. We can use existing ‘off set pin’ feature to report to relay that there is a 200 kVAr capacitive 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.*

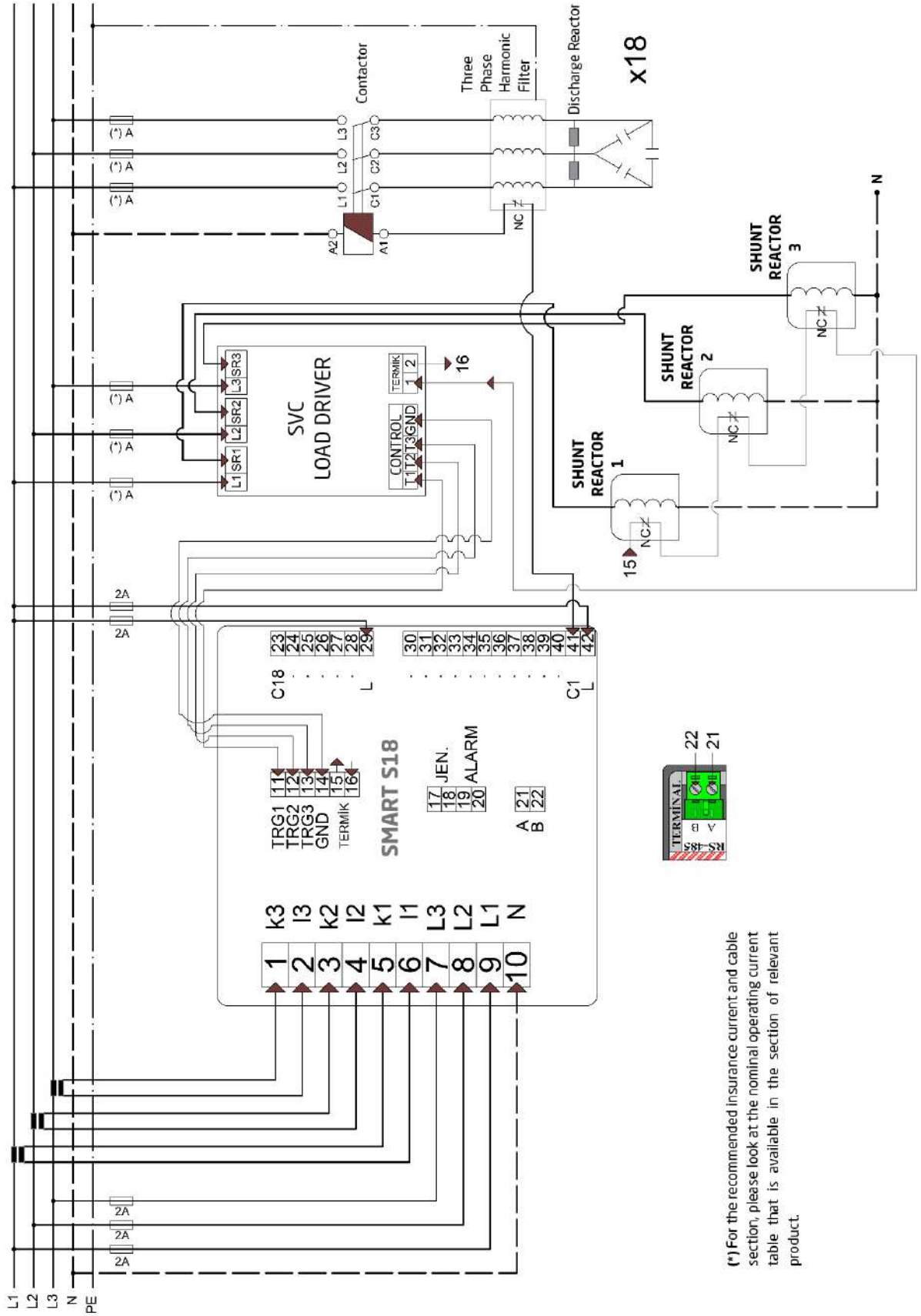
1.4 Connection Diagrams

1.4.1 SMART S12



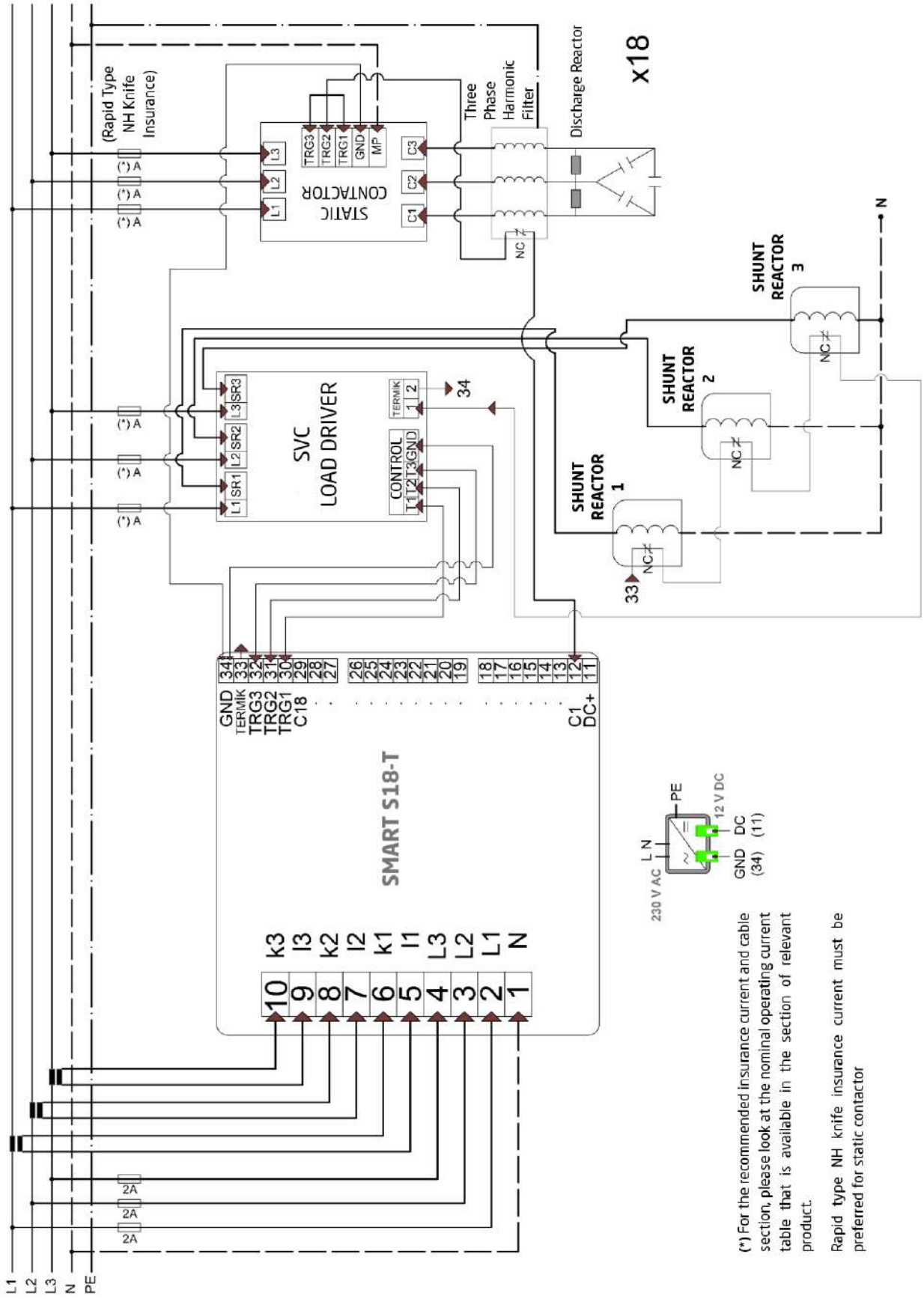
(*) For the recommended insurance current and cable section, please look at the nominal operating current table that is available in the section of relevant product.

