Three Phase AC-DC Converters

1. AC-DC Converters

1.1. The Purpose Of The Experiment

To examine the operating characteristics and circuit structures of 3-phase controlled and uncontrolled rectifiers. 3 Phase rectifiers will be examined in different load types. Before coming to the experiment, it is absolutely necessary to study the test sheet and the equipment to be used in the experiment. There will be an exam before starting the experiment.

1.2. General Information

In many power electronics applications, the input power is in the form of 50-60 Hz AC power from the mains and is converted to DC in practice. In applications where controlled voltage or power transfer is not required in the industry, the general trend in terms of cost is to use diode rectifiers. In diode rectifiers, the power flow is from the mains to the load and is only unidirectional. Diode rectifiers are preferred in DC power supply, AC motor drivers, battery chargers, UPS applications, DC motor control and many more. Since diode rectifiers rectify the voltage from the network, there are voltage oscillations on them at the frequency of the harmonics of the network, depending on the type of rectifier. To reduce them, a capacitor is added to the output before the load. The larger the capacitor, the less oscillations in the output voltage will be. One of the bad features of diode rectifiers is that they draw very high distortion current from the network. Since this is limited by the total harmonic distribution standards (THD), diode rectifiers may not be used in all cases. Instead, controlled rectifiers are used to simulate the current with various control strategies. We can classify diode rectifiers as single-phase, three-phase and half-wave rectifiers and full-wave rectifiers.

If the industrial application requires an adjustable voltage rather than a constant, then we cannot use diode rectifiers. In such applications, diodes are replaced by phase-controlled thyristors. The output voltage of the thyristor can be controlled by current by changing the delay or ignition angle of the thyristor. The thyristor is turned on with a current pulse applied to the gate terminal and turns off only when the voltage on it is negative and the current drops below a certain value. In AC systems, voltage and current naturally go to negative, but since this is not the case in DC systems, thyristor cannot be used in these systems. Because phase-controlled systems are simple, efficient and relatively inexpensive, they are widely used in industrial applications, especially in adjustable speed drive systems, in a wide range from a few kW to MW levels.

Thyristor rectifiers, like diode rectifiers, will be examined as single-phase, three-phase and half-wave, full-wave rectifiers.

2.Conducting Experiments

- **The following tests will be done in order. Save the oscilloscope images to use in your report. Connections will be made under the control of the research assistant responsible for the experiment, and do not energize the set without the approval of the research assistant.**

2.1. Three Phase Half Rectified Converter Experiments

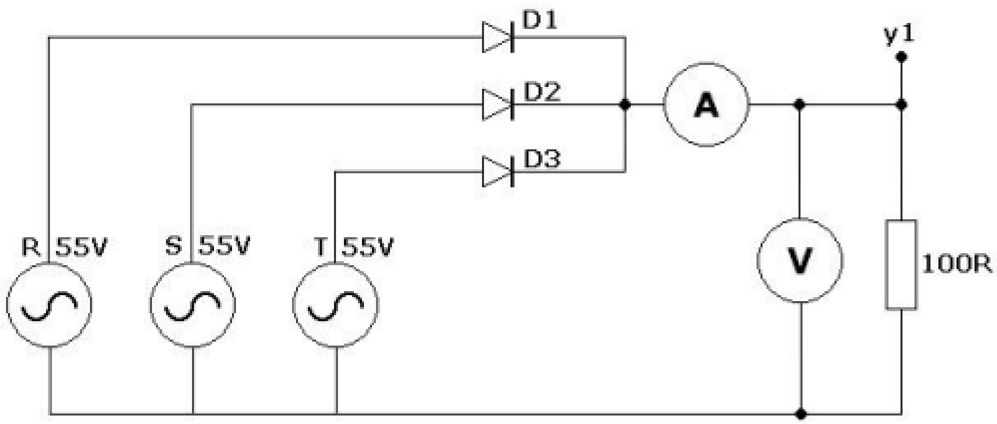

Figure 1. Three Phase Half Rectified Converter Circuit

Set up the circuit in Figure 1 with the help of a single line circuit and a set connection diagram. The three-phase half-wave rectifier is formed by connecting the common ends of 3 single-phase half-wave rectifiers to the load, as shown in Figure 1. . 3-phase converters produce output voltages with higher frequency and lower oscillation. Thus, more easily filtered output voltages are obtained in terms of cost and size. The experimental setup is also shown in Figure 2. Draw the waveform of the load voltage seen in the Y1 channel of the oscilloscope by constructing the circuit. Note the average and effective values of the load voltage and current.

