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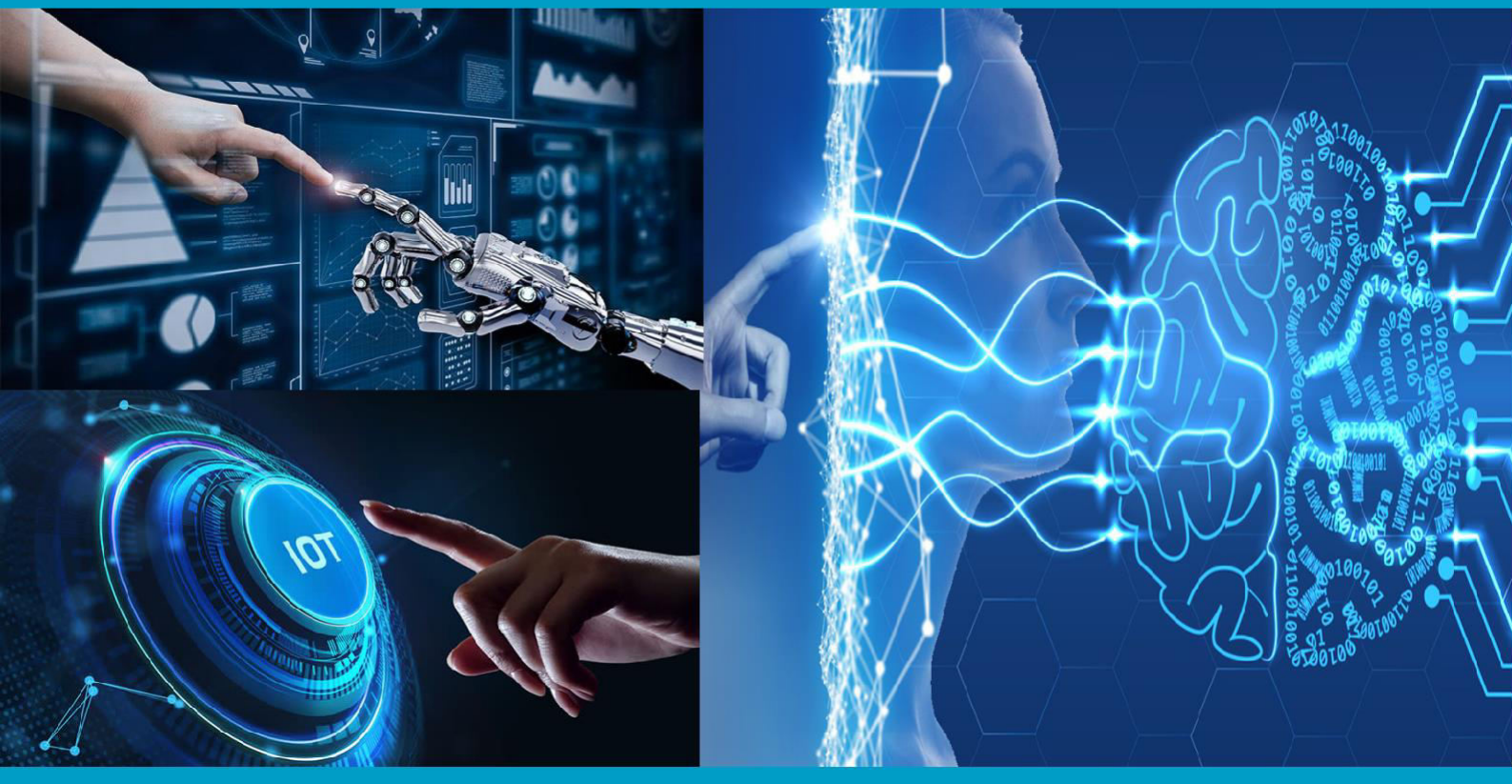

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Automatic Power Factor Compensation for Industrial Power Use to Minimize Penalty