1.4.2 SMART S18

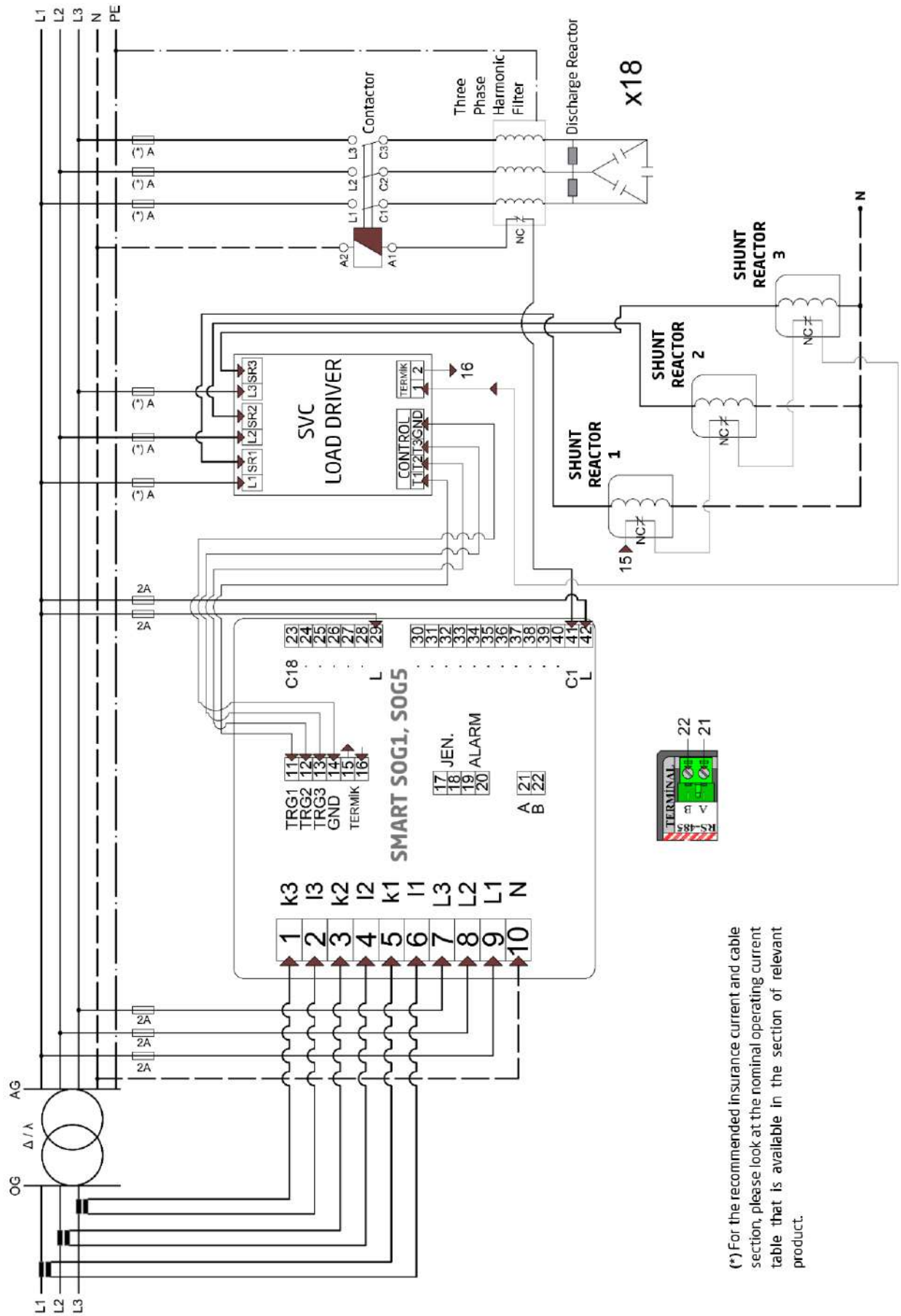


(*) For the recommended insurance current and cable section, please look at the nominal operating current table that is available in the section of relevant product.