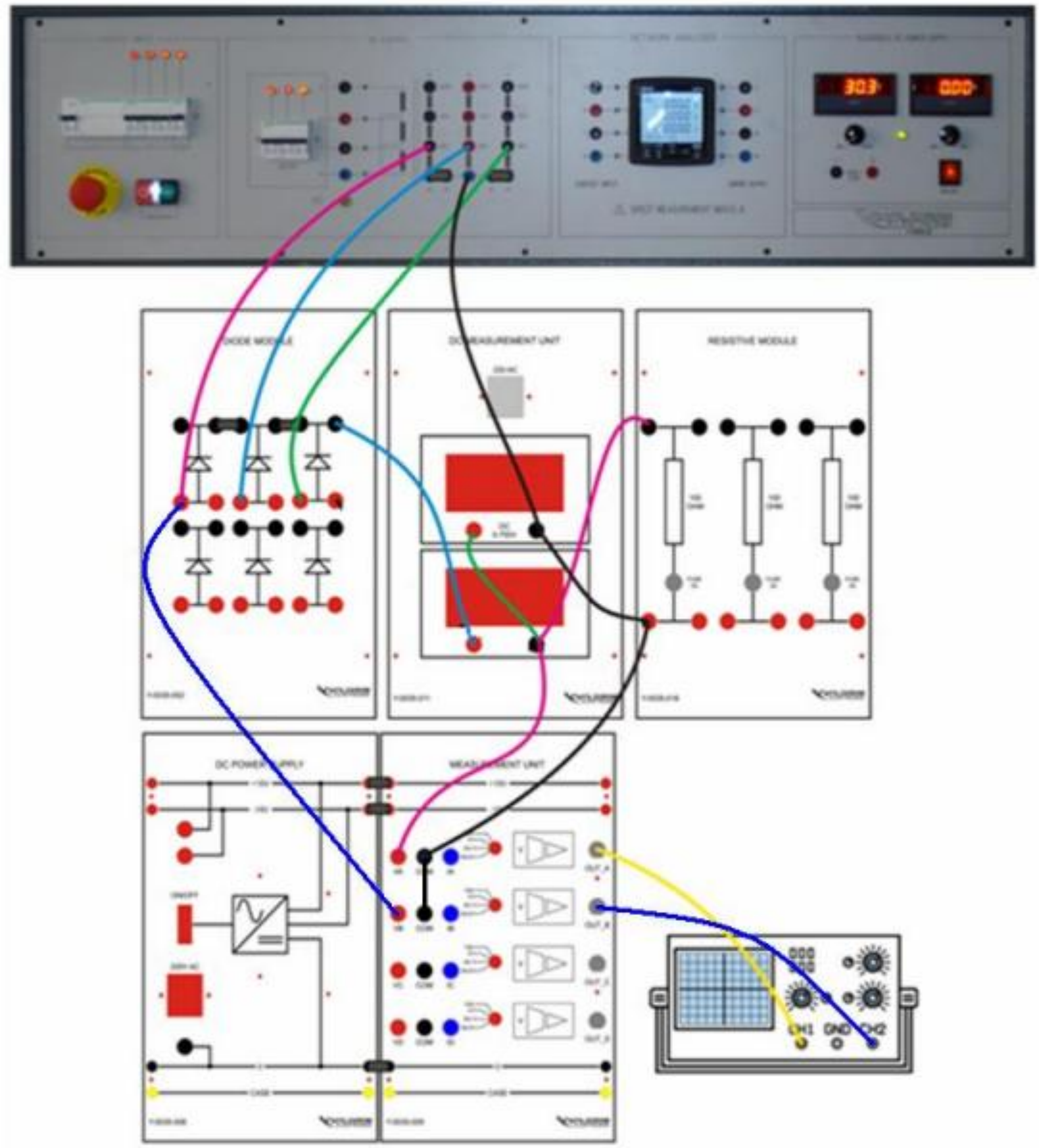

Figure 2. Three Phase Half Rectified Converters Connection Diagram

2.2. Three Phase Full Rectified Converter

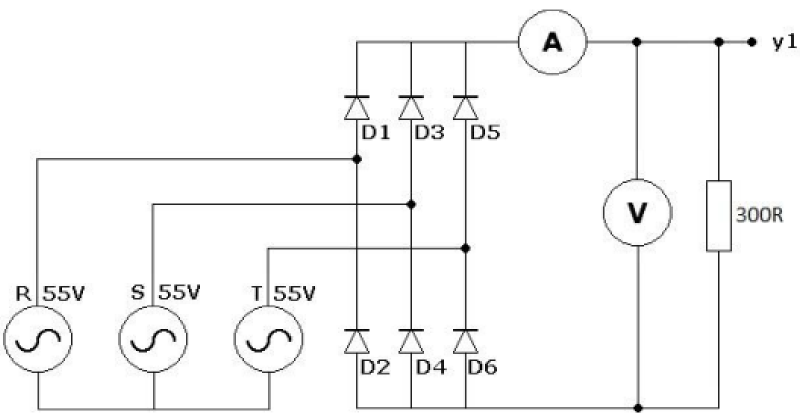

Figure 3. Three Phase Full Rectified Converter

Set up the circuit in Figure 3 with the help of a single line circuit and a set connection diagram. Half-wave rectifiers are generally not used because of their effects on the grid. Single-phase and three-phase bridge rectifiers are commonly used rectifier circuits. In this experiment, the properties of the three-phase bridge rectifier will be demonstrated. Set up and run the circuit as shown in the figure. Draw the waveform of the load voltage. Note the average and effective values of the load voltage and current.