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ABSTRACT: In modern times the use of electricity is increasing day by day and most of the electrical energy utilized in industrial sector other than residential and farming sector. The conservation of electrical energy is of great importance because of resources are decreasing as the time passes. In industrial sector most of the loads are of inductive in nature that is lagging type load. These lagging types of loads requires which is to be provided by the power generating utility. But the loads are continuously varying so, the need of reactive power varies. The poor power factor causes more losses in our power system also poor power factor leads to wastage of energy. The industrial commercial installation in country as large inductive loads installed which causes lagging power factor and gives penalties to consumers by utilities. So, we need power factor correction which can compensate reactive power requirement by the loads. For rapidly varying loads it is difficult to manually switch compensating capacitors. APFC unit which uses micro controller compensate the reactive power by switching capacitor banks automatically and maintain power factor near to unity.

KEYWORDS:Power factor (PF), Active power, Apparent power, Reactive power, current transformer (CT), Potential transformer (PT) , LCD ,Capacitor bank (CB).

I. INTRODUCTION

Power factor is the ratio between real power and the apparent power of the equipment. In the present trend, Automatic Power Factor Controller design can be achieved by using programmable device. As we think about programmable device embedded system comes forefront. Embedded system nowadays is very popular and microcontroller proves to be advantageous with the reduction of cost, extra hardware use such as timer, RAM, ADC are avoided. Only the relays used are disadvantageous as they are too bulky and need regular maintenance. Now the embedded technology has become cheaper with the help of technical revolution so as to apply it in all the fields. Automatic Power Factor Correction device is very useful to improve the transmission of active power efficiently. Power factor must be maintained within a limit. As inductive load is connected, Power factor lags and when Power factor goes below the lagging Power factor, then a penalty is charged by the supplying company. Therefore, it is necessary to maintain Power factor within limit. APFC techniques can be applicable to industries, power systems and also to households to make them stable and also help in improving the efficiency of the system. Poor Power factor can be improved by addition of Power factor correction, but a poor Power factor which is caused due to distortion in current waveform needs to have a change in the design of the equipment APFC is to be developed based on microcontroller (AT89S52\C51).

II.EXCISTING SYSTEM

BY USING CAPACITORS:

Improving P F means decreasing the phase difference of the voltage and the current. Inductive loads require some reactive power for them to work. The reactive power is provided by bank of capacitors that are connected parallel to load. It can be said that capacitors are a source of local reactive power, and hence lesser reactive power flows from the line. They decrease the phase difference in the voltage and current. When capacitors are used Losses are low and also requires very less maintenance. Installation of capacitors is easy because of lighter weight and do not require foundation.

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BY USING SYNCHRONOUS CONDENSERS:

Like a capacitor bank, we can use an overexcited synchronous motor to improve the poor power factor of a power system. The main advantage of using synchronous motor is that the improvement of power factor is smooth. When a synchronous motor runs with over-excitation, it draws leading current from the source. We use this property of a synchronous motor for the purpose. Here, in a three-phase system, we connect one three phase synchronous motor and run it at no load.

III.PROPOSED SYSTEM

The microcontroller is the heart of the Automatic power factor correction unit. It processes the algorithms which are specified by the user to ensure the variation in the power factor in specifying limit and maintain power quality. The current transformer and voltage transformer are used to get the current and voltage signals which are inputs to the microcontroller. This automatic power factor correction unit detects the phase lag between the voltage and current waveform by using zero crossing detector to determine the existing power factor. To bring it to unity, it is required to connect capacitor bank with the system. The number of capacitors that is to be connected for compensation is determined by the algorithms in microcontroller. When the power factor is not near to unity then the microcontroller sends the signal to switching unit which will switch the number of capacitors that is Demanded from the capacitor bank and connect it to the system with the help of relay. The relay driver is used for interface between the microcontroller and the capacitor banks. The LCD displays the existing power factor and also the result of compensation.