1.4.3 SMART S18-T

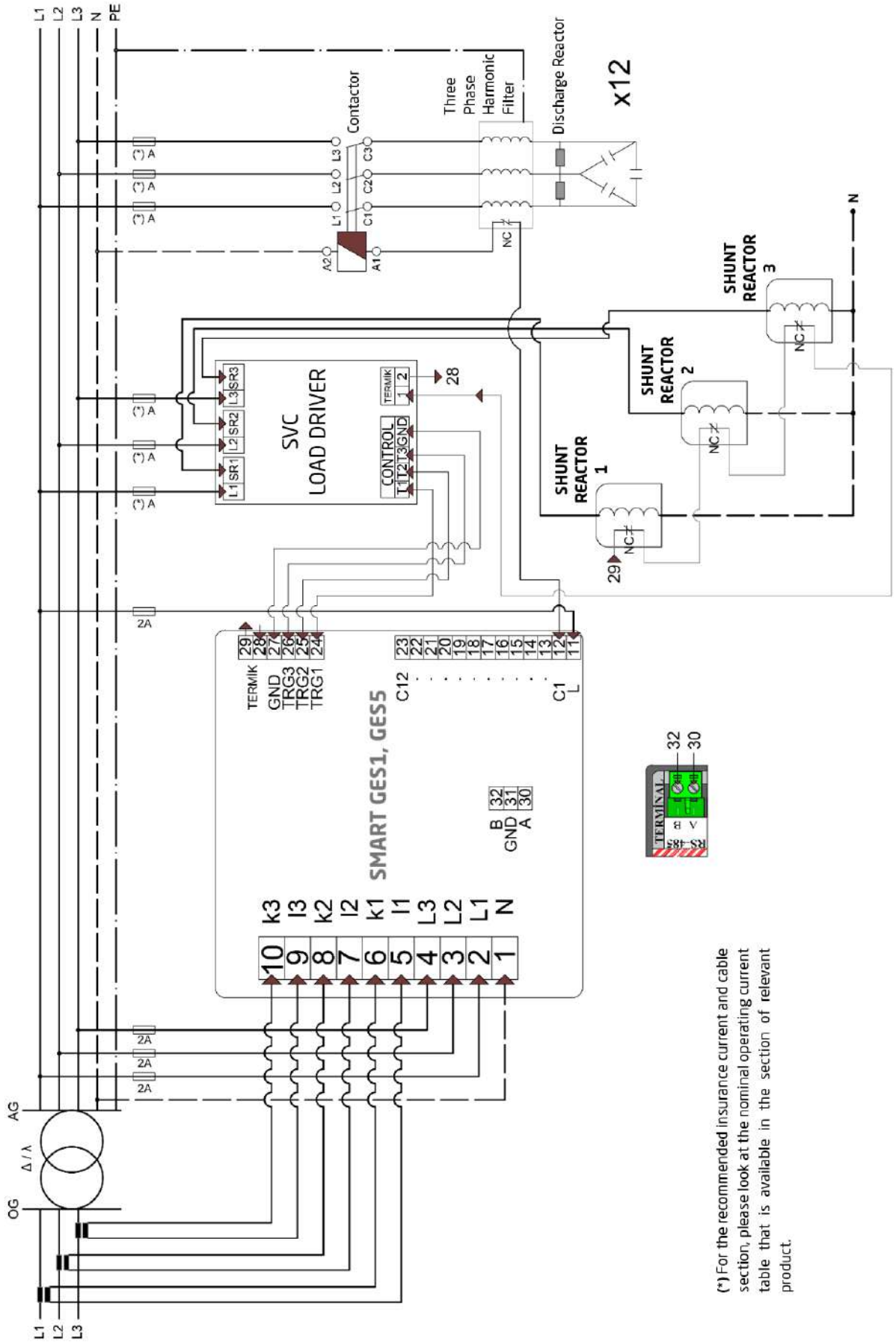


1.4.4 SMART SOG1, SOG5



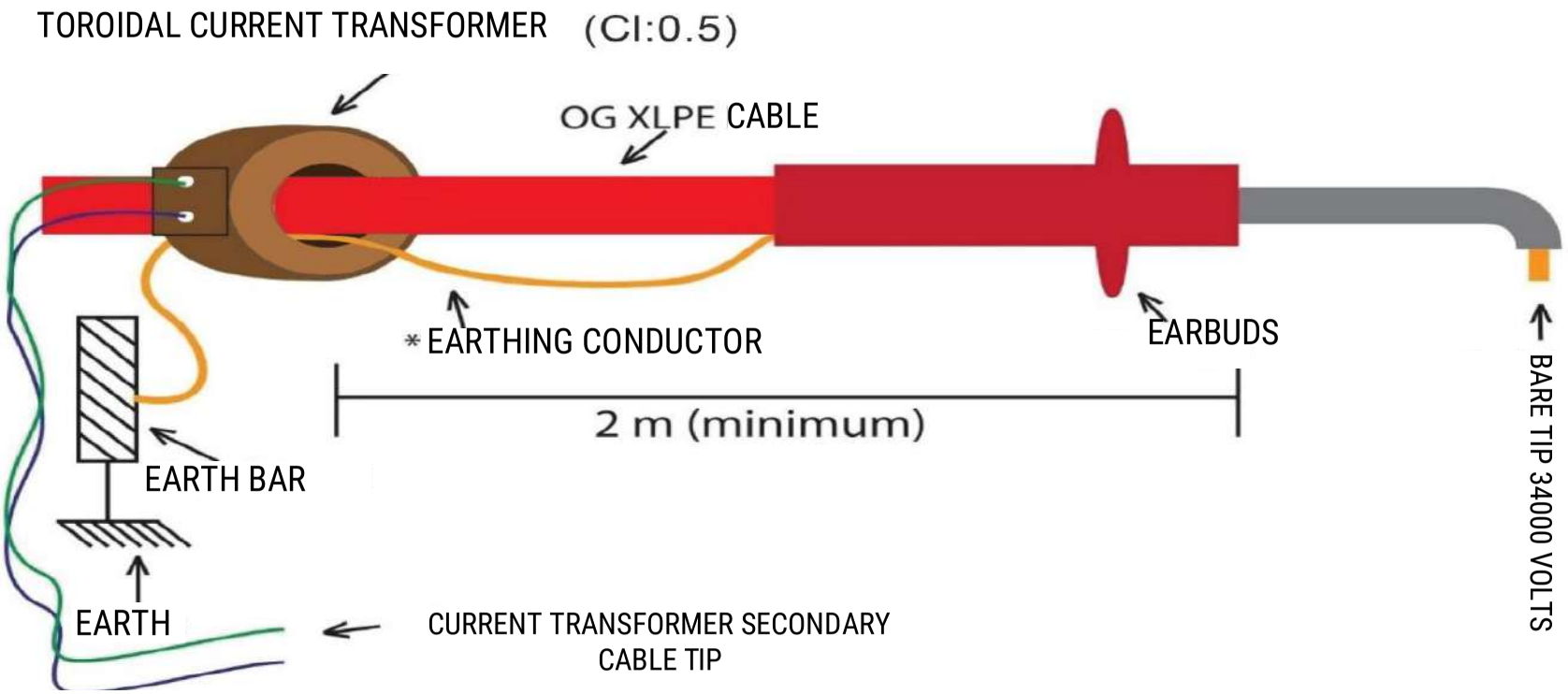
(*) For the recommended insurance current and cable section, please look at the nominal operating current table that is available in the section of relevant product.

1.4.5 SMART GES1, GES5



(*) For the recommended insurance current and cable section, please look at the nominal operating current table that is available in the section of relevant product.

1.4.6 OG Toroidal Current Transformer



Cable grounding must be done by just one tip. If grounding was done on the breaker side but not on the transformer side, reset process must be done by passing grounding conductor through toroid current transformer in opposite side like it is shown above for current measurement.

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.

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.

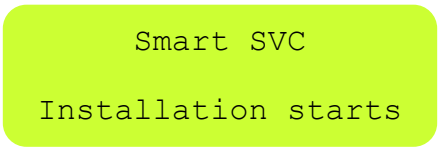


Figure 2.1

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

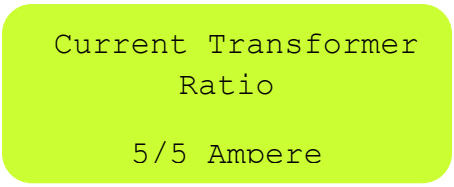


Figure 2.2

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

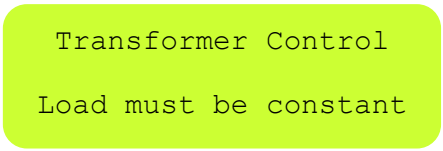


Figure 2.3

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 SVC 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.

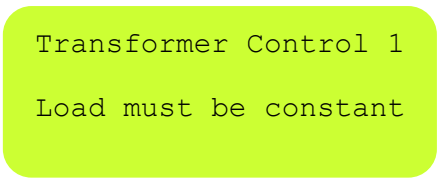


Figure 2.4

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

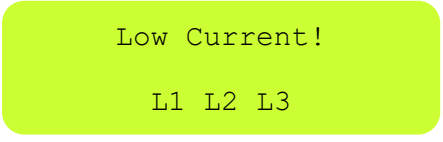


Figure 2.5

In this case SMART SVC 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.

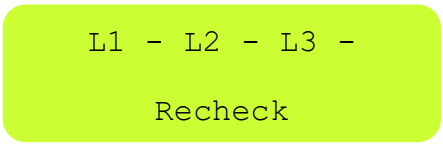


Figure 2.6

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 SVC 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.

