LAB 1&2

Single-Phase Transformer

Three-Phase Transformer

SECTION NUMBER : …….

GROUP NUMBER : …….

GROUP MEMBERS : …….

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Unit 1: Single Phase Transformer

1.a. Open-Circuit Test

After completing this exercise, you should be able to demonstrate the open-circuit test and determine the iron loss of a single-phase transformer.

EQUIPMENT REQUIRED

Qty	Description	Cat. No.
1	Three-phase Power Supply Module	EM-3310-1B
1	3Φ AC/DC Power Supply	EM-3310-1D
1	Three-pole Current Limit Protection Switch Module	EM-3310-2A
1	Digital ACA Meter	EM-3310-3C
1	Digital ACV Meter	EM-3310-3D
1	Fuse Set	EM-3310-5B
1	Single-phase Transformer	EM-3340-1A
1	Laboratory Table	EM-3380-1A
1	Experimental Frame	EM-3380-2B
	or Experimental Frame	EM-3380-2A
1	Connecting Leads Holder	EM-3390-1A
1	Connecting Leads Set	EM-3390-3A
1	Safety Bridging Plugs Set	EM-3390-4A

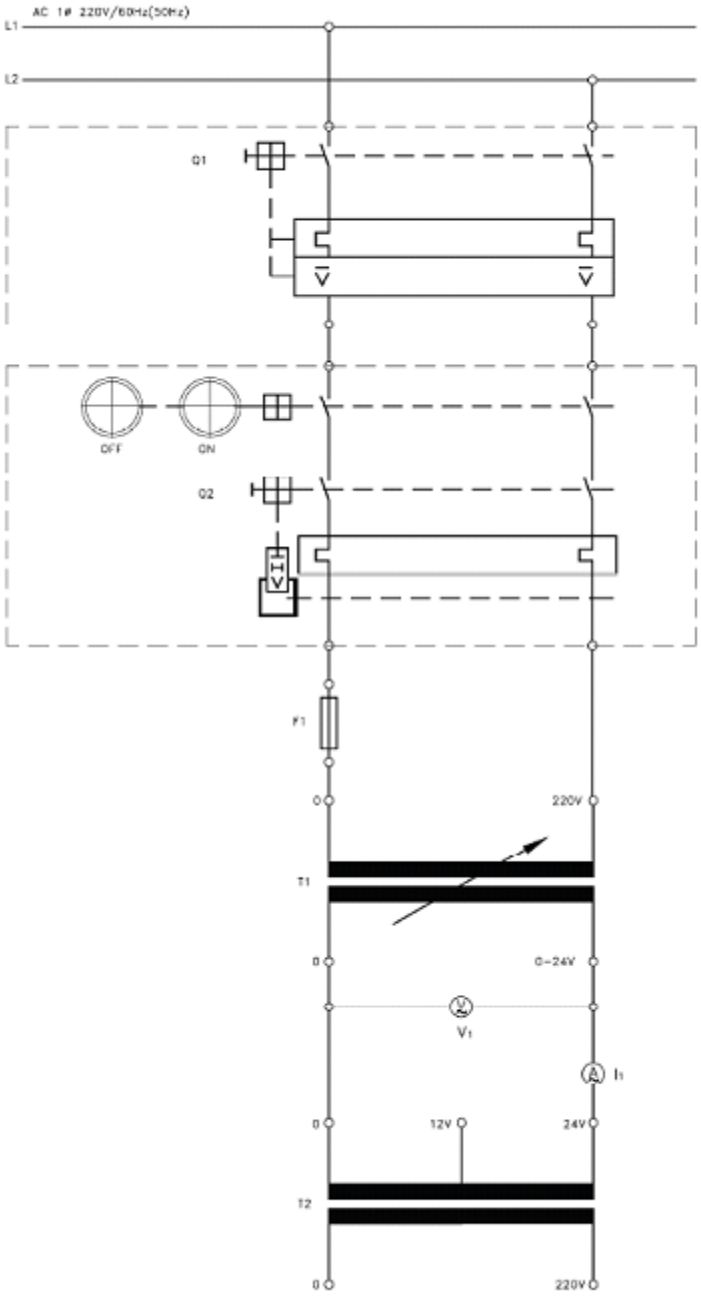

Fig. 1. Circuit diagram for polarity and turns ratio tests

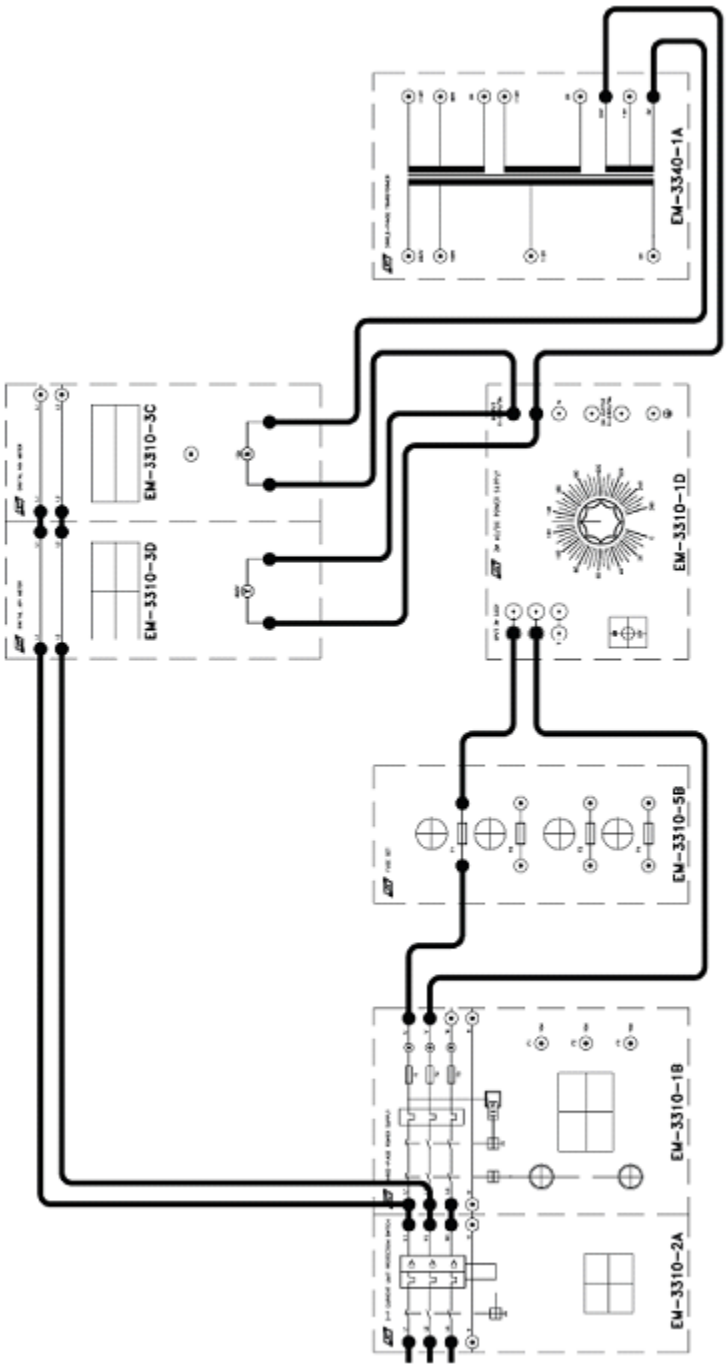

Fig. 2. Connection Diagram for Open-Circuit Test

PROCEDURE

CAUTION: High voltages are present in this laboratory exercise! Do not make or modify any connections with the power on unless otherwise specified! If any danger occurs, immediately press the red EMERGENCY OFF button on the Three-phase Power Supply Module.

1. Place the 3Φ AC/DC Power Supply on the Laboratory Table. Install the required Modules in the Experimental Frame.

2. Construct the circuit in accordance with the circuit diagram in Fig. 1-2-1 and the connection diagram in Fig. 1-2-2. On the 3Φ AC/DC Power Supply, set the voltage control knob to the 0 position.

3. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power Supply Modules.

4. Turn on the 3Φ AC/DC Power Supply. Slowly turn the voltage control knob clockwise so that the primary voltage V_1 is equal to 24 Vac.

5. Record the values of winding voltage V_1 (obtained from the Digital ACV Meter) and winding current I_1 (obtained from the Digital ACA Meter) in Table 1-2-1.

Table 1-2-1 Measured voltage and current values

V_1	I_1

6. Sequentially turn off the 3Φ AC/DC Power Supply, Three-phase Power Supply, and 3-P Current Limit Protection Switch Modules.

7. Calculate iron loss by using the equation:

Iron Loss = 0.4 x V_1 x I_1 = _____

1.b. Short-Circuit Test

OBJECTIVE

After completing this exercise, you should be able to demonstrate the short-circuit test and determine the copper loss of a single-phase transformer.

