# Flexible Ac Transmission System By Static Variable Compensator

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***Abstract-*** *The FACTS (Flexible AC Transmission System) is a broad term representing the application of power electronics based solutions to AC power system. More and more power semiconductor based devices, called FACTS , with ratings from tens to hundreds of Giga watts, have been utilized in the power systems to satisfy the function of achieving better power transferability and enhancing power system controllability with the maturity of manufacturing and development and application of power electronics technology. FACTS actually is the application of power electronic equipment, with one or multiple functions, to regulate and control the electrical parameters that govern the operation of transmission systems including voltage, current, impedance, phase angle and damping of oscillations .*

***Keywords***- Motor, FACTS, Controller, Regulator, Transformer, Microcontroller.

## I. INTRODUCTION

The FACTS (Flexible AC Transmission System) is a broad term representing the application of power electronics based solutions to AC power system. FACTS controllers can cause rapid changes of the important system parameters mentioned above. Their presence, therefore, can significantly affect the operation of traditional distance schemes when either series or shunt connected FACTS devices introduce new dynamic controls into the power systems. They would inevitably affect the characteristics of a protective relay in a transmission line to some extent.

Energy efficiency is a topic that has become more and more prominent as demand for electrical power grows. When inductive loads are introduced to the power system by customers, the voltage at customers point reduces. This is due to the increased load current caused by an increase in the amount of reactive power the utility has to supply to the inductive load. This further increases the systems loss and reduces the efficiency of the power system. To the customer, this will cause them to pay more for the electricity bill and they may receive penalties by the utility company if the required reactive power is significant.

This type of problem is typically indicated by the low power factor at the load. A widely used approach to mitigate this problem is through the use of corrective capacitors. Capacitor is an electrical component that can supply reactive power, and hence fits well for the reactive power thirst inductive load. Using a set of capacitance may be sufficient to correct power factor in predominantly inductively load; however, real world loads vary with time and hence a fixed set of capacitance can potentially lead to overcompensation.

This in turn will produce an unnecessary boost in voltage which could further damage the loads. Hence, a better method to improve power factor is needed. In particular, an approach that would match the reactive power requirement of the load as it changes will be desirable. One known technique to improve power factor or to compensate for reactive power uses power electronics. Power electronics deals with the flow control of electricity through switching or power semiconductors.

## II. OBJECTIVE

- In this project to improve power factor of transmission lines using static variable compensator.
- This proposed system demonstrates power factor compensation using thyristor switched capacitors
- The time lag between the zero voltage pulse and zero current pulse duly generated by suitable operational amplifier circuits
- Thereafter program takes over to actuate appropriate number of opto-isolators duly interfaced to back to back SCRs

## III. SYSTEM DESIGN

In this paper to improve power factor of transmission lines using static variable compensator. These were inefficient and because of large rotating parts they got damaged quickly. Static VAR Compensation under FACTS uses TSC (Thyristor Switched Capacitors) based on shunt compensation duly controlled from a programmed microcontroller.

This proposed system demonstrates power factor compensation using thyristor switched capacitors. The time lag between the zero voltage pulse and zero current pulse duly generated by suitable operational amplifier circuits in comparator mode are fed to two interrupt pins of the 8 bit microcontroller of 8051 family. Prior to the implementation of static variable compensator, power factor compensation was done by large rotating machines such as synchronous condenser or switched capacitor banks.

Shunt capacitive compensation – This method is used to improve the power factor. Whenever an inductive load is connected to the transmission line, power factor lags because of lagging load current. To compensate for this, a shunt capacitor is connected which draws current leading the source voltage. The net result is improvement in power factor.

Thereafter program takes over to actuate appropriate number of opto-isolators duly interfaced to back to back SCRs. Further the project can be enhanced to thyristor controlled triggering for precise PF correction instead of thyristor switching in steps. This result in bringing shunt capacitors into the load circuit to get the power factor till it reaches unity.

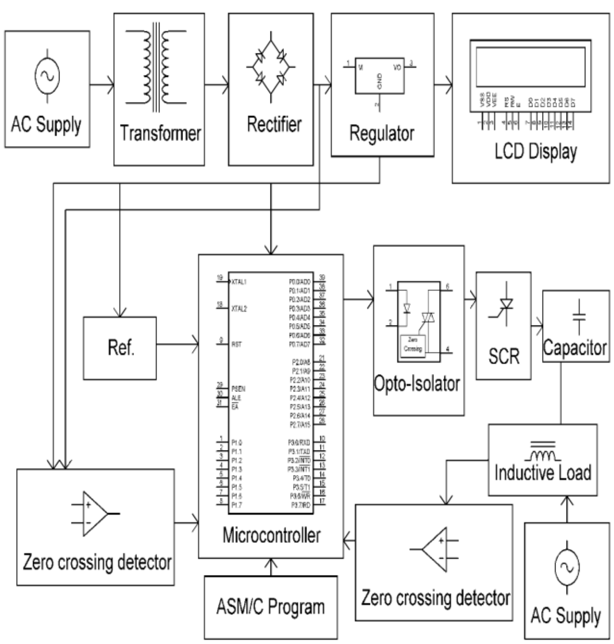



Fig. 1.1 BLOCK DIAGRAM