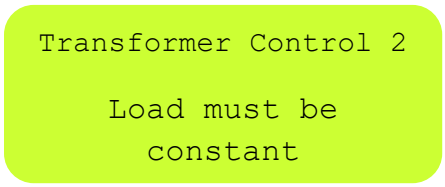


Figure 2.7

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

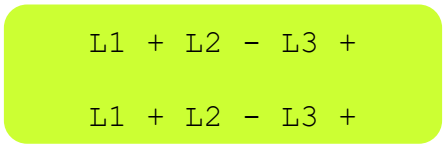


Figure 2.8

Transformer test is completed. (*Figure 2.9*).

Figure 2.9

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

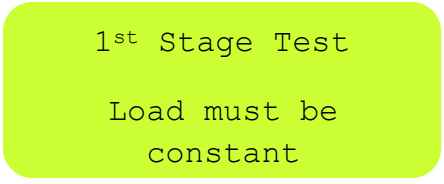


Figure 2.10

The stages are measured automatically starting from first stage and value of the stage is recorded in SMART SCV 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.

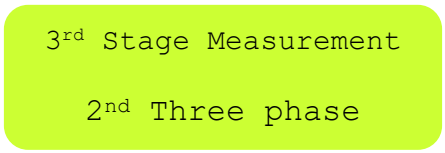


Figure 2.11

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

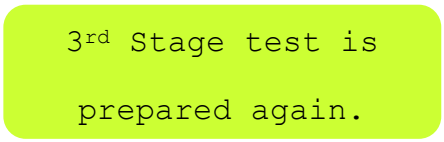


Figure 2.12

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.

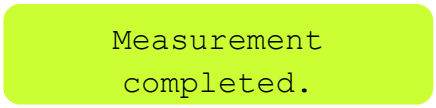


Figure 2.13

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

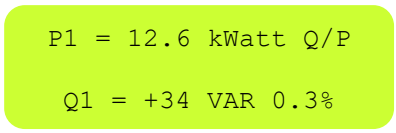


Figure 3.1

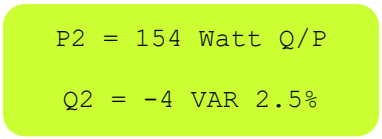


Figure 3.2

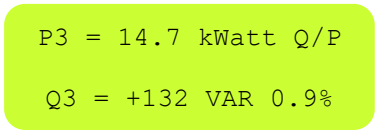
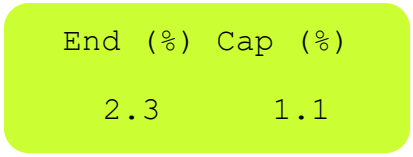


Figure 3.3

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.



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

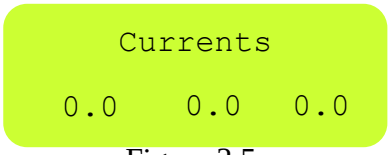


Figure 3.5

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

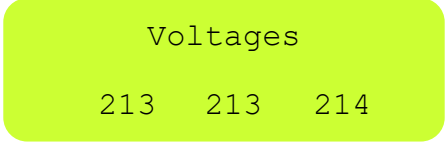


Figure 3.6

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.

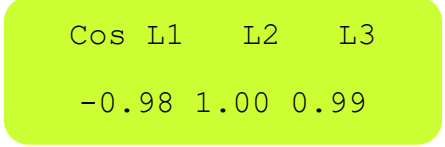


Figure 3.7

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.

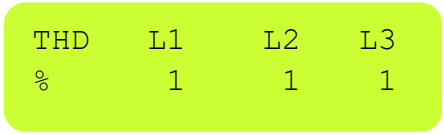


Figure 3.8

3.1.7 Phase Sequence

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

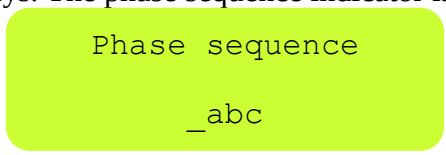


Figure 3.9

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.

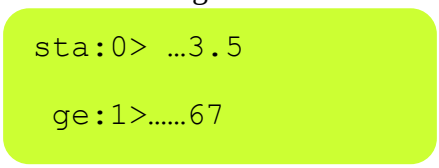


Figure 3.10

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 SVC RELAY.

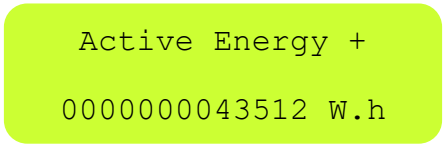


Figure 3.11

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 SVC RELAY.

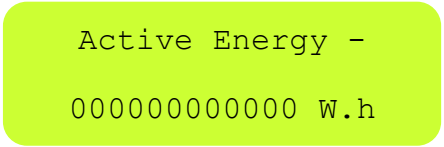


Figure 3.12

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.*

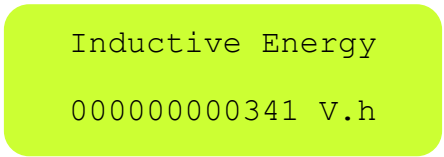


Figure 3.13

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.*

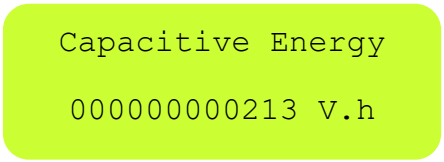


Figure 3.14

3.2 Main Menu and Sub-Menus of Smart SVC 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.

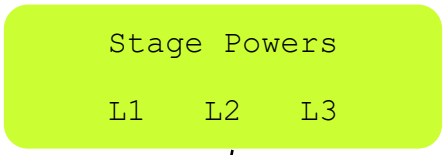


Figure 3.15

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.** In SVC featured relays, information about reactors is given in the last 3 stages. The value of the reactors connected to stage is stated as –.

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.

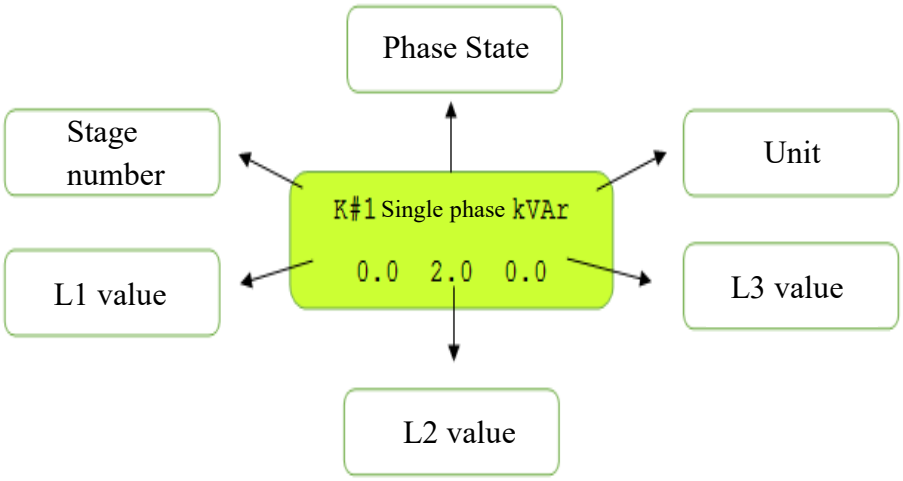


Figure 3.17

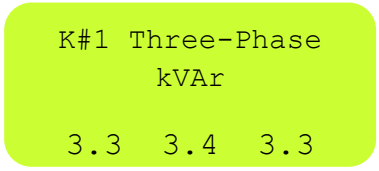


Figure 3.18

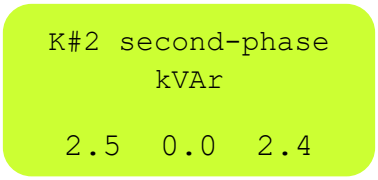


Figure 3.19

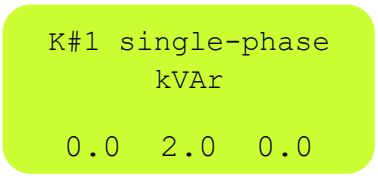


Figure 3.20

The shunt reactors that inductive load driver controls are displayed in stages 13, 14, and 15. (19, 20, 21 in 18-stage relays) For example, 13th stage is displayed like below *(Figure 3.21)*.

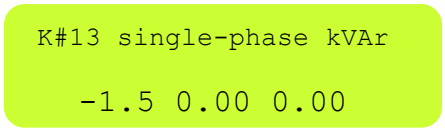


Figure 3.21

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 *3.22*)

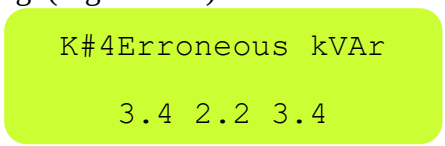


Figure 3.22

Cancellation Message

SMART SVC RELAY automatically cancels the stages that any capacitor or reactor does not connect a screen like following *(Figure 3.23)* informs user that this stage is cancelled.

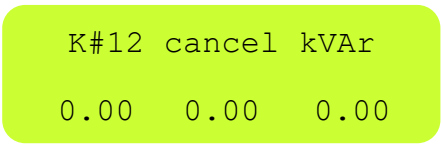


Figure 3.23

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 3.24)*. For a healthy compensation, the problem of this stage must be fixed by the user.

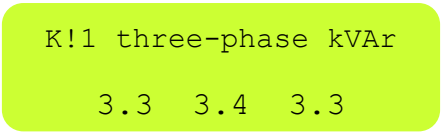


Figure 3.24

3.2.2 Stage Test

The Stage Test menu is displayed after the Stage Powers menu. *(Figure 3.25).*

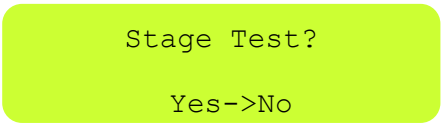


Figure 3.25

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 3.26)*

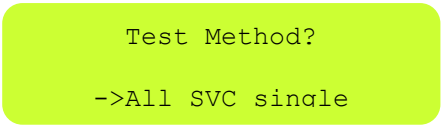


Figure 3.26

A test for all stages (1-18) with **"All"** and for shunt reactor stages that the driver controls (13-14-15 for 12-stage relays, 19-20-21 for 18-stage relays) with **"SVC"** is started. If "**Single"** option is selected, the wanted stage is selected with **UP / DOWN** from sub-menu below *(Figure 3.27)* and stage test is started.

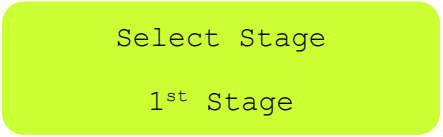


Figure 3.27

Press **SET** key to start stage test. Stage test starts after informing user with the screen below. *(Figure 3.28)*

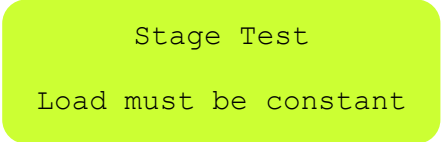


Figure 3.28

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 SVC RELAY. During measurement, the message in the *Figure 3.29* 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 3.30* is displayed.

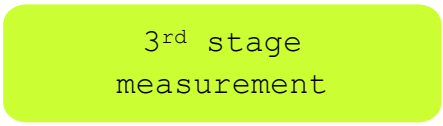


Figure 3.29

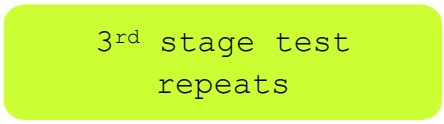


Figure 3.30

The stage test is completed with the message below *(Figure 3.31)* after all the stage measurements are done.

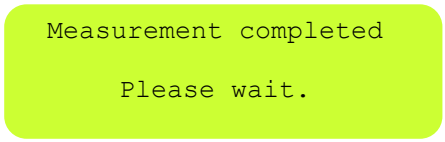


Figure 3.31

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 3.32).*

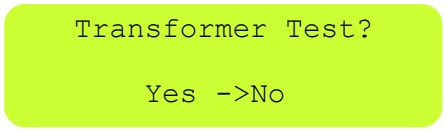


Figure 3.32

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 3.33)*

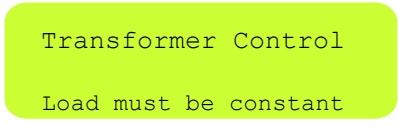


Figure 3.33

With the message in *Figure 3.34, the* device starts current transformer test by activating the first three stages.

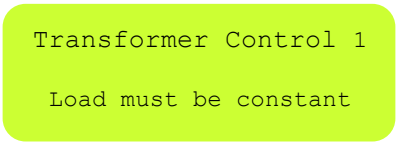


Figure 3.34

If the connections are correct, the information about completion of the first test is given to the user after the message in *Figure 3.35.*

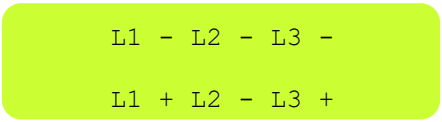


Figure 3.35

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 3.36*) will display on the screen and the current transformer test repeats for control.

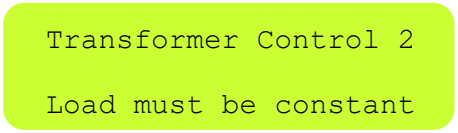


Figure 3.36

After the repeated current transformer test, the message in *Figure 3.37 informs* the user about current transformer directions and the process completed by receiving the message in *Figure 3.38.*

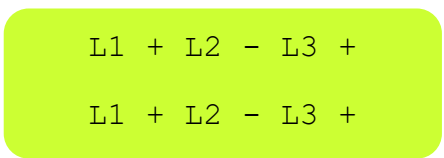


Figure 3.37

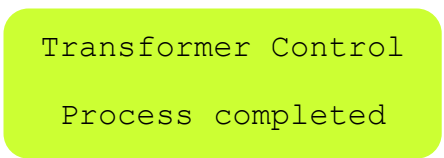


Figure 3.38

NOTE*: If SMART SVC 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

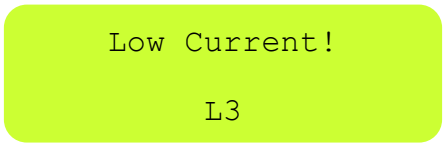


Figure 3.39

Possible causes and solutions according to *Figure 3.39:*

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

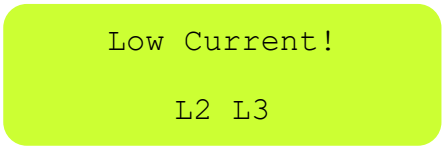


Figure 3.40

Possible causes and solutions according to *Figure 3.40:*

- 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.