IV.OPERATION

The step down of the current and voltage is required to be done to provide appropriate voltage level to the microcontroller with the help of voltage and
+ current transformer. The lowered value is fed into the microcontroller for its operation. Now, voltage and current signals are passed through zero crossing detector. which detects the zero crossing time of both the waveforms. The IC LM311 is used for this purpose. This is the second stage of the operation. The phase difference is the time difference of both the waveform when it crossed the zero level. Using this phase difference. the microcontroller calculates the power factor. The next step refers to the automatic control unit with continuously monitors load and maintain the power quality of the system.

Case 1: In case of resistive load, there is no phase delay between current and voltage signals so they are in phase. The power factor in this case would be unity and no insertion of capacitors is required for improvement.

Case 2: When Inductive load is turned ON the phase delay between voltage and current signals is sensed by microcontroller. The power factor is calculated and the desired value of capacitor is inserted to improve the power factor of the system. Now after the insertion of the capacitors the current and voltage waveform is in phase and hence the power factor is improved.

V.POWER FACTOR CORRECTION

The power factor of an AC electric power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number between 0 and 1 (frequently expressed as a percentage, e.g. 0.5 pf = 50% pf). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be greater than the real power. In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor. Linear loads with low power factor (such as induction motors) can be corrected with a passive network of capacitors or inductors. Non-linear loads, such as rectifiers, distort the current drawn from the system. In such cases, active or passive power factor correction may be used to counteract the distortion and raise the power

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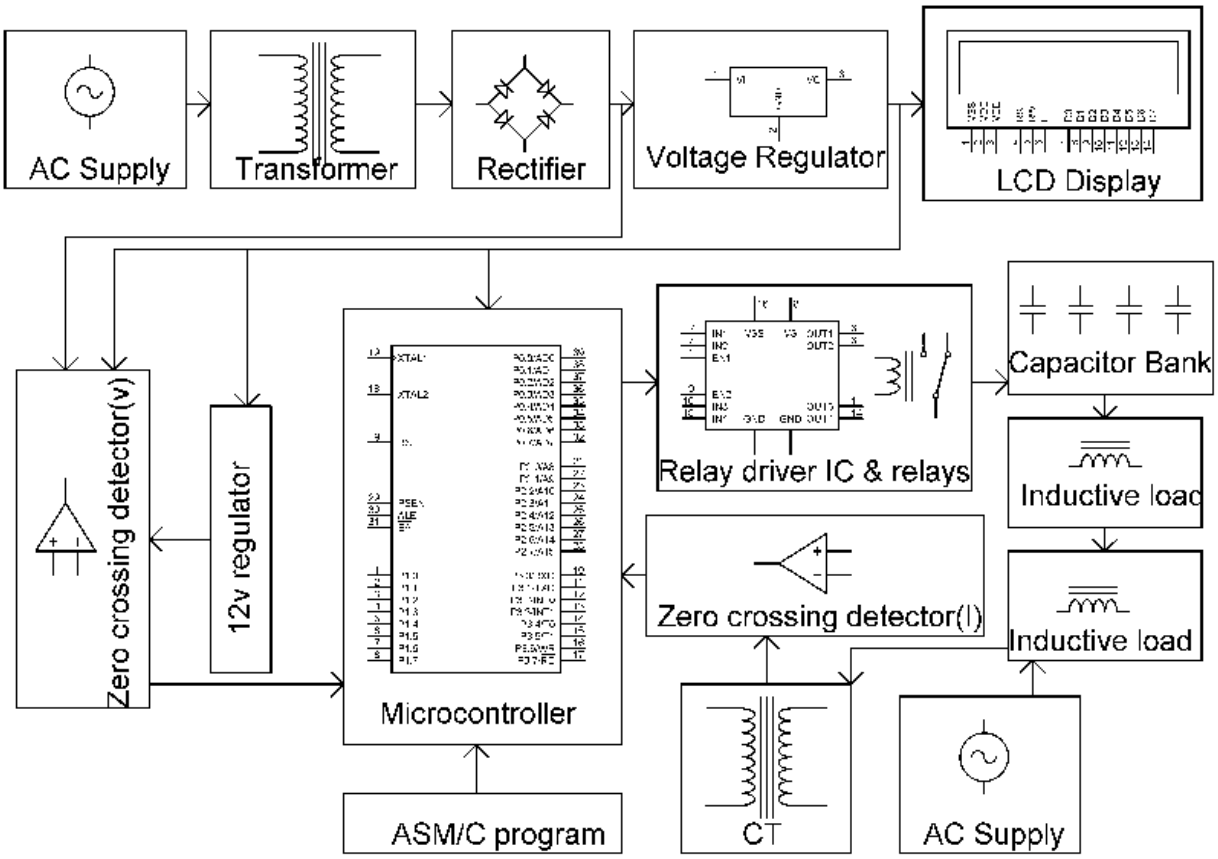
factor. The devices for correction of the power factor may be at a central substation, spread out over a distribution system, or built into power-consuming equipment.