EQUIPMENT REQUIRED

Qty	Description	Cat. No.
1	Three-phase Power Supply Module	EM-3310-1B
1	3Φ AC/DC Power Supply	EM-3310-1D
1	Three-pole Current Limit Protection Switch Module	EM-3310-2A
2	Digital ACA Meter	EM-3310-3C
1	Digital ACV Meter	EM-3310-3D
1	Fuse Set	EM-3310-5B
1	Single-phase Transformer	EM-3340-1A
1	Laboratory Table	EM-3380-1A
1	Experimental Frame	EM-3380-2B
	or Experimental Frame	EM-3380-2A
1	Connecting Leads Holder	EM-3390-1A
1	Connecting Leads Set	EM-3390-3A
1	Safety Bridging Plugs Set	EM-3390-4A

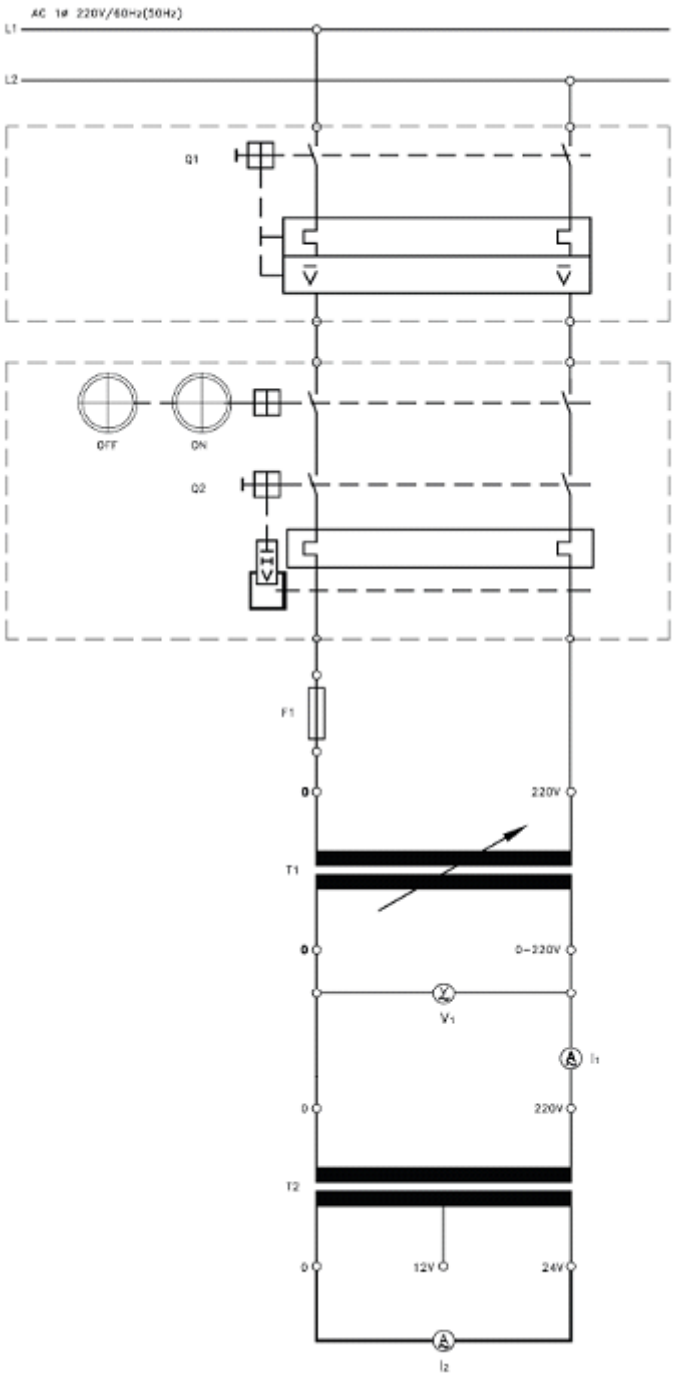

Fig. 3. Circuit diagram for short-circuit test

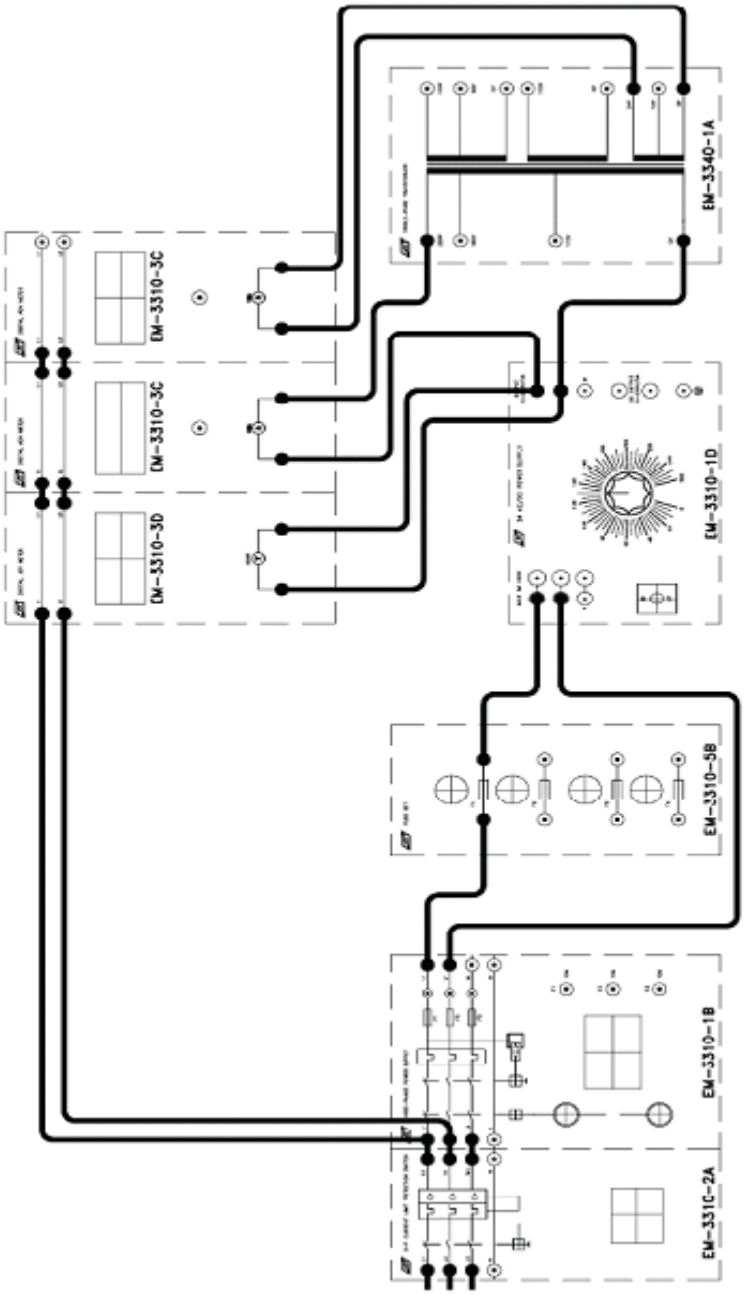

Fig. 4. Connection diagram for short-circuit test

PROCEDURE

CAUTION: High voltages are present in this laboratory exercise! Do not make or modify any connections with the power on unless otherwise specified! If any danger occurs, immediately press the red EMERGENCY OFF button on the Three-phase Power Supply Module.

1. Place the 3Φ AC/DC Power Supply on the Laboratory Table. Install the required Modules in the Experimental Frame.

2. Construct the circuit in accordance with the circuit diagram in Fig. 1-3-1 and the connection diagram in Fig. 1-3-2. On the 3Φ AC/DC Power Supply, set the voltage control knob to the 0 position.

3. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power Supply Modules.

4. Turn on the 3Φ AC/DC Power Supply. Slowly turn the voltage control knob clockwise so that the secondary current I_2 is equal to the rated current of 5 A.

5. Record the values of primary voltage V_1, primary current I_1, and secondary current I_2 in Table 1-3-1.

Table 1-3-1 Measured voltage and current values

V_1	I_1	I_2

6. Sequentially turn off the 3Φ AC/DC Power Supply, Three-phase Power Supply, and 3-P Current Limit Protection Switch Modules.

7. Calculate copper loss by using the equation:

Copper Loss = V_1 x I_1 = _____

2.a. Load Characteristics

OBJECTIVE

After completing this exercise, you should be able to demonstrate the characteristics of a single-phase transformer under resistive, inductive and capacitive loads.

EQUIPMENT REQUIRED

Qty	Description	Cat. No.
1	Three-phase Power Supply Module	EM-3310-1B
1	Three-pole Current Limit Protection Switch Module	EM-3310-2A
1	Resistive Load Module	EM-3310-4R
1	Inductive Load Module	EM-3310-4L
1	Capacitive Load Module	EM-3310-4C
1	Digital ACA Meter	EM-3310-3C
2	Digital ACV Meter	EM-3310-3D
1	Fuse Set	EM-3310-5B
1	Single-phase Transformer	EM-3340-1A
1	Laboratory Table	EM-3380-1A
1	Experimental Frame	EM-3380-2B
	or Experimental Frame	EM-3380-2A
1	Connecting Leads Holder	EM-3390-1A
1	Connecting Leads Set	EM-3390-3A
1	Safety Bridging Plugs Set	EM-3390-4A