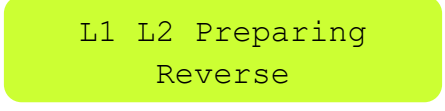


Figure 3.41

Possible causes and solutions according to *Figure 3.41:*

- 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.

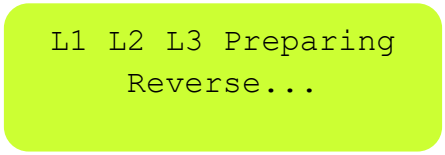


Figure 3.42

Possible causes and solutions according to *Figure 3.42:*

- 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.

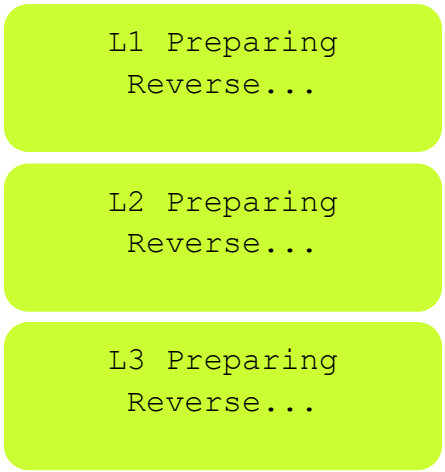


Figure 3.43

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 *3.44*) menu.

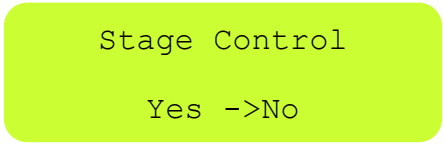


Figure 3.44

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 3.45)*

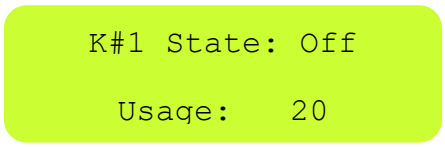


Figure 3.45

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 3.46), the state of the selected stage can be changed manually.

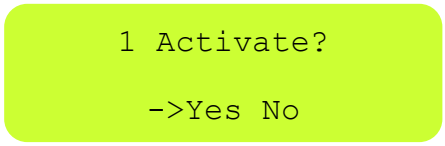


Figure 3.46

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

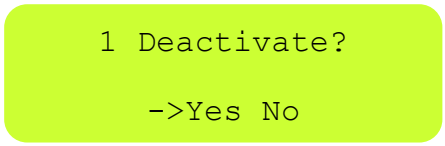


Figure 3.47

If the stage is activated, the user is directed with the screen in Figure 3.47 when pressed **SET** key.

NOTE**:** *The user can control manually the relevant stage via SMART SVC 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 SVC 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 SVC 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 SVC 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.

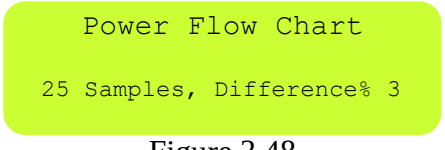


Figure 3.48

The power flow chart firstly gives information to the user with the screen above. In the screen above *(Figure 3.48)*, it is stated that there are 25 samples and the difference between the samples is 3%. This message disappears after 2-3 seconds.

SMART SVC 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.

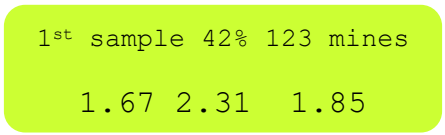


Figure 3.49

The positive values in the second row of power sample screen *(Figure 3.49)* 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 3.50).*

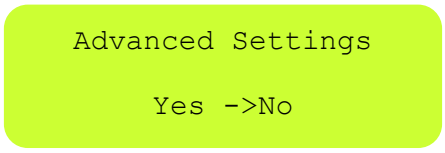


Figure 3.50

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 *3.51*

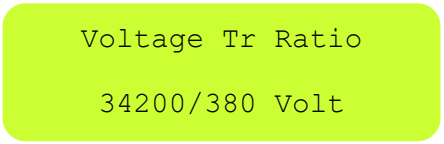
Figure 3.51

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 3.52. 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)



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.

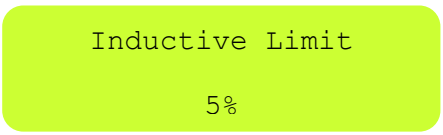


Figure 3.53

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.

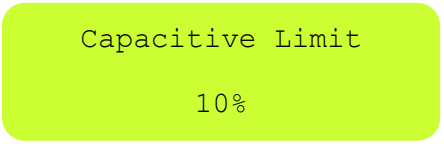


Figure 3.54

LC Offset

It exists in all the 18-stage relays. The message screen is seen in Figure *3.55. It is used to synchronize the meter and relay in very low load-loaded systems.*

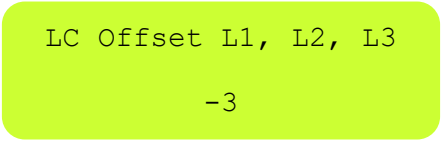


Figure 3.55

Reactive Response Time

The reactive response time message screen is like in *Figure 3.56*.

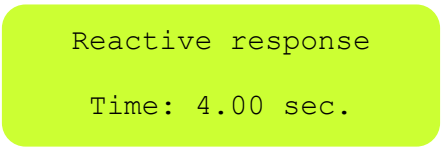


Figure 3.56

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 SVC RELAY calculated, can response after limit value is exceeded. As this time shortens, the response time of SMART SVC 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.*

SVC Response Time

The SVC response time message screen is like in *Figure 3.57*. This menu exists only in the relays with SVC system.

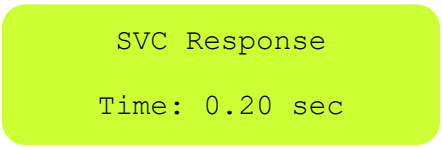


Figure 3.57

Normal Response Time

The normal response time message screen is like in *Figure 3.58*. This menu exists only in relays with SVC system.

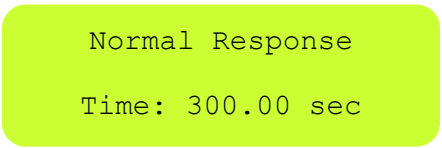


Figure 3.58

This value can be set with **UP / DOWN** keys. The value is confirmed with **SET** key and proceeds to the next menu. The normal response time is the parameter that determines how much time later the new found solution can be applied to the system when the reactive ratios that SMART SVC RELAY calculated are under the limit value. As this time shortens, SMART SCV RELAY will get more dynamic. It is not recommended to shorten this time unless it is necessary!

NOTE**:** *The factory output time for this parameter is 300 sec.*

Capacitor Discharge Time

The capacitor discharge time message screen is like in *Figure 3.59.*

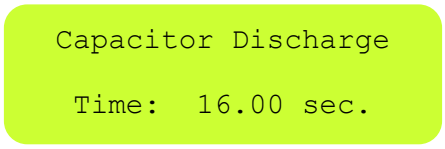


Figure 3.59

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. (*Figure3.60).*

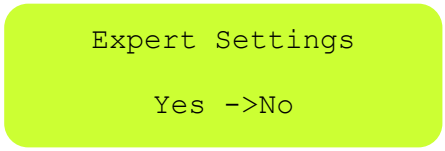


Figure 3.60

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.