V.BLOCK DIAGRAM



HARDWARE COMPONENTS:

1. TRANSFORMER (230 – 12 V AC)
2. VOLTAGE REGULATOR
3. RECTIFIER
4. FILTER
5. MICROCONTROLLER (AT89S52/AT89C51)
6. RELAY
7. RELAY DRIVER
8. PUSH BUTTONS
9. LCD
10. LM339
11. CURRENT TRANSFORMER
12. INDUCTIVE LOAD
13. SHUNT CAPACITOR
14. LED
15. 1N4007 / 1N4148
16. RESISTOR
17. CAPACITOR

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VI.MICROCONTROLLER AT89S52

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard 80C51 instruction set and pin out. The on chip Flash allows the program memory to be reprogrammed in a system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

Features:

• Compatible with MCS®-51 Products
• 8K Bytes of In-System Programmable (ISP) Flash Memory
– Endurance: 10,000 Write/Erase Cycles
• 4.0V to 5.5V Operating Range
• Fully Static Operation: 0 Hz to 33 MHz
• Three-level Program Memory Lock
• 256 x 8-bit Internal RAM
• 32 Programmable I/O Lines
• Three 16-bit Timer/Counters
• Eight Interrupt Sources
• Full Duplex UART Serial Channel
• Low-power Idle and Power-down Modes
• Interrupt Recovery from Power-down Mode
• Watchdog Timer
• Dual Data Pointer
• Power-off Flag
• Fast Programming Time
• Flexible ISP Programming (Byte and Page Mode)
• Green (Pb/Halide-free) Packaging Option