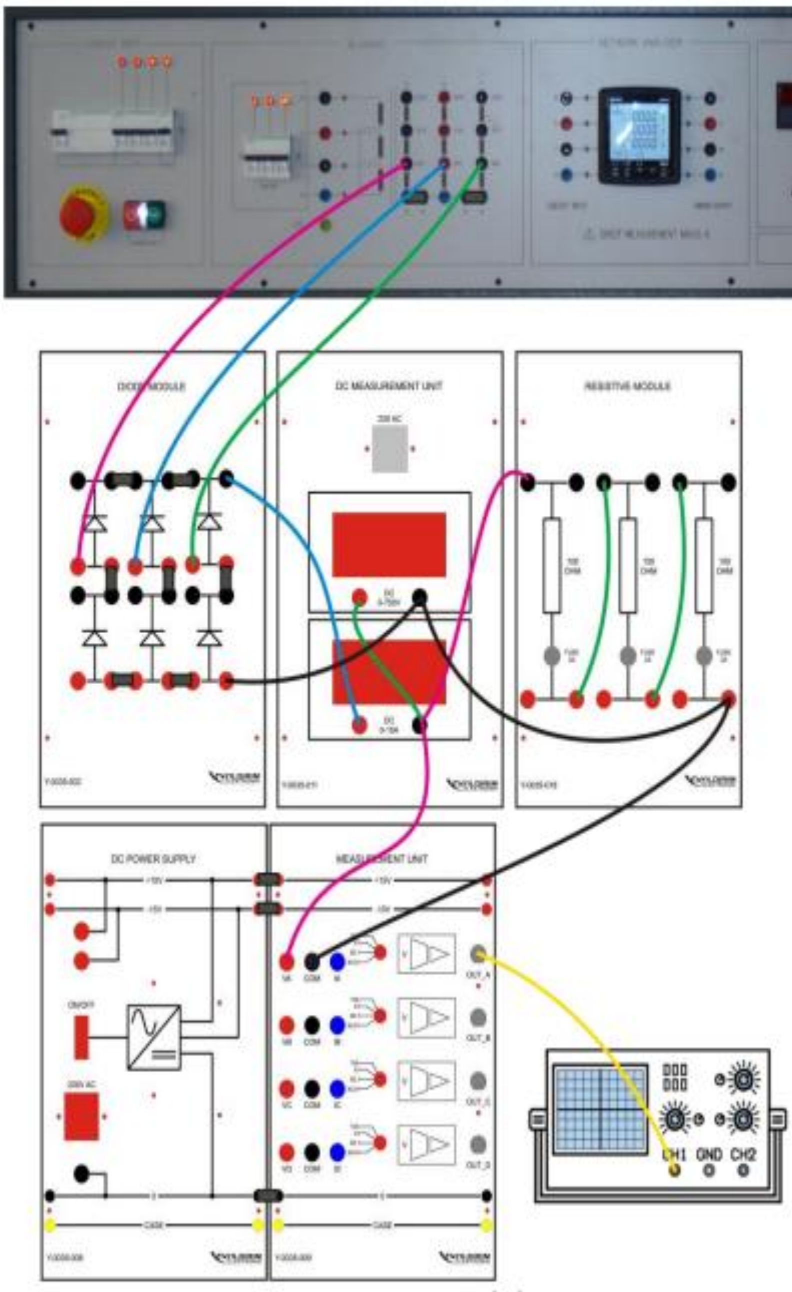

Figure 4. Three Phase Full Rectified Converter Connection Diagram

2.3. Three Phase Controlled Half Rectified Converter

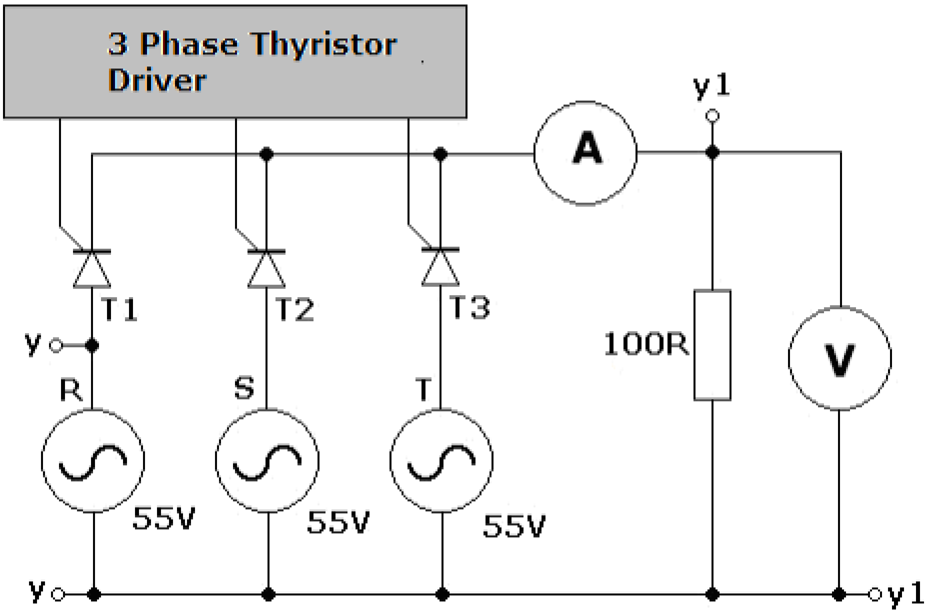

Figure 5. Three Phase Controlled Half Rectified Converter

Three-phase, controlled half-wave rectifier diodes are replaced by thyristors in similar circuits as in the diode experiments. As in previous thyristor applications, the output voltage can be adjusted by changing the ignition angle of the thyristor. Take the necessary drawings and measurements by running the circuit given in the figure with a load of 100 ohms, taking into account the set connection.

Note: The ignition angle can be taken between 0-180 degrees, but in three-phase circuits the reference for the ignition angle is generally taken from the point where the voltages between phases are 0 volts, not a single phase. That is, the thyristor of the first phase is α+30, the thyristor of the second phase is α+30+120, and the thyristor of the third phase is α+30+240 respectively. (It is assumed that the angles of the phases are arranged in this way. If the phase order is different, the firing order should be changed accordingly.)

