MET-487 Instrumentation and Automatic Control, Summer II, 2009

Lab 4. Light Activated Single-Phase AC Motor

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Students: ____________________ _________________ _________________

Parts Needed:
- 1 x 2N3904 transistor, 5 x 1N 4001 diode, CdS photo resistor
- 1 x green LED
- 1 x 510 Ω, 1 x 10 kΩ, 22 kΩ, 1 x 25 kΩ pot
- 1 x 12 V relay, contact (Common, NC, NO) 10 A 250 AC or 30 V DC
- 1 x SSR (Solid State Relay) – DC input (3 to 32 volt), AC output (250 V, 10A)
- 1 x 7805, 1 x 7812
- 1 x 22 μF, 1 x 47 μF , 1 x 100 μF
- 5 and 12 V power supply, 1 x DMM, 1 x Digital oscilloscope
- 1 x bread board

A. Light Activated Single-Phase AC Motor
1. Use the light activated relay from previous lab. Retest to make sure that the photo sensor is properly adjusted to the ambient light intensity so that relay is clicked on when there is a light on the surface of the photo resistor CdS.
2. Connect the 510 ohms resistor and the green LED to form the indicator subcircuit.
3. Make sure the DC 12 V power supply is turned off.
4. Connect the DC 3 to 32 V input (+ and -) of the Solid State Relay (SSR) as shown in Figure 1 to the Common and NC terminals of the 12V relay.
5. Connect the AC side of the SSR to the coil of magnetic contactor as shown in Figure 1.
6. Connect the single phase AC 120V motor to the contactor terminals as shown in Figure 1.
7. Connect the AC 120V power source to the contactor.
8. Turn on DC 12V power supply, AC power supply, and motor control breaker.
9. Test the control circuit by covering and exposing the photo resistor to the ambient light. You should observe that the motor is turned on when CdS is exposed to the light.
B. Construct On Board 12 V DC Power Supply

1. Instead of using the power supply from the lab we construct a DC 12V power supply, as shown in Figure 2, for use by the photo relay circuit.
2. Place 4 diodes on the bread board to form a full-wave bridge rectifier.
3. Place 12 V IC regulator, 7812, on the bread board.
4. Connect the two capacitors (22 μF and 50 μF)
5. Connect the transformer to the AC input of the bridge rectifier.
C. Testing 12 V On-Board Power Supply

1. Set DMM to AC 200 V range. Then connect AC 120V to primary side of the transformer
2. Measure the RMS (root-mean-square or effective) voltages of the Vin = ________ and Vac = ________ volt, as shown in the Figure 2. Compute transformer turn ratio (primary side voltage OVER secondary side voltage) Vac/Vout = ____________.

![Figure 2. AC input voltage measurement](image1)

3. Set DMM to DC V measurement (range > 20 V) and measure the DC voltages of Vout = ________ (unregulated) and Vs = ________ (regulated).

![Figure 3. DC Output voltage measurement](image2)
D. Measure Voltage Waveforms of 12V DC Power Supply

1. Disconnect the AC 120 V power source.
2. Write down the brand and model number of the Digital Oscilloscope: _______________________________________.
3. Connect the Channel 1 (CH 1) of the Digital Oscilloscope to $V_{ac}$ (secondary side of the transformer - 6.3 V/ 6.3 V) as shown in Figure 4.
4. Connect the Channel 2 (CH 2) of the Digital Oscilloscope to $V_{out}$ (full-wave rectified output voltage) as shown in Figure 4.

5. Turn on the power of Digital oscilloscope; then turn on the AC 120 V input to the transformer.
6. Push the Auto Test button to observe both $V_{ac}$ and $V_{out}$.
7. Adjust the Horizontal knob to show less than 2 complete cycles of waveforms.
8. Take a digital picture of the displayed screen.
9. Sketch the two waveforms and write down all the information displayed on the screen.

Figure 4. Voltage Waveform Measurement using Digital Scope

Figure 5. Sketch of Vac and Vout voltage waveform
10. Turn off or remove AC 120 V power soured
11. Remove C1, 100 μF, capacitor, then turn on the AC 120 V input to the transformer, as shown in Figure 6.

![Digital Oscilloscope](image)

Figure 6. Voltage Waveform Measurement using Digital Scope (without C1)

12. Push the Auto Test button to observe both $V_{ac}$ and $V_{out}$.
13. Adjust the Horizontal knob to show less than 2 complete cycles of waveforms.
14. Take a digital picture of the displayed screen.
15. Sketch the two waveforms and write down all the information displayed on the screen.

![Waveforms](image)

Figure 7. Sketch of $V_{ac}$ and $V_{out}$ voltage waveform (without C1)
E. Verifying Frequency, and Voltages 12V DC Power Supply
1. Verify the frequency of the power source is \( f = ________ \) (60 Hz) and the period \( T = ________ \) (16.67 ms).

2. Calculate and Verify the Vac and Vout.
   a) Compute maximum secondary voltage of the transformer (6.3V + 6.3V side)
      \( \text{VacMax} = \text{VacRMS} \times \sqrt{2} = ________ \) volts. Where \( \text{VacRMS} = ________ \) is the measured voltage from DMM (Step A.2). Verify that this value is equal to the measurement from Digital Oscilloscope.
   b) Compute the full-wave DC output voltage \( \text{Vout \_calculated} = \text{VacRMS} \times 0.9 = ________ \) volts. And \( \text{Vout \_calculated} = \text{Vout} = ________ \) equals to the measured DC voltage from DMM (Step A.3).