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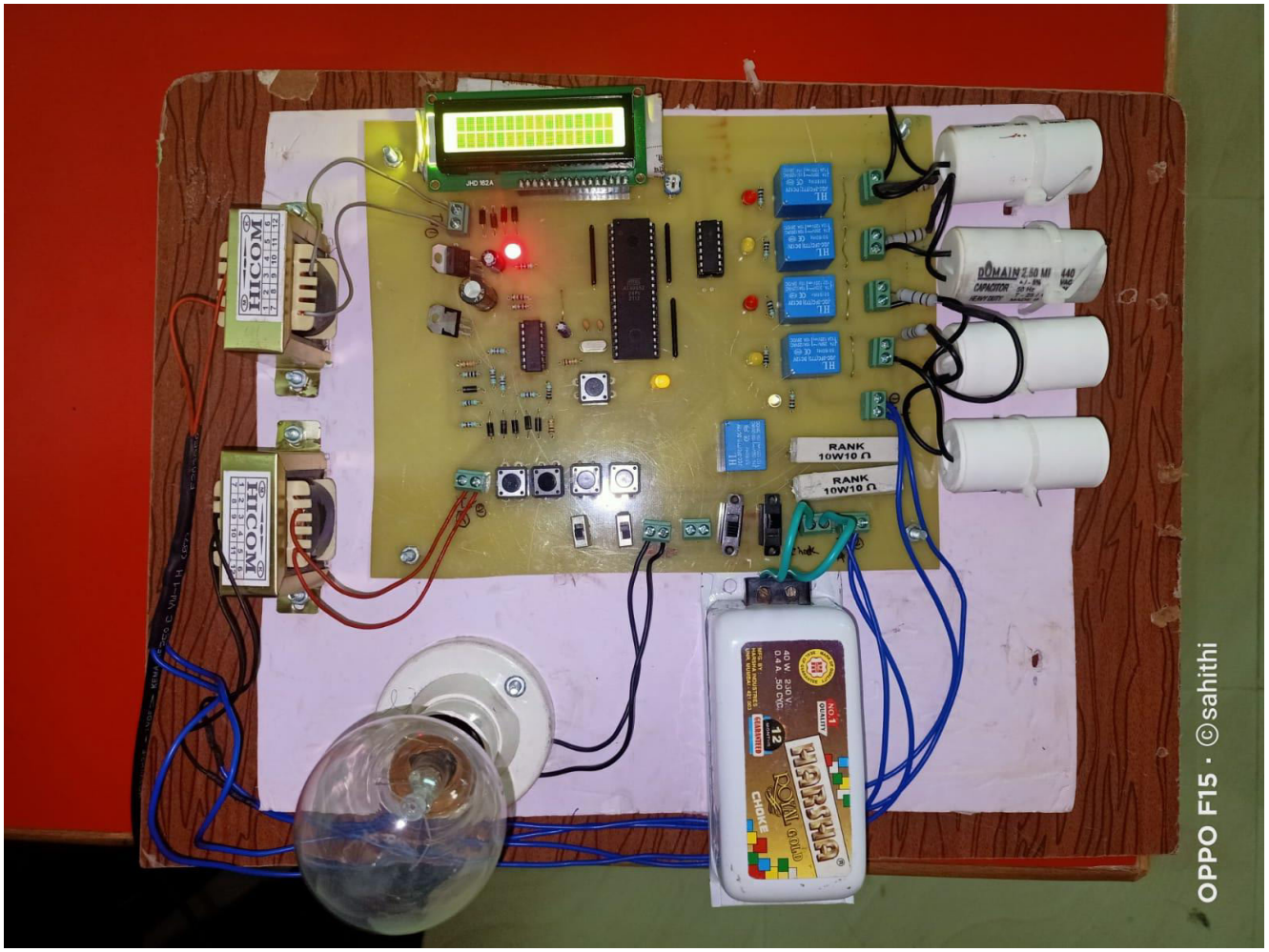
VII.PROJECT KIT



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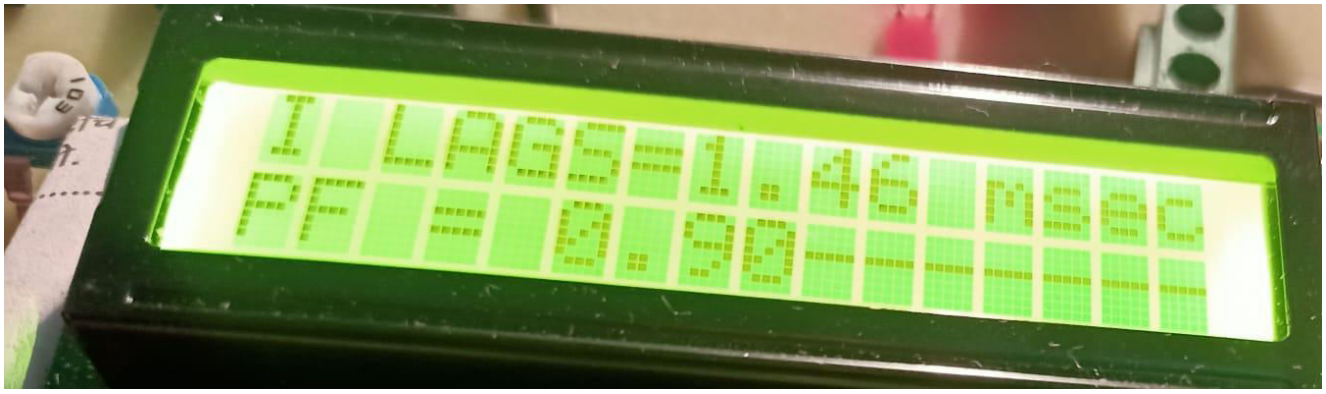
VIII. RESULTS