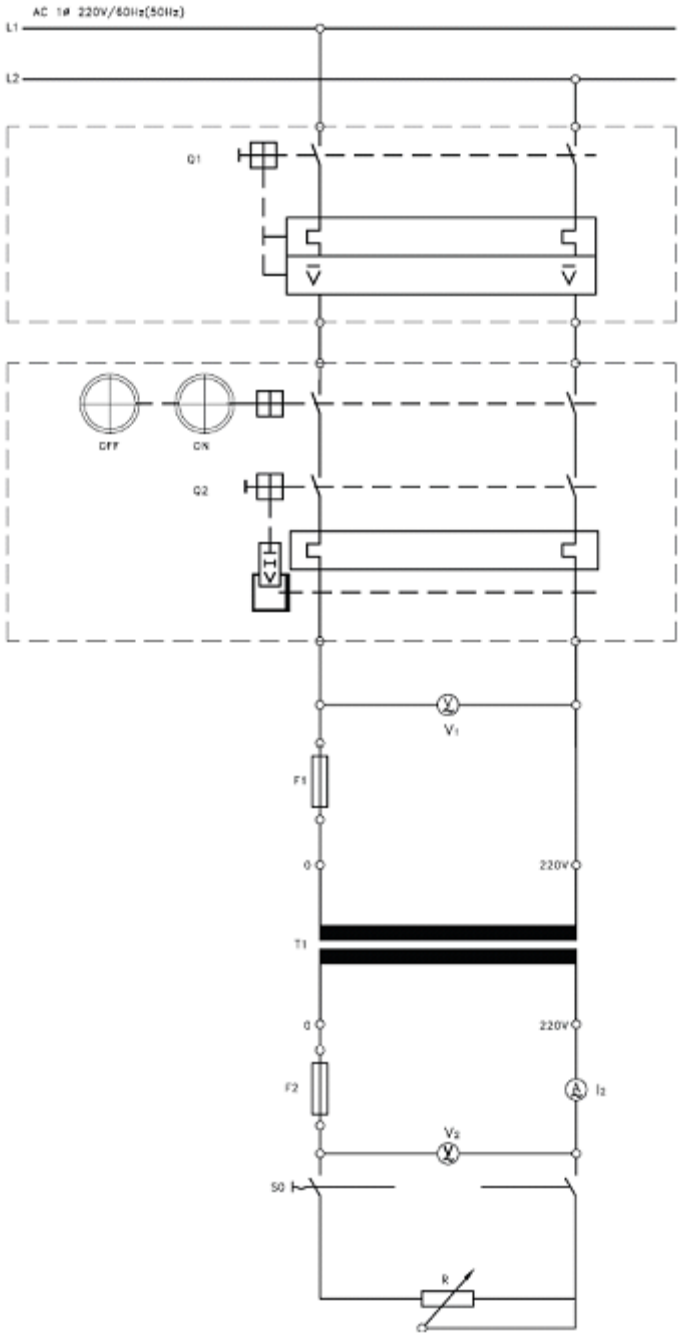

Fig. 5. Circuit diagram for transformer with resistive load

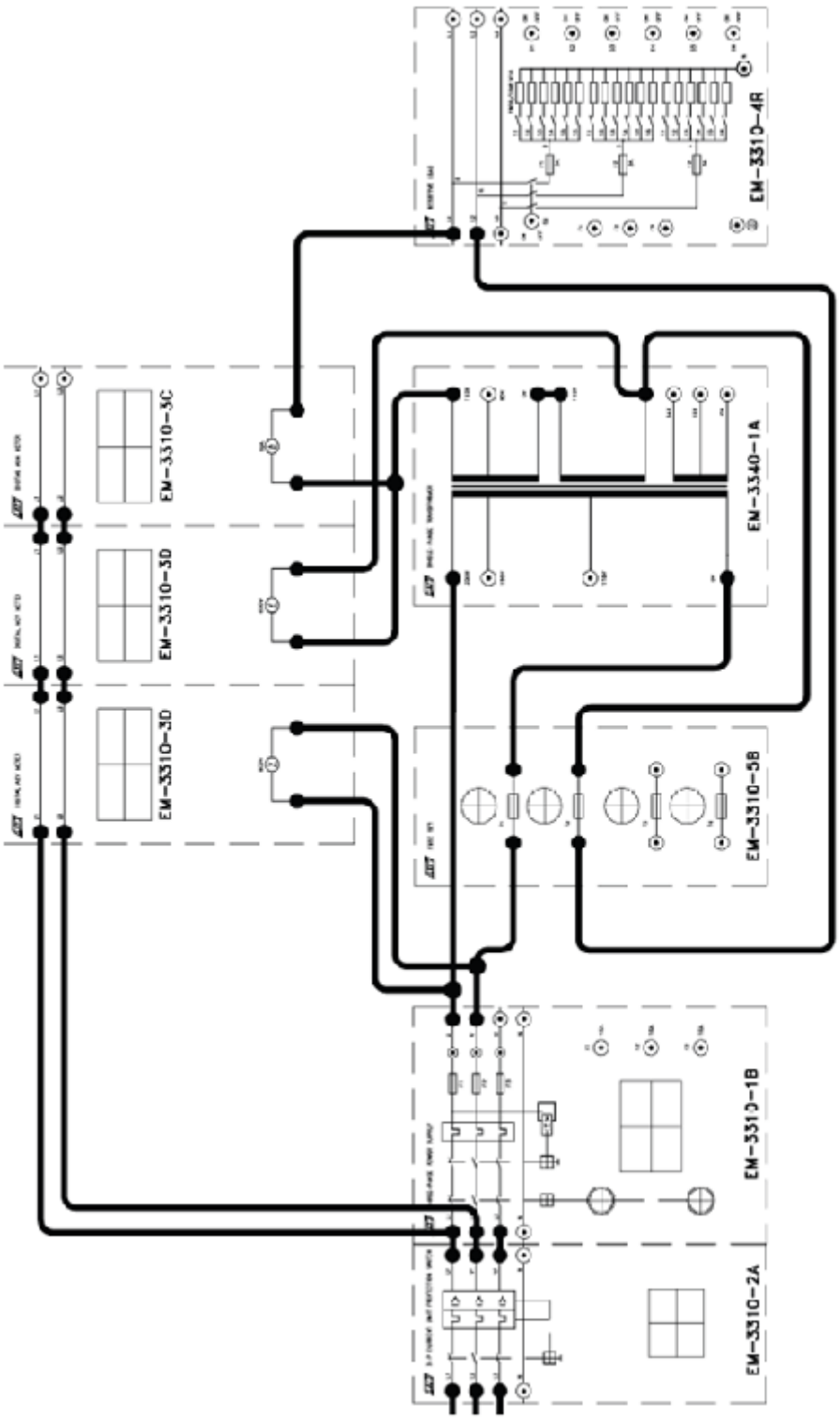

Fig. 6. Connection diagram for transformer with resistive load

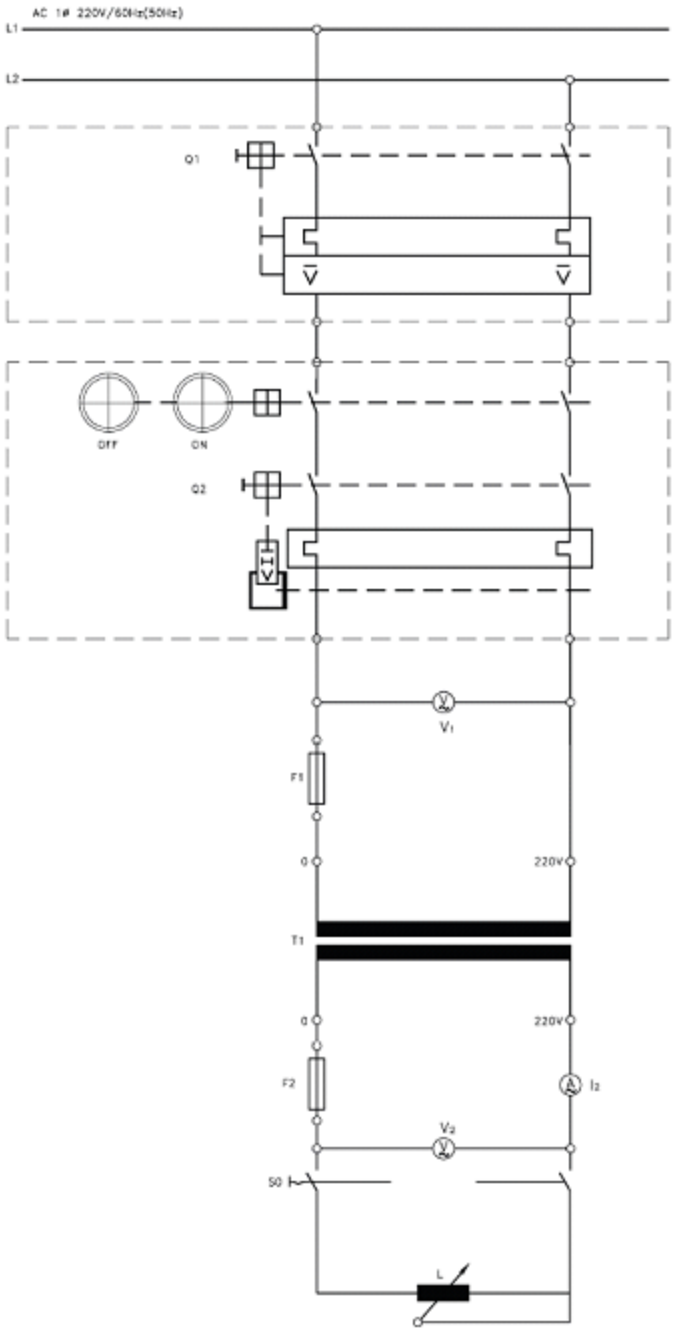

Fig. 7. Circuit diagram for transformer with inductive load

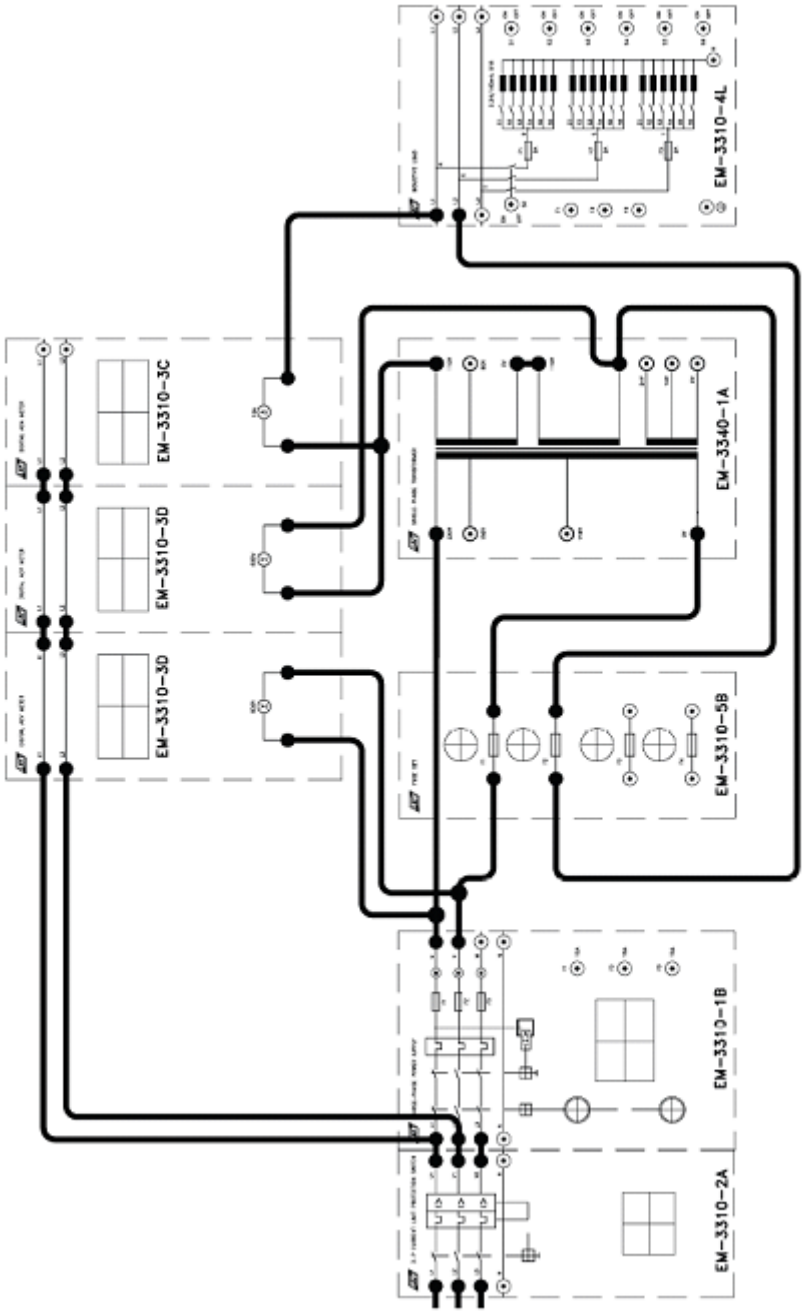

Fig. 8. Connection diagram for transformer with inductive load

PROCEDURE

CAUTION: High voltages are present in this laboratory exercise! Do not make or modify any connections with the power on unless otherwise specified! If any danger occurs, immediately press the red EMERGENCY OFF button on the Three-phase Power Supply Module.

1. Install the required Modules in the Experimental Frame. Construct the circuit in accordance with the circuit diagram in Fig. 1-4-1 and the connection diagram in Fig. 1-4-2. The single-phase transformer is connected to a resistive load.

2. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power Supply Modules.

3. Record the voltage and current values for each of switch positions of the Resistive Load Module in Table 1-4-1. Calculate the values of real power.