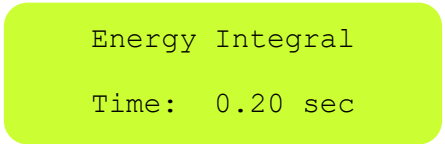


Figure 3.61

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.

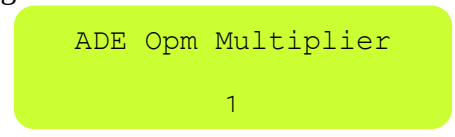


Figure 3.62

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.

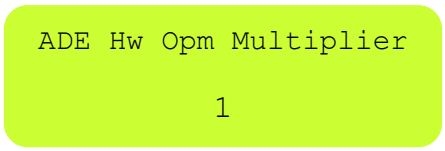


Figure 3.63

Modbus Address

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

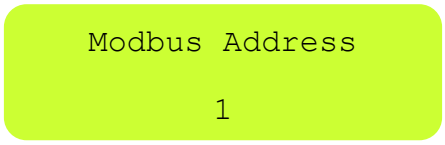


Figure 3.64

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.

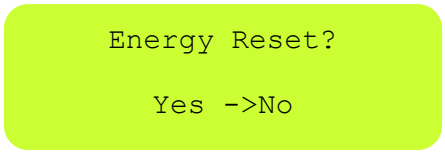


Figure 3.65

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.

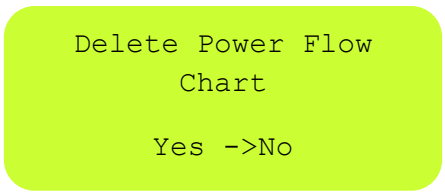


Figure 3.66

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.

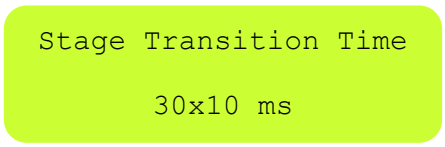


Figure 3.67

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.*

LC Max Opening (L1, L2, L3)

What percentage of the activated bobbin will be used is set with this menu. The user set this value according to the bobbin to be used. It exists in all relays with SVC feature.

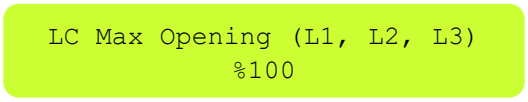


Figure 3.68

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

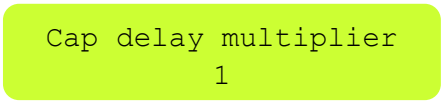


Figure 3.69

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

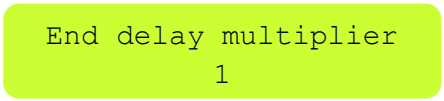


Figure 3.70

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 SVC 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.

Figure 3.71

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'.

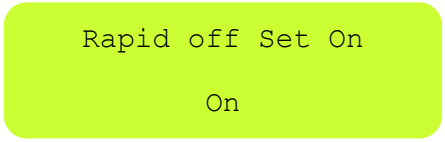


Figure 3.72

Off Set Output

If you want “Off Set” stage to give input when this feature is activated, you should make it ‘on’.

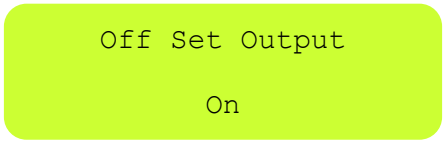


Figure 3.73

Off Set Enter

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

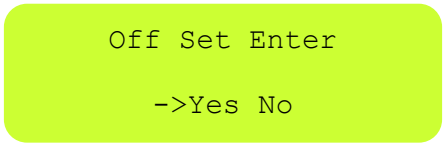


Figure 3.74

Off Set Reactive

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

Figure 3.75

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.

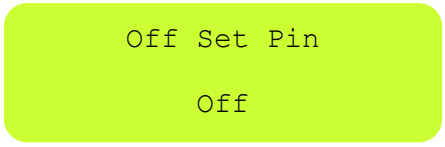


Figure 3.76

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.*

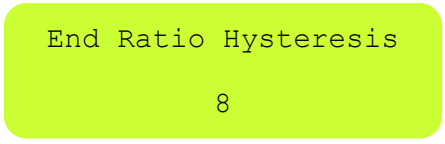


Figure 3.77

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%.*

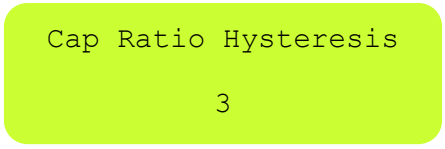


Figure 3.78

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.

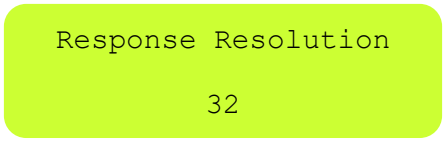


Figure 3.79

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.

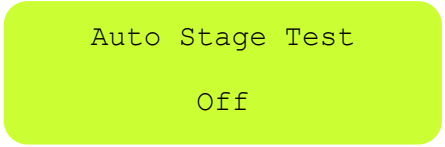


Figure 3.80

LC Protection Multiplier

If the power that is demanded from SVC by the system is bigger than reactor power multiplier, the SVC becomes ‘off’ to protect reactors. This multiplier can be set as 1/2, 2/2, 3/2, 4/2, 5/2, 6/2, 7/2, 8/2. If you want to deactivate the feature, make LC Protection Multiplier ‘off’.

EXAMPLE: *Suppose that our reactor is 3 kVAr, LC Protection multiplier is 3/2, if the system demands more than 3 x 3 / 2= 4.5 kVAr from the SVC, the SVC is switched off.*

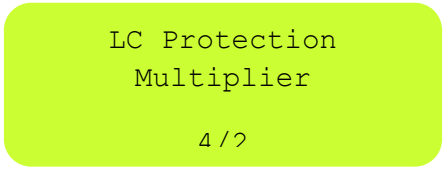


Figure 3.81

LC Protection Ratio

If the power demanded from SVC is less than the multiplier of active power drawn from the system, SVC becomes 'off' for not to deactivate reactors unnecessarily. This multiplier is set between 1 and 50. If the feature is not wanted, it is switched off.

EXAMPLE: *Suppose that the power demanded from SVC is 3 kVAr, multiplier is 20 and the power drawn from the system is 160 kW. Since SVS's off limit is 3x20=60 kW, SVC will be disabled in our system (for 160 kW) since SVC will be off for larger values of active power.*

Figure 3.82

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.

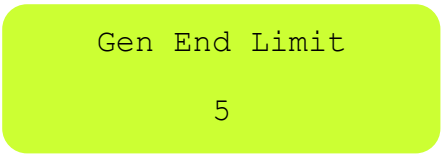


Figure 3.83

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.

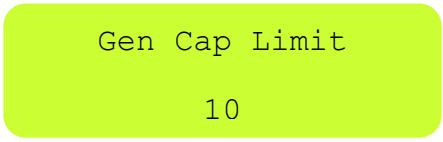


Figure3.84

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.