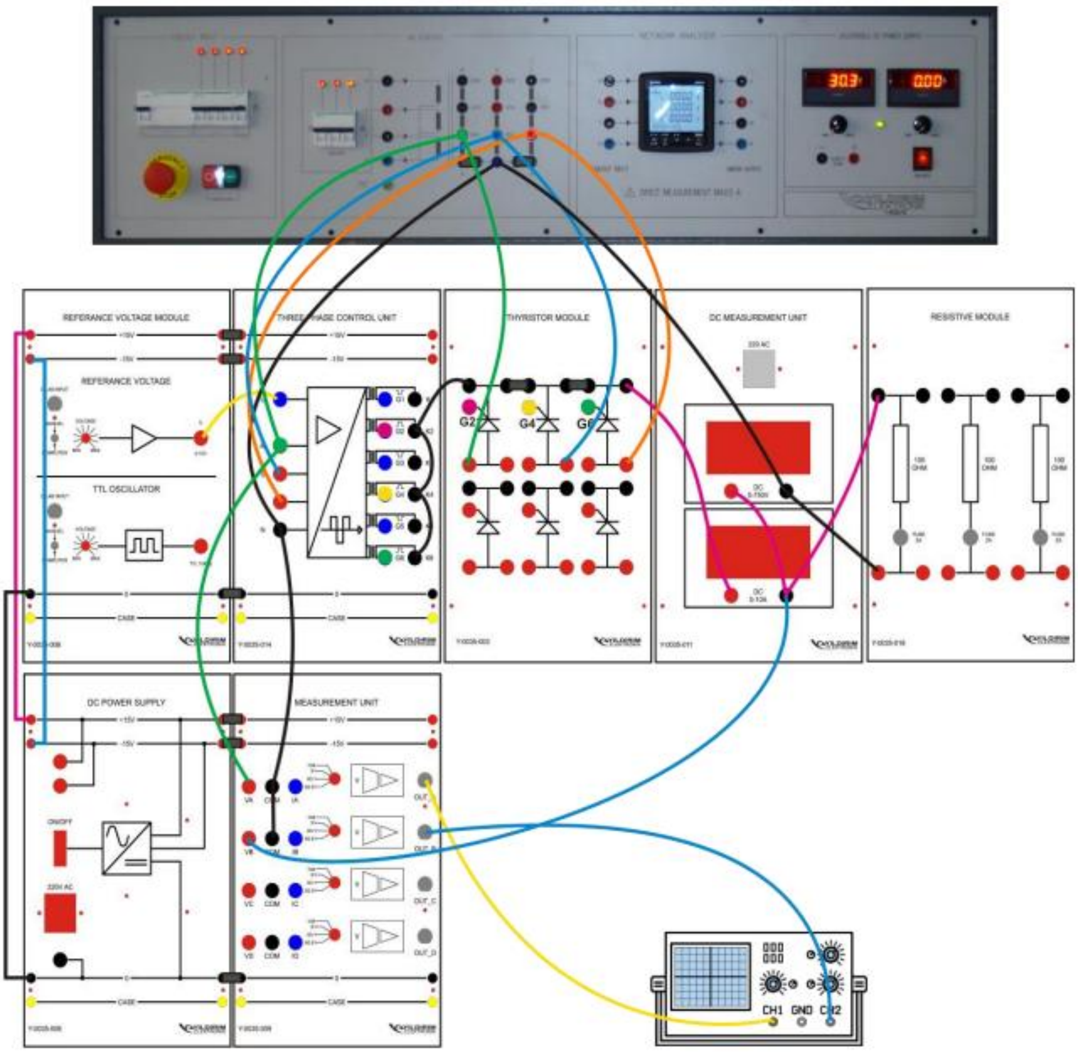

Figure 6. Three Phase Controlled Half Rectified Converter Connection Diagram

2.4. Three Phase Half Rectified Converter (Inductive Load)

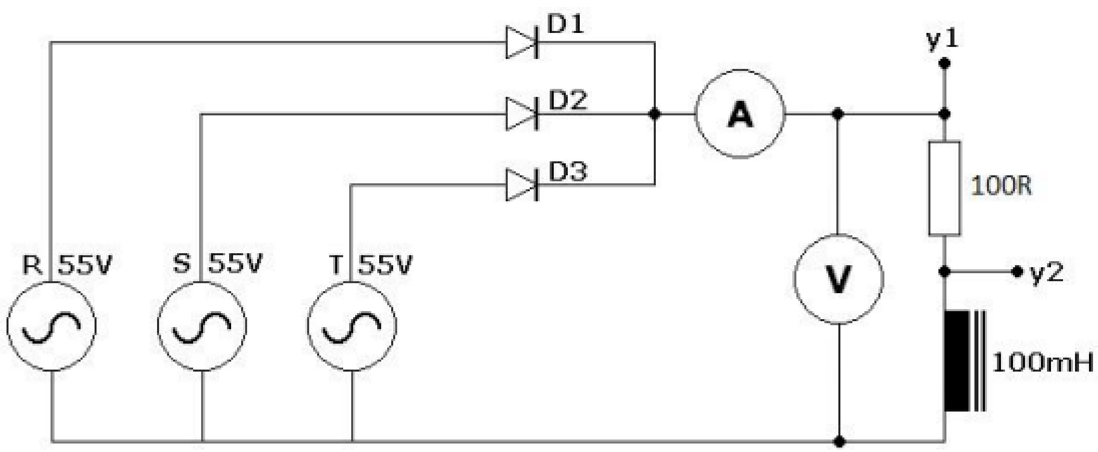

Figure 7. Three Phase Half Rectified Converter Circuit (Inductive-Resistive Load)

Set up the three-phase half-wave rectifier by adding a series inductance of 100mH to the resistor as shown in figure 7. Draw the waveform of the load voltage seen in the Y1 channel of the oscilloscope by constructing the circuit. Note the average and effective values of the load voltage and current.