4. Sequentially turn off the Three-phase Power Supply and 3-P Current Limit Protection Switch Modules.

5. Using the results of Table 1-4-1, plot the V vs I curve on the graph of Fig. 1-4-7.

6. Using the results of Table 1-4-1, plot the P vs I curve on the graph of Fig. 1-4-8.

Table 1-4-1 Measured and calculated values (resistive load)

	Measured Values			Calculated Value
Switch Positions	Primary Voltage (V)	Secondary Voltage (V)	Secondary Current (A)	Real Power (W)
All Switches OFF				
S1=ON				
S1-S2=ON				
S1-S3=ON				
S1-S4=ON				
S1-S5=ON				
S1-S6=ON				

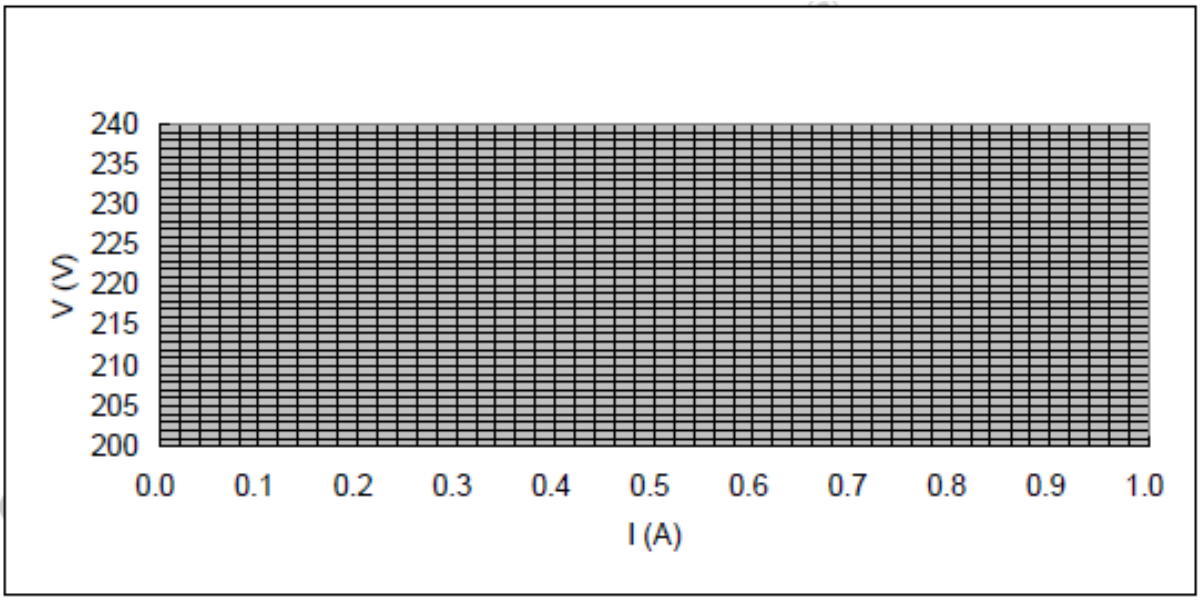

Fig. 1-4-7 The V vs I curve (resistive load)

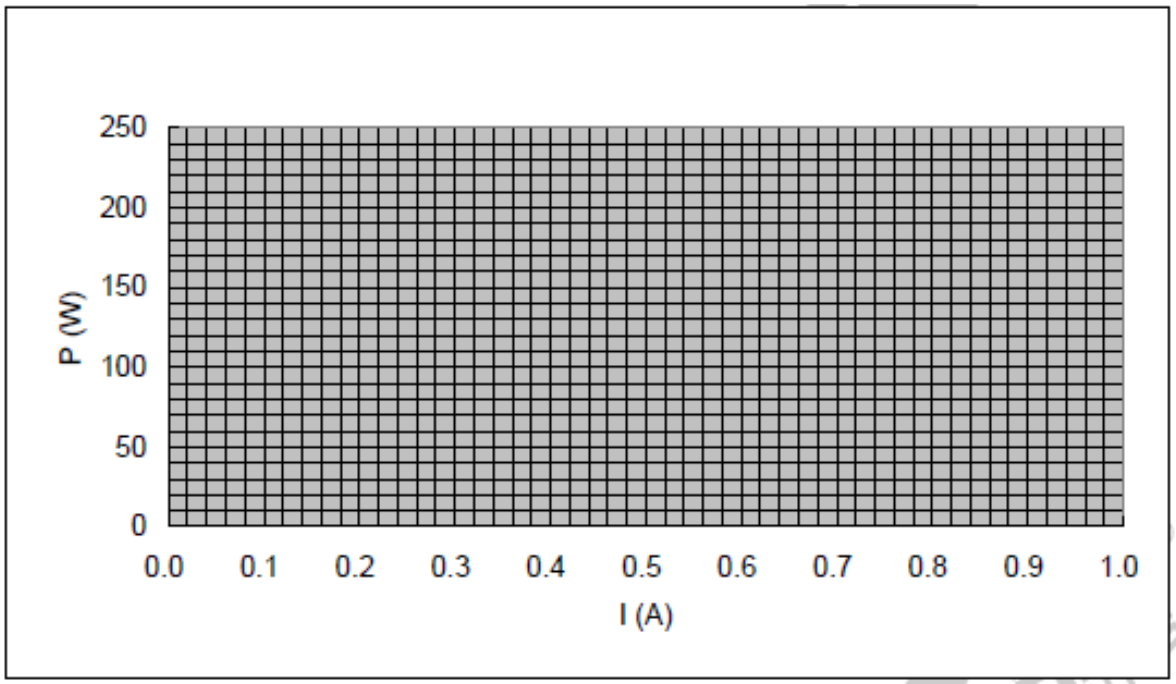

Fig. 1-4-8 The P vs I curve (resistive load)

7. Reconstruct the circuit in accordance with the circuit diagram in Fig. 1-4-3 and the connection diagram in Fig. 1-4-4. The single-phase transformer is connected to an inductive load.

8. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power

Supply Modules.

9. Record the voltage and current values for each of switch positions of the Inductive Load Module in Table 1-4-2. Calculate the values of reactive power.

10. Sequentially turn off the Three-phase Power Supply and 3-P Current Limit Protection Switch Modules.

11. Using the results of Table 1-4-2, plot the V vs I curve on the graph of Fig. 1-4-9.

12. Using the results of Table 1-4-2, plot the P vs I curve on the graph of Fig. 1-4-10.

Table 1-4-2 Measured and calculated values (inductive load)

	Measured Value			Calculated Value
Switch Positions	Primary Voltage (V)	Secondary Voltage (V)	Secondary Current (A)	Reactive Power (VAR)
All Switches OFF				
S1=ON				
S1-S2=ON				
S1-S3=ON				
S1-S4=ON				
S1-S5=ON				
S1-S6=ON				

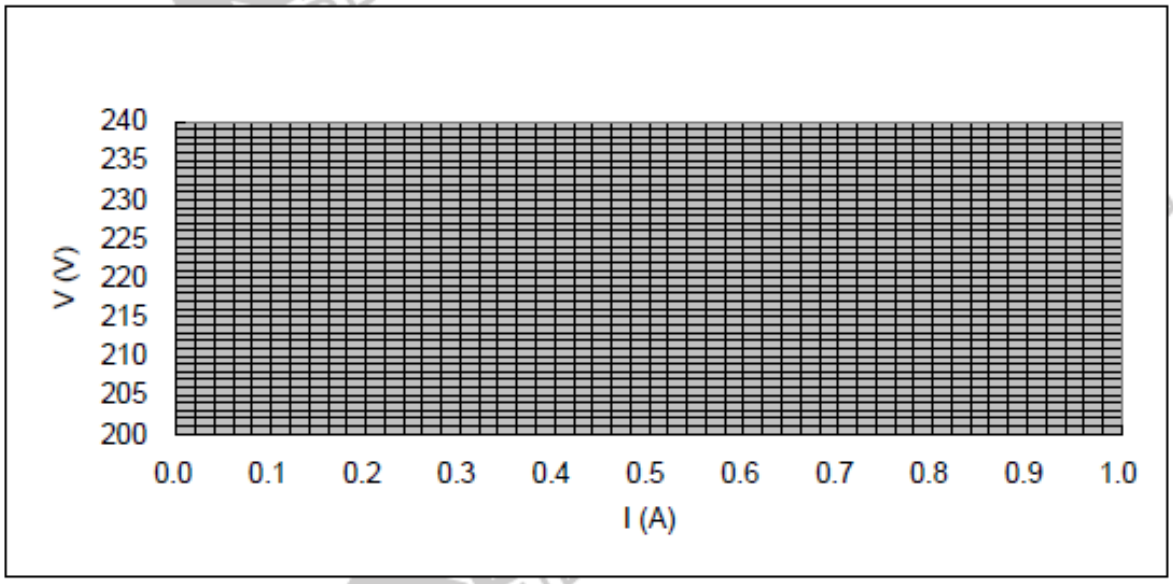

Fig. 1-4-9 The V vs I curve (inductive load)

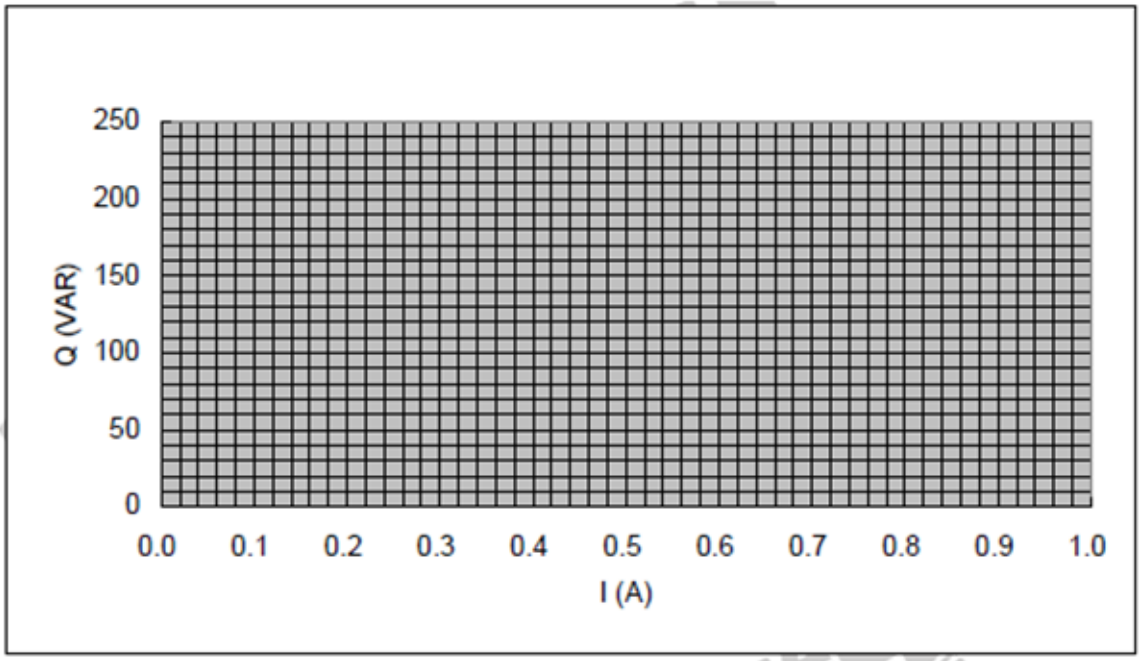

Fig. 1-4-10 The Q vs I curve (inductive load)

Unit 2: Three Phase Transformer

2.a. Connecting Types

OBJECTIVE

After completing this exercise, you should be able to connect three-phase transformers in various configurations and measure the voltages of windings.

EQUIPMENT REQUIRED

Qty	Description	Cat. No.
1	Three-phase Power Supply Module	EM-3310-1B
1	Three-pole Current Limit Protection Switch Module	EM-3310-2A
1	Digital ACV Meter	EM-3310-3D
1	Fuse Set	EM-3310-5B
1	Three-phase Transformer	EM-3340-3A
1	Laboratory Table	EM-3380-1A
1	Experimental Frame	EM-3380-2B
	or Experimental Frame	EM-3380-2A
1	Connecting Leads Holder	EM-3390-1A
1	Connecting Leads Set	EM-3390-3A
1	Safety Bridging Plugs Set	EM-3390-4A

PROCEDURE

CAUTION: High voltages are present in this laboratory exercise! Do not make or modify any connections with the power on unless otherwise specified! If any danger occurs, immediately press the red EMERGENCY OFF button on the Three-phase Power Supply Module.

Wye-Wye Connection

1. Install the required Modules in the Experimental Frame. Construct the circuit in accordance with the circuit diagram in Fig. 2-1-1 and the connection diagram in Fig. 2-1-2. The transformer is connected in wye-wye configuration.

2. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power Supply Modules.

3. With the power on, measure and record the voltage values using the Digital ACV Meter in Table 2-1-1.

Table 2-1-1 Measured voltages (wye-wye connection)

Primary Winding		Secondary Winding	
Test Terminals	Voltage	Test Terminals	Voltage
1U3-1U2		2U1-3U2	
1V3-1V2		2V1-3V2	
1W3-1W2		2W1-3W2	
1U3-1V3		2U1-2V1	
1V3-1W3		2V1-2W1	
1W3-1U3		2W1-2U1	

4. Sequentially turn off the Three-phase Power Supply and 3-P Current Limit Protection Switch Modules.

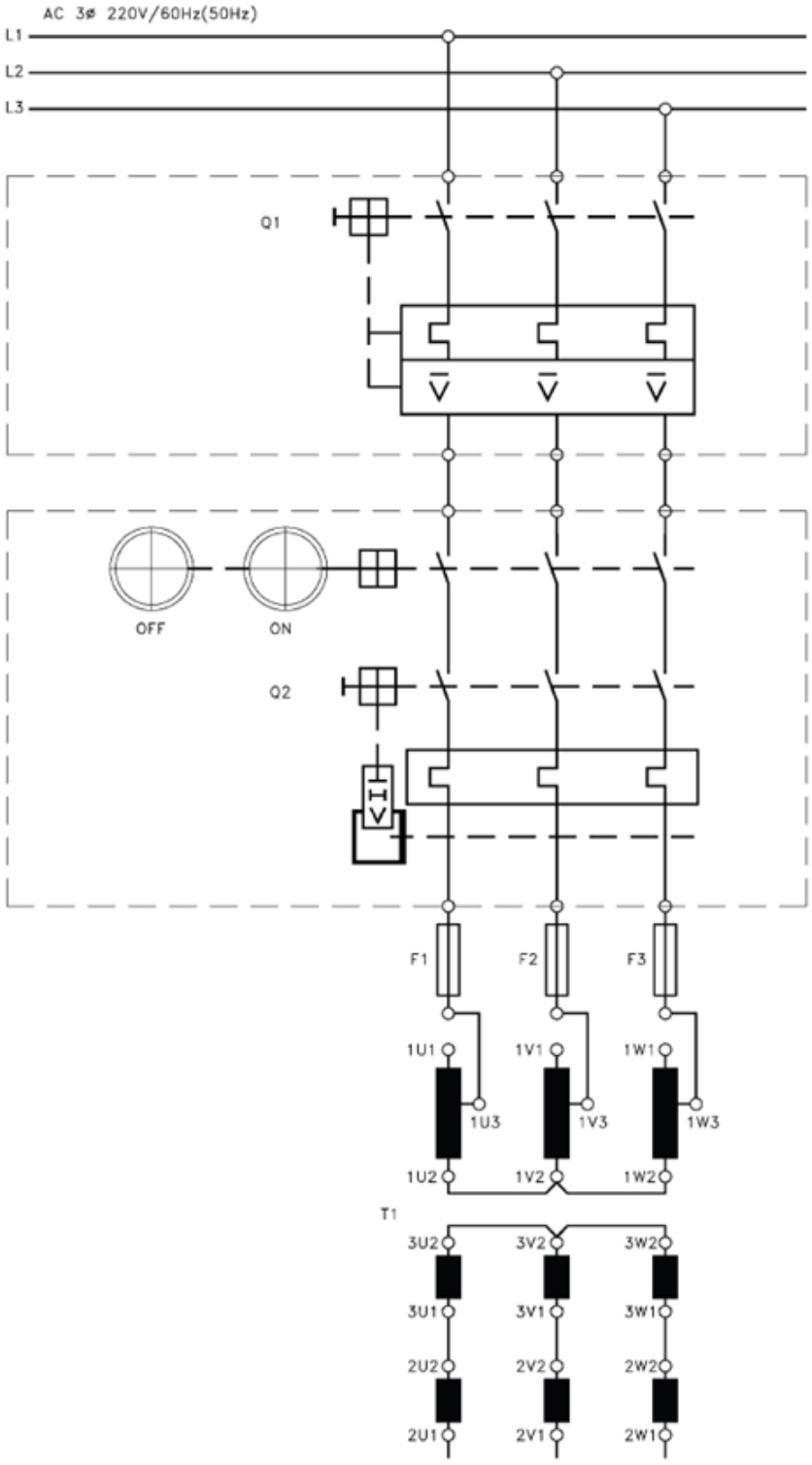

Fig. 9. Circuit diagram for wye-wye connection

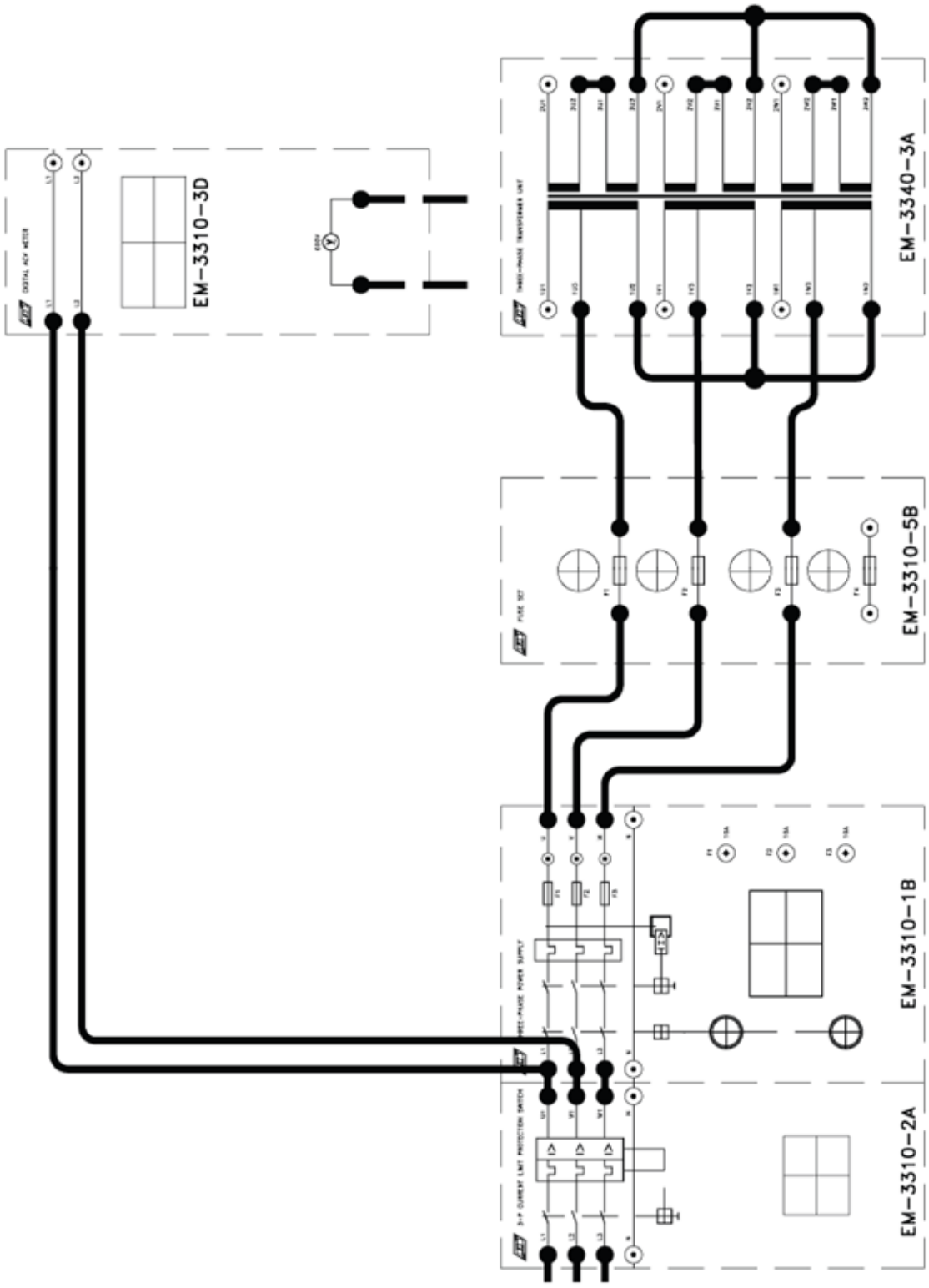

Fig. 10. Connection diagram for wye-wye connection

Wye-Delta Connection

5. Reconstruct the circuit in accordance with the circuit diagram in Fig. 2-1-3 and the connection diagram in Fig. 2-1-4. The transformer is connected in wye-delta configuration.

6. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power Supply Modules.

7. With the power on, measure and record the voltage values using the Digital ACV Meter in Table 2-1-2.

Table 2-1-2 Measured voltages (wye-delta connection)

Primary Winding		Secondary Winding	
Test Terminals	Voltage	Test Terminals	Voltage
1U3-1U2		2U1-3U2	
1V3-1V2		2V1-3V2	
1W3-1W2		2W1-3W2	
1U3-1V3		2U1-2V1	
1V3-1W3		2V1-2W1	
1W3-1U3		2W1-2U1	

8. Sequentially turn off the Three-phase Power Supply and 3-P Current Limit Protection Switch Modules.

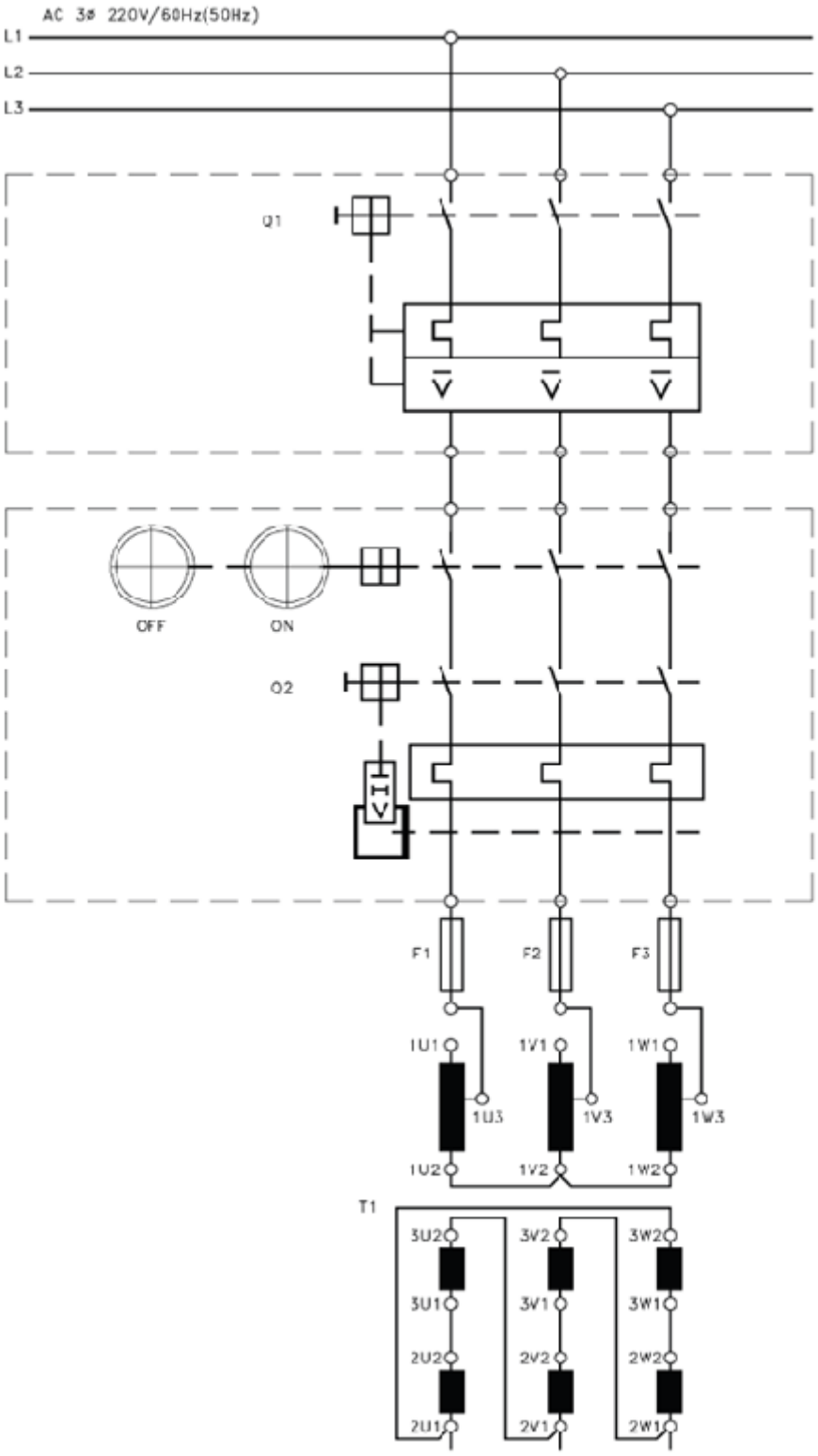

Fig. 11. Circuit diagram for wye-delta connection

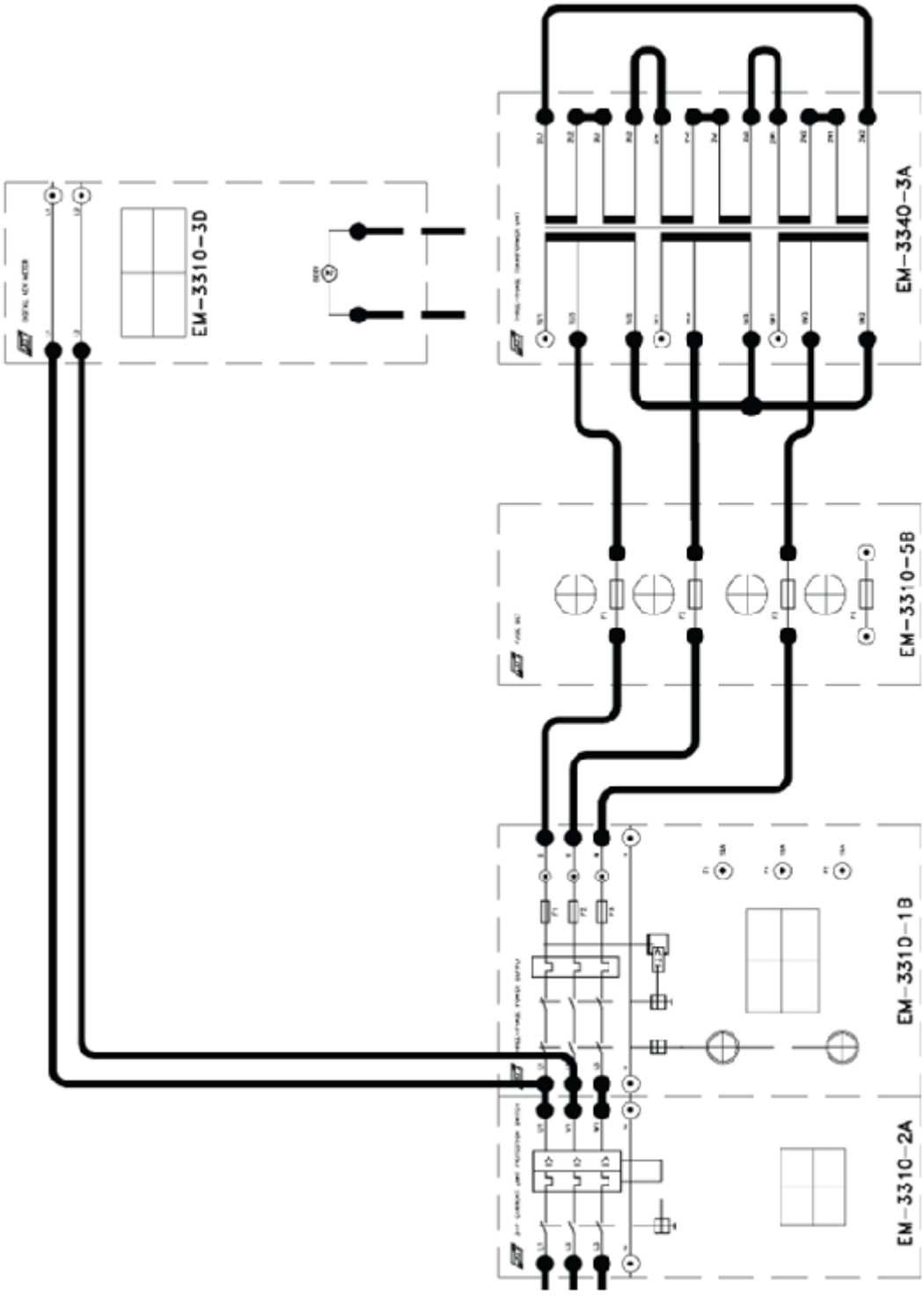

Fig. 12. Connection diagram for wye-delta connection

Delta-Wye Connection

13. Reconstruct the circuit in accordance with the circuit diagram in Fig. 2-1-7 and the connection diagram in Fig. 2-1-8. The transformer is connected in delta-wye configuration.

14. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power Supply Modules.

15. With the power on, measure and record the voltage values using the Digital ACV Meter in Table 2-1-4.

Table 2-1-4 Measured voltages (delta-wye connection)

Primary Winding		Secondary Winding	
Test Terminals	Voltage	Test Terminals	Voltage
1U1-1U2		2U1-3U2	
1V1-1V2		2V1-3V2	
1W1-1W2		2W1-3W2	
1U1-1V1		2U1-2V1	
1V1-1W1		2V1-2W1	
1W1-1U1		2W1-2U1	

16. Sequentially turn off the Three-phase Power Supply and 3-P Current Limit Protection Switch Modules.

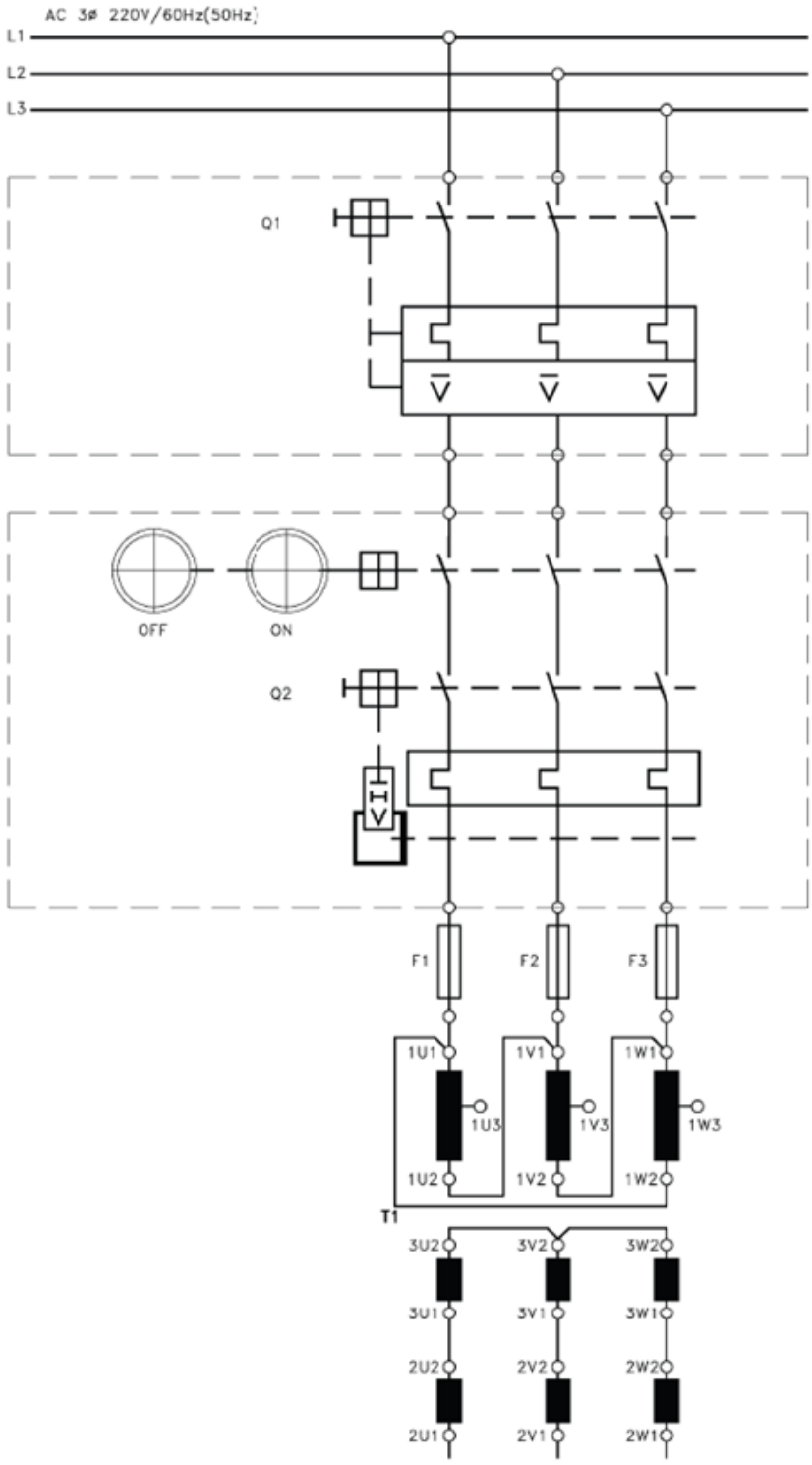

Fig. 13. Circuit diagram for delta-wye connection

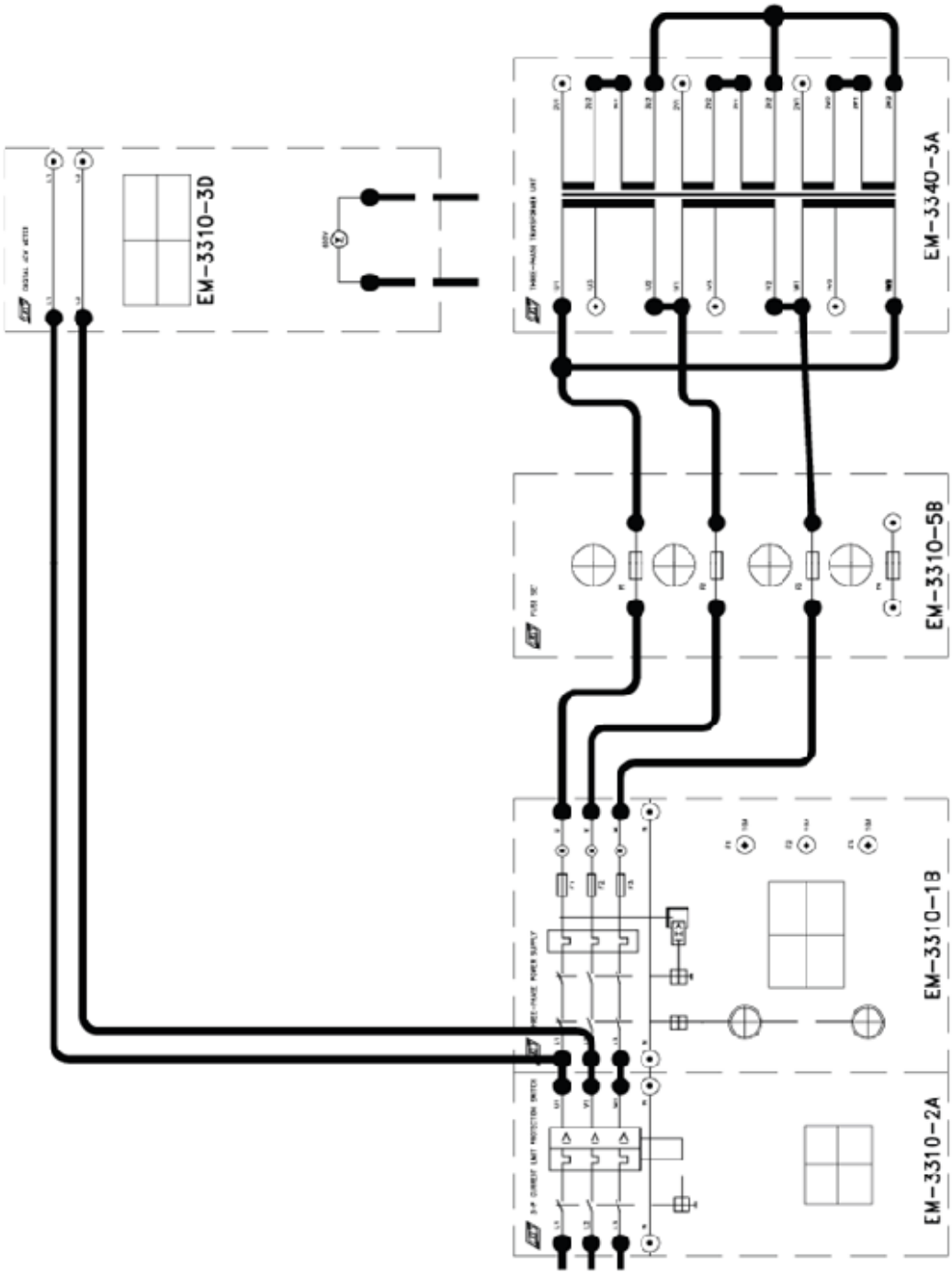

Fig. 14. Connection diagram for delta-wye connection

Delta-Delta Connection

17. Reconstruct the circuit in accordance with the circuit diagram in Fig. 2-1-9 and the connection diagram in Fig. 2-1-10. The transformer is connected in delta-delta configuration.