OBSERVATION	I LAGS	POWER FACTOR	IMPROVED POWER FACTOR
NO CAPACITOR	3.03	0.58	0
ONE CAPACITOR	1.46	0.90	0.32
TWOCAPACITOR	0.21	1.00	0.42
THREE CAPACITOR	2.91	0.61	0.20

WHEN ONE CAPACITOR IS ACTUATED



WHEN TWO CAPACITOR IS ACTUATED

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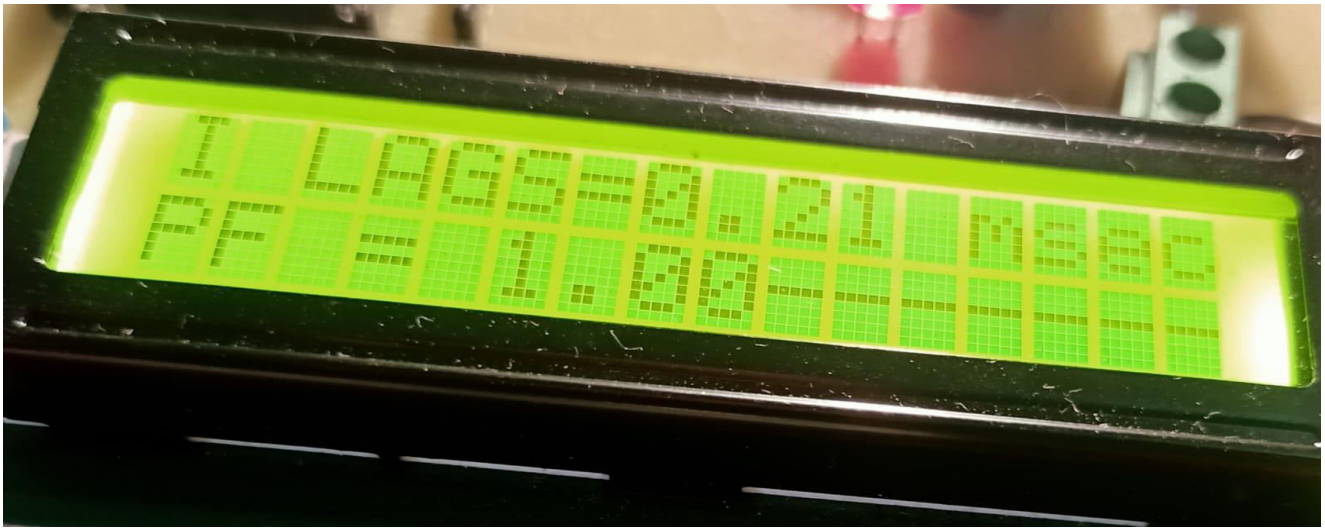
WHEN THREE CAPACITORS IS ACTUATED



FUTURE SCOPE

The automatic power factor correction using capacitive load banks is a very efficient as it reduces the cost by decreasing the power drawn from the supply. As it operates automatically Manpower is not required and this Automated Power Factor Correction using capacitive load banks can be used for the industries purpose in the future.

ADVANTAGES

1. Reactive power decreases
2. Efficiency of supply system and apparatus increases.
3. The electrical consumption tariffs depend on power factor.
4. Avoid poor voltage regulation
5. Overloading is avoided
6. Copper loss decreases
7. Transmission loss decreases
8. Improved voltage control
9. Efficiency of supply system and apparatus increases

IX. CONCLUSION

The Automatic power factor correction unit is the cheapest way to implement the power factor compensation for the lagging loads which are continually varying. It brings the power factor near to unity. Also we can define the power factor range which should be maintained for a particular system using this unit. It also monitors the lagging and leading power factor and takes the necessary control action. The real time data for the power factor can also be stored using this unit. The consumers using power near unity power factor is also provided incentives to encourage the efficient use of electricity.

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