**43. Test of 3-phase systems**

43. Laboratory tests.

 Diagram of the measuring system for tests of the 3-phase system is presented in Fig. 43.20.

 

**Figure 43.20.** Diagram of the measuring system for tests of the 3-phase system

 Marks:

 V1f, V2f, V3f, VN – digital voltmeter

 A1f, A2f, A3f, AN – digital ammeters

 W, W1, W2, W3,N – circuit breakers

 ZA, ZB, ZC – phase impedances of 3-phase receiver

 Tr – 3-phase transformer to decreased the voltage value

MPS – Measuring Parameters System

(line voltages measurement: V12, V13, V23

line currents measurement: A1, A2, A3)

**Note:** The values of the phase currents **should not exceed 1 A** due to technical limits resulted of used slide resistors.

**43.2.1** Determination of the phase sequence for supply grid

To determine the phase sequence of L1, L2, L3 connect the equivalent phase sequence indicator (the capacitor connect to phase L1).

**43.2.2** Test of the receiver connected in the star.

 Between pair of terminal A1 – A2, B1 – B2, C1 – C2 connect phases of receiver ZA, ZB, ZC according to the Fig. 43.21.



**Figure 43.21.** Receivers in 3-phase system

 Labels: R1, R2, R3 – slide resistors,

 B1, B2, B3 – signaling bulbs.

 Slide resistors are used as the receiver in the laboratory tests, coupled in parallel with the lighting bulbs. Resistors allow for smooth adjustment of the rms value of the phase currents. Such receivers ZA, ZB, ZC have resistance character.

The receivers have to be connected in the star in the systems (Fig. 43.21), short points A3, B3 and C3 with each other, or by connecting these points with the point N of the receiver (4- wire system).

Measurements shall be performed for all currents, voltages and power in the following cases:

1. **4-wire symmetrical** system (Switch on: W1,W2,W3,WN and W)

Set resistors to obtain same values of phase currents.

2) **4-wire** system **with a break in one phase**.

Open the switch in the selected phase wire

e.g. W1. (Switch on: W2, W3, WN and W)

3) **3-wire symmetrical** system. Switch on W1.

Open the switch WN. (Switch on: W1,W2,W3 and W)

4) **3-wire** system **with a break in one phase**.

Open the switch in the selected phase line

e.g. W1. (Switch on: W2,W3 and W)

5) **3-wire** system **with short circuit in one phase**.

Open the switches: W, W1,W2,W3. Using wire short selected receiver.

e.g. A1 with A2. Make sure that the switch WN is not closed. Power on. (Switch on: W1,W2,W3 andi W)).

The results of the measurements note in table 1a and 1b.

Line values of currents and voltages read from the Measuring Parameters System (MPS), and voltmeter VN and ammeter AN.

The phase values of the current and voltage of the receiver read from voltmeters V1f , V2f , V3f and ammeters A1f , A2f , A3f .

The power values retrieved by the receivers are read from Measuring Parameters System (MPS)**Table 1a.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | U12 | U23 | U31 | UN | I1 | I2 | I3 | IN |
| [V] | [V] | [V] | [V] | [A] | [A] | [A] | [A] |
| 1. |  |  |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |  |  |
| 3. |  |  |  |  |  |  |  |  |
| 4. |  |  |  |  |  |  |  |  |
| 5. |  |  |  |  |  |  |  |  |

Line parameters

**Table 1b.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | U1P | U2P | U3P | I1P | I2P | I3f | P1P | P2P | P3P |
| [V] | [V] | [V] | [A] | [A] | [A] | [W] | [W] | [W] |
| 1. |  |  |  |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |  |  |  |
| 3. |  |  |  |  |  |  |  |  |  |
| 4. |  |  |  |  |  |  |  |  |  |
| 5. |  |  |  |  |  |  |  |  |  |

Phase parameters

Based on obtained results:

1. desrcibe the relationship between the phase and line voltages of the symmetrical system,
2. calculate the impedance of load of each phase,

using the following formulas:

 $Z\_{P}=\frac{U\_{P}}{I\_{P}}$ , $φ\_{P}=arccos\frac{P\_{P}}{U\_{P}×I\_{P}}$ , (43.36)

where:

*PP - measured power values, or values calculated from the formula:* $P\_{P}=U\_{P}×I\_{P}$

*for load with resistance character* (cosϕ= 1)*,*

*UP -indication of the voltmeter measuring voltage at the load of the selected phase,*

*IP -indication of the ammeter measuring current of the selected load phase,*

*ZP -module of the total load impedance of the selected phase,*

*P -the angle between the voltage and current indication of the selected phase.*

1. draw phasors diagrams of voltages and currents for the measuring points selected by the teacher.

Results of the calculation note in table 2 and provide example calculations.

**Table 2.**

A summary of the calculation results for the receiver connected in the star.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  Z A  |  A |  Z B |  B |  ZC |  C |
| [] | [ ] | [] | [ ] | [] | [ ] |
| 1. |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |
| 3. |  |  |  |  |  |  |
| 4. |  |  |  |  |  |  |
| 5. |  |  |  |  |  |  |

**43.2.3** Test of the receiver connected in the delta .

The receivers have to be connected in the delta in the systems (Fig. 43.21) by short the corresponding points. Since there may be two possibilities to connect to the delta - you need to note which points were connected (e.g. ammeter A1f can measure current I12 or I13). For proper operation of the MPS meter, it is necessary to switch of WN.

Measurements shall be performed for all currents, voltages and power in the following cases:

1. **3-wire symmetrical** system.

Set the same values for the phase currents. (Switch on: W1,W2,W3 and W)

1. **3-wire** system **with break in one phase**. Open the switch in the selected phase line e.g. W1. (Switch on: W2,W3 and W)

The results of the measurements note in table 3a and 3b:

**Table 3a.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | U12 | U23 | U31 | I1 | I2 | I3 |
| [V] | [V] | [V] | [A] | [A] | [A] |
| 1. |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |

Line parameters

**Table 3b.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | U1P | U2P | U3P | I1P | I2P | I3f | P1P | P2P | P3P |
| [V] | [V] | [V] | [A] | [A] | [A] | [W] | [W] | [W] |
| 1. |  |  |  |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  | - | - | - |

Phase parameters

Based on obtained results:

1. verify the theoretical relationship between the rms phase and line voltages, currents values of the receiver connected to the delta,
2. calculated on the basis of the indications of voltmeters and ammeter the total load impedance of each phase (according to 43.36),
3. draw phasors diagrams of voltages and currents for the measuring points selected by the teacher.

Results of the calculation note in table 4, and provide example calculations:

**Table 4**

Summary of calculation results for the receiver connected to the delta.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  Z A  |  A |  Z B |  B |  ZC |  C |
| [] | [ ] | [] | [ ] | [] | [ ] |
| 1. |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |