EXPERIMENT PE1: POWER DEVICE CONTROL

Related course: KIE3008 (Power Electronics)

OBJECTIVES:

1. To arrange and test rectifier circuits that contain power devices
2. To record the output of power device circuits
3. To determine the capability and use of power devices

EQUIPMENT:

15V DC power supply, Voltage control unit, 6-pulse control unit, Thyristor (panel), Diode (panel), Current probe, Digital oscilloscope, Analog multimeter, 3-phase converters, Isolation amplifier, Inductive load, Lamp

INSTRUCTIONS:

1. Record all your results and observations in a log book / paper
2. Follow the experiment procedure properly

REFERENCES:

Refer to the main references of KIE3008

TESTS:

Test 1: Controlled one-pulse half-wave rectifier
Test 2: Balanced two-pulse circuit
Test 3: Fully-controlled AC power controller with thyristor in non-parallel circuit

INTRODUCTION:

For control of electric power or power conditioning, conversion of electric power from one form to another is necessary. Static power converters perform power conversion. A converter may be considered a switching matrix. A controlled rectifier is a type of converter that changes sinusoidal waveforms into DC form of controllable output. Thus, a converter (building block) is a basic module of a power electronics system. To be more specific, in AC to DC and DC to AC conversions, rectifier refers to converter when the average power flow is from AC to DC side. For a given AC input voltage, the magnitude of average output voltage in thyristor converters can be controlled by delaying the instants at which thyristors are allowed to start conduction.

TEST 1: Controlled one-pulse half-wave rectifier

Objective: To investigate the relationship between load power, firing angle α^o and current flow angle $\theta°$

1. Connect the circuit as shown in Figure 1. Use firing angle = 90° and save the following oscilloscope figures in a pendrive or capture using a camera:
   a) Input voltage V_{in}
   b) Voltage across the load V_{load}
   c) Current through the load I_d
   d) Voltage across the thyristor V_{AK}

   Then, repeat step 1 for firing angle = 135°.
2. Change the firing angle using voltage control from 0V to 10V at interval of 1V. For each step, measure and record the power of the load. Using oscilloscope, measure and record the current flow angle. Complete Table 1.

3. Short circuit the inductive load at firing angle of 90°. Save the following oscilloscope figures in a pendrive or capture using a camera:
   a) Input voltage V_{in}
   b) Voltage across the load V_{load}
   c) Current through the load I_d
   d) Voltage across the thyristor V_{AK}

   Then, compare the figures obtained between step 1 and 3. Give comment.

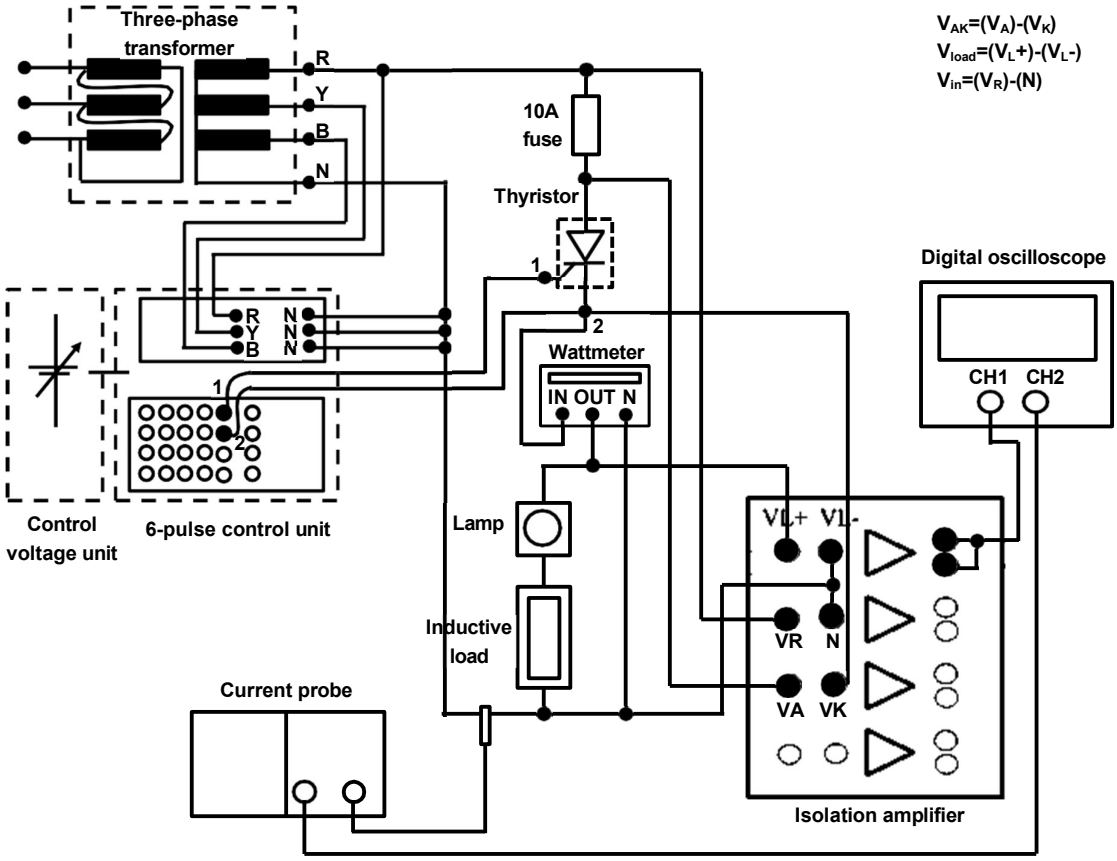


Figure 1

QUESTIONS:

1. From Table 1, plot a graph of power against firing angle and a graph of current flow angle versus firing angle. Comment on the graph.
2. State one application of controlled one-pulse half-wave rectifier.

TEST 2: Balanced two-pulse circuit

Objective: To study the control properties for balanced two pulse rectifier and its response against resistive load and compound loads

1. Connect the circuit as shown in Figure 2. Change the firing angle using voltage control from 0V to 10V at interval of 1V. Measure and record the DC voltage at load V_{da} in Table 2. At firing angle of 90°, save the input voltage V_{in} and load voltage V_{load} curves from the oscilloscope figure in a pendrive or capture using a camera.
2. Insert a diode between point *x* and *y*, where the cathode of the diode faces *y*. At firing angle of 90°, save the input voltage V_{in} and load voltage V_{load} curves from the oscilloscope figure in a pendrive or capture using a camera.

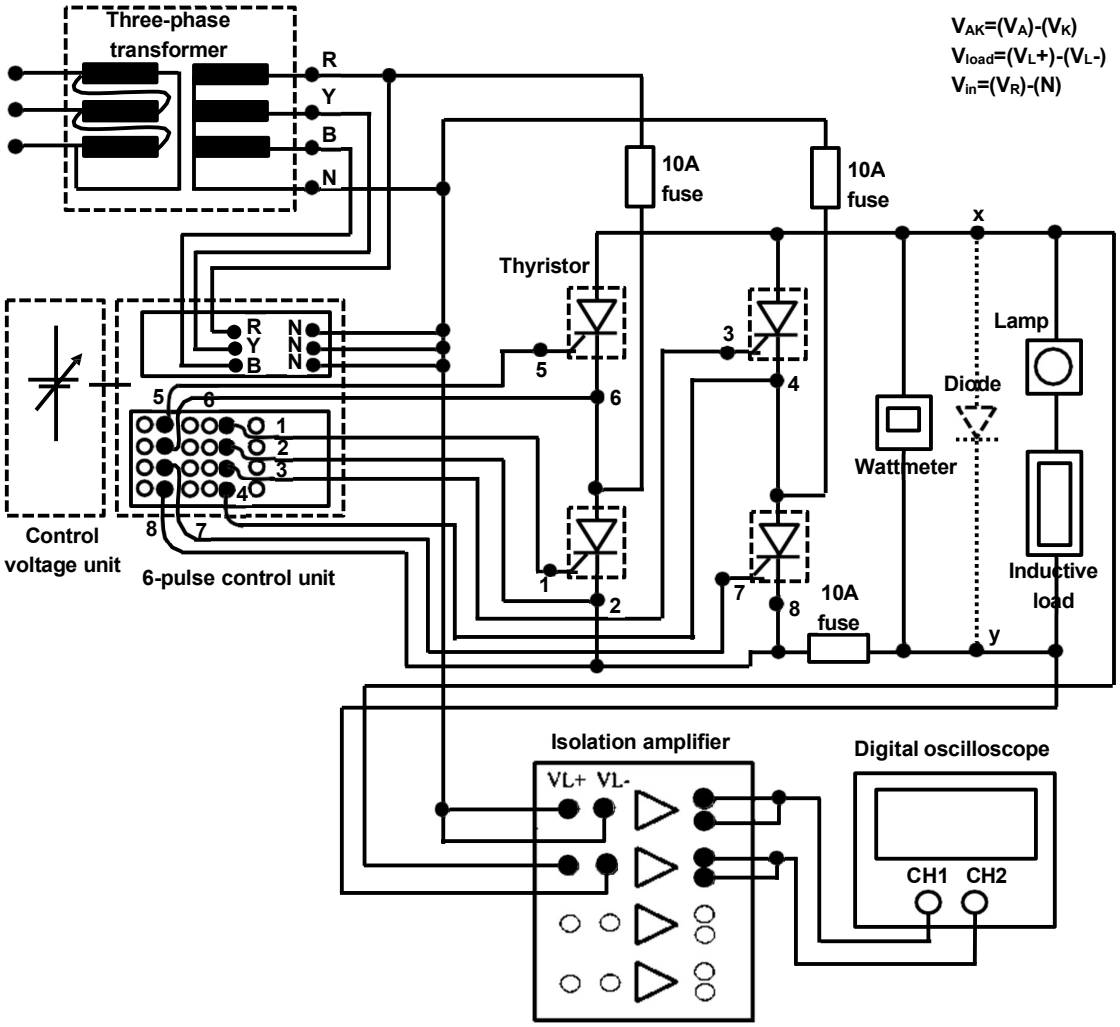


Figure 2

TEST 3: Fully-controlled AC power controller with thyristor in non-parallel circuit

Objective: To understand the control properties of AC power controller using two thyristors with compound loads and its behavior

1. Connect the circuit as in Figure 3. Vary the firing angle using voltage control from 0V to 10 V. At each step, measure and record load voltage V_α. Complete Table 3.
2. Change the firing angle to 90°. Save the following oscilloscope figures in a pendrive or capture using a camera:
   a) Input voltage V_{in}
   b) Voltage across the load V_{load}
   c) Current through the load I_d
   d) Voltage across the thyristor V_{AK}

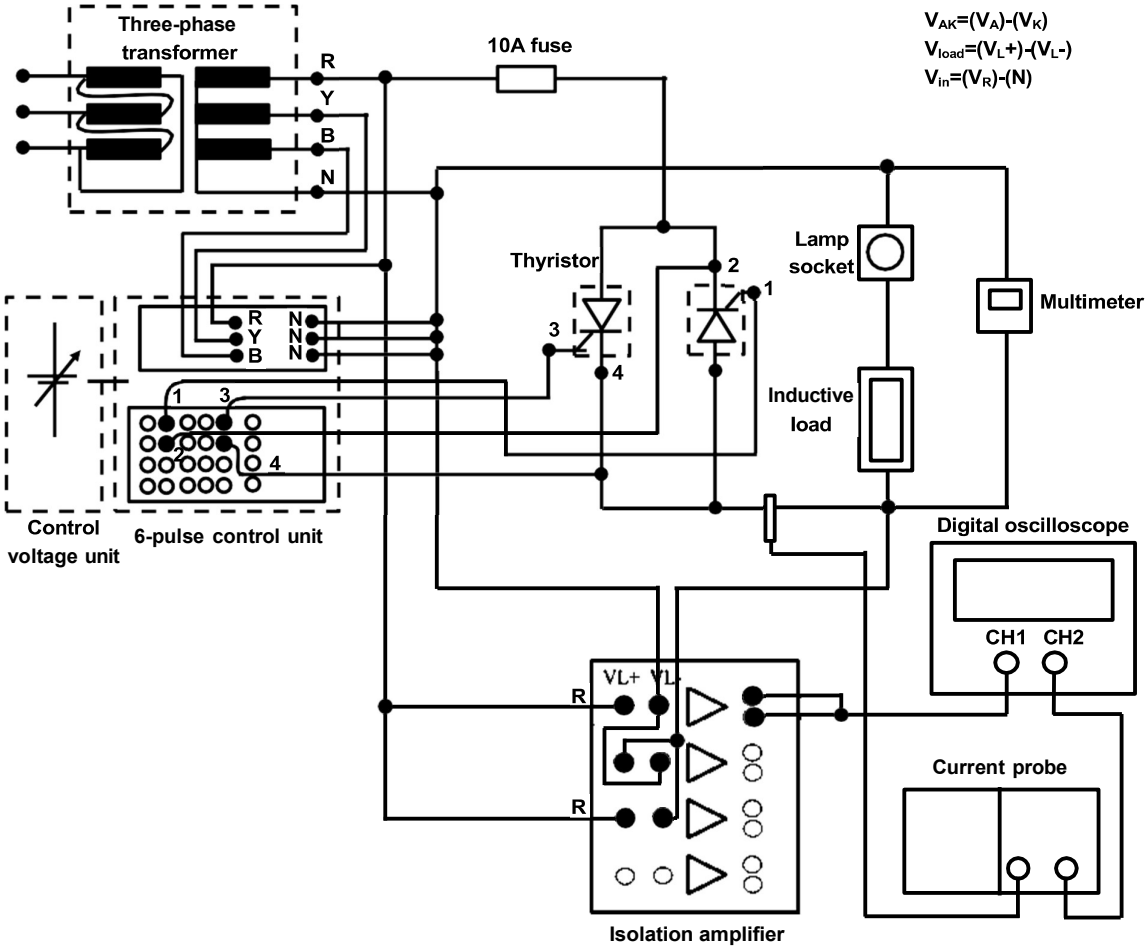


Figure 3

QUESTIONS:

1. From Table 2, plot a graph of ($V_{d\alpha}/V_{d0}$) versus firing angle. (Note: V_{d0} is the voltage value at load at firing angle of 0°). Comment on the graph.
2. From Table 3, plot a graph of (V_α/V_{d0}) versus firing angle. Comment on the graph.
3. State one application of AC power controller with thyristor in non-parallel circuit.

END OF EXPERIMENT

STUDENT LAB ANSWER SHEET

EXPERIMENT PE1: POWER DEVICE CONTROL
GROUP :
NAME :
MATRIC NO :
TIME :

STUDENT SIGNATURE: _____

LAB LECTURER/INSTRUCTOR/TECHNICIAN ACKNOWLEDGMENT:

THIS SECTION IS TO BE COMPLETED BY THE LECTURER/LAB INSTRUCTOR OR TECHNICIAN UPON THE STUDENT'S SUBMISSION OF THE COMPLETED PRELAB/IN LAB ANSWER SHEET.

IN LAB SUBMISSION TIME: _____ AM/PM

SIGNATURE: _____

COMMENTS
(CHECHK WETHER THE STUDENT COMPLETE THE IN LAB TASK OR NOT):

In Lab Task

TEST 1: Controlled one-pulse half-wave rectifier

Table 1

Voltage control (V)	1	2	3	4	5	6	7	8	9	10
Firing angle										
Power (W)										
Current flow angle										

TEST 2: Balanced two-pulse circuit

Table 2

Voltage control (V)	1	2	3	4	5	6	7	8	9	10
DC voltage at load ($V_{d\alpha}$)										

TEST 3: Fully-controlled AC power controller with thyristor in non-parallel circuit

Table 3

Voltage control (V)	1	2	3	4	5	6	7	8	9	10
AC voltage at load (V_{α})										