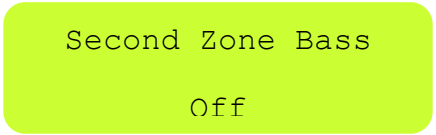


Figure 3.85

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.*

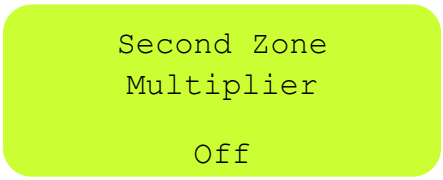


Figure 3.86

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.

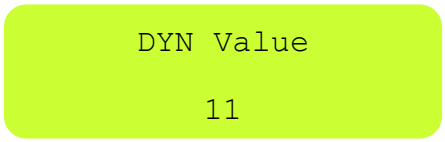


Figure 3.87

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’.

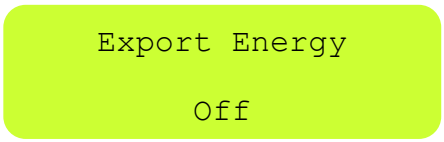


Figure 3.88

In Expr Comp Off

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

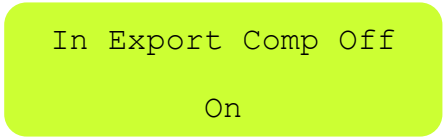


Figure 3.89

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.

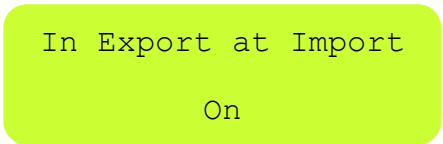


Figure 3.90

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.

Slayt On

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

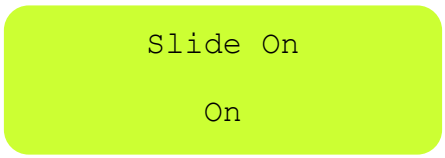


Figure 3.92

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.

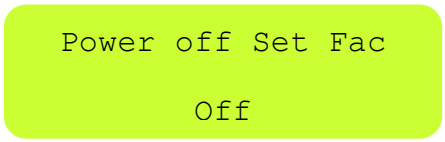


Figure 3.93

AC Off Set Fac L1, L2, L3

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

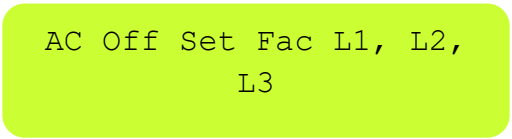


Figure 3.94

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.

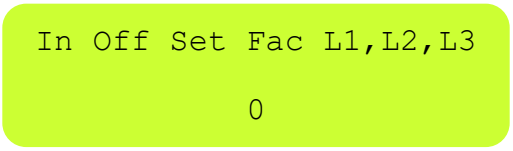


Figure 3.95

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.

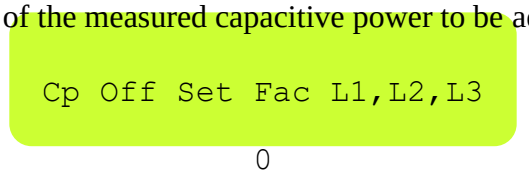


Figure 3.96

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.

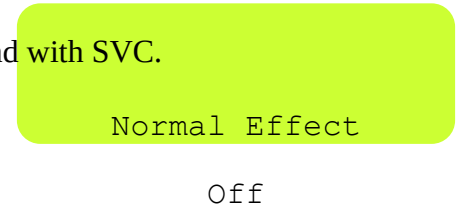


Figure3.97

Ignore Mode

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

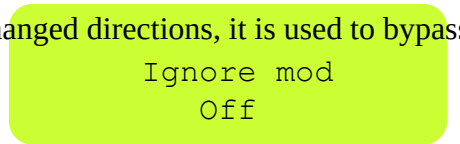


Figure 3.98

LC Force Fac

It used to direct the system to capacitive or move away from capacitive.

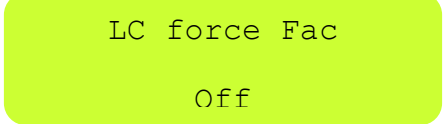


Figure 3.99

Auto Transformer Control

In the case of current direction change, it enables to start current transformer test automatically.

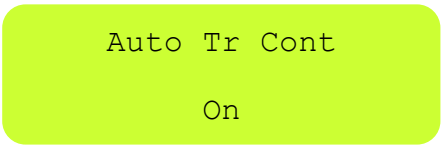


Figure 3.100

LC Add Fac

It is used to optimize the use of SVC and capacitor to ensure stability in unbalanced systems.

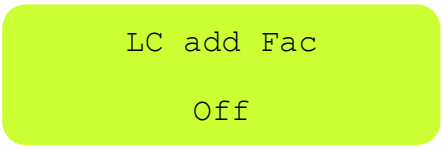


Figure 3.101

Oto Opm Mode

It automatically activates opamps in small currents to increase resolution.

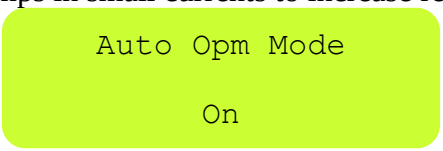


Figure 3.102

Sec Opm Mode

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

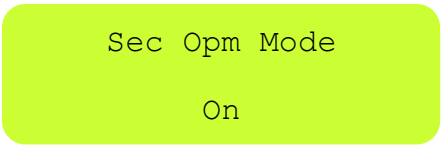


Figure 3.103

Adv Comp Mode

It activates advanced compensation mode.

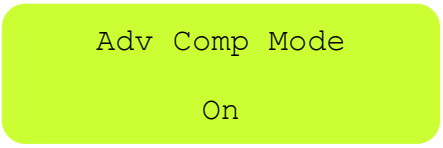


Figure 3.104

Prll Comp Mode

It enables two relays to work parallel.

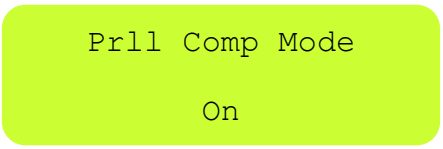


Figure 3.105

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.

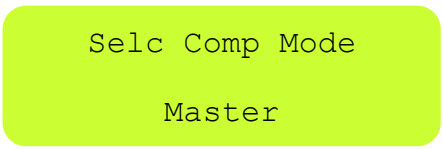


Figure 3.106

Ade Reset On

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

Figure 3.107

Back Light

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

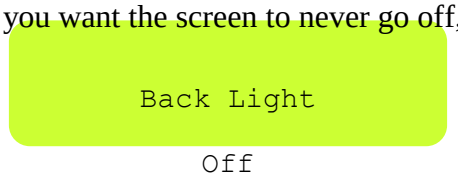


Figure 3.108

Default Values

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

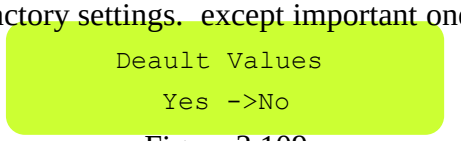
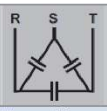
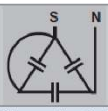
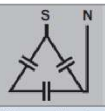


Figure 3.109

4. 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


grup
ARGE