18. Sequentially turn on the 3-P Current Limit Protection Switch and Three-phase Power Supply Modules.

19. With the power on, measure and record the voltage values using the Digital ACV Meter in Table 2-1-5.

Table 2-1-5 Measured voltages (delta-delta connection)

Primary Winding		Secondary Winding	
Test Terminals	Voltage	Test Terminals	Voltage
1U1-1U2		2U1-3U2	
1V1-1V2		2V1-3V2	
1W1-1W2		2W1-3W2	
1U1-1V1		2U1-2V1	
1V1-1W1		2V1-2W1	
1W1-1U1		2W1-2U1	

20. Sequentially turn off the Three-phase Power Supply and 3-P Current Limit Protection Switch Modules.

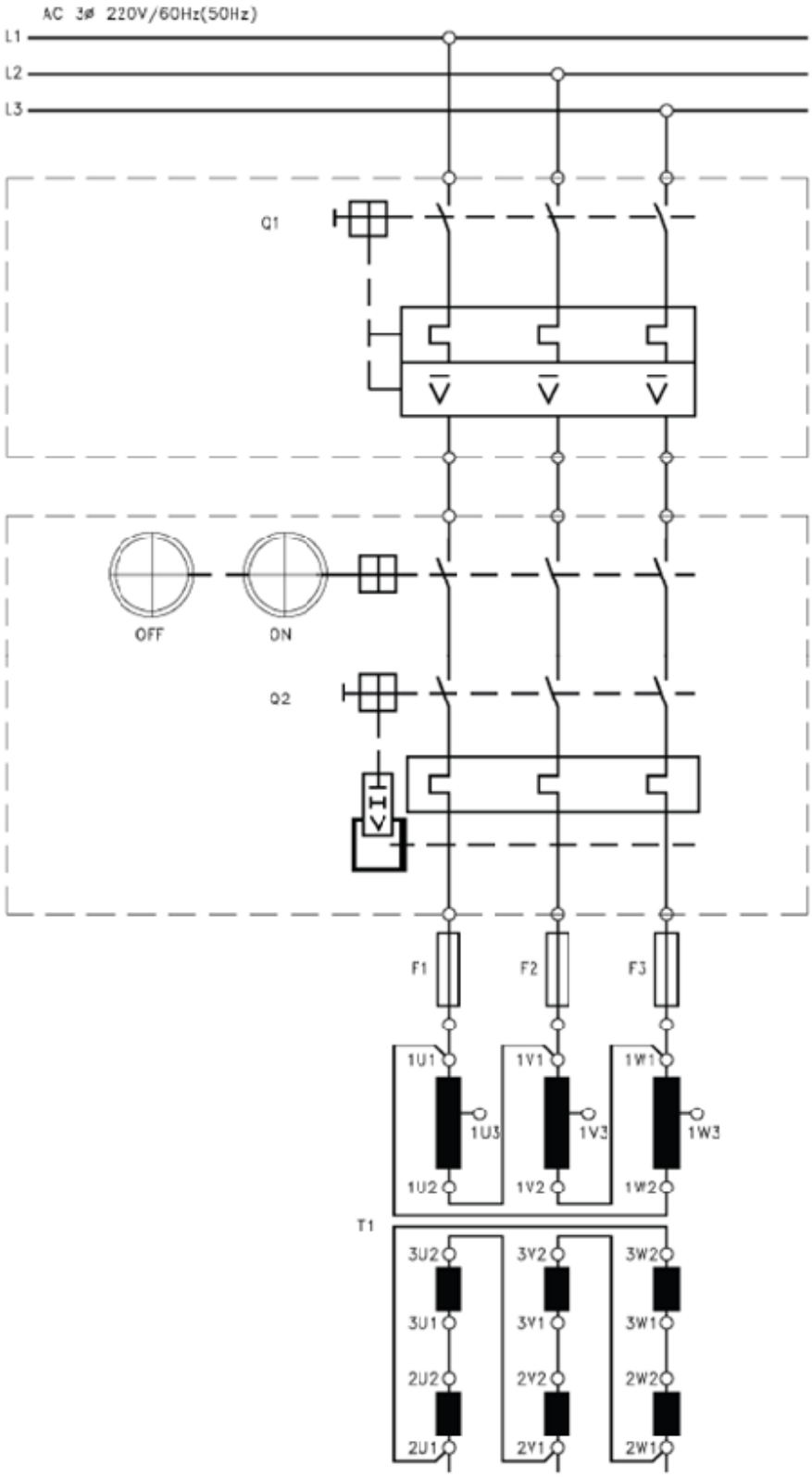

Fig. 15. Circuit diagram for delta-delta connection

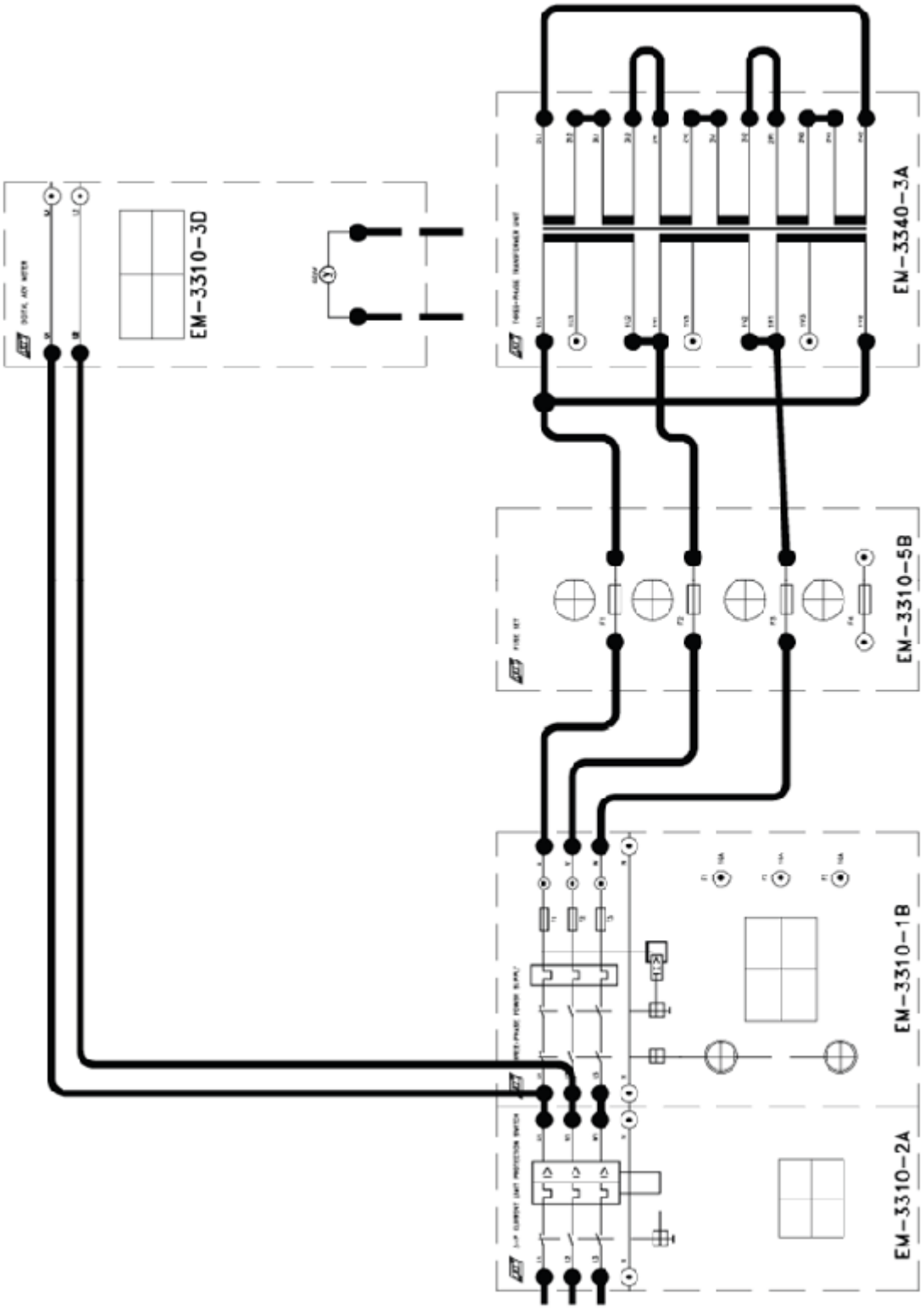

Fig. 16. Connection diagram for delta-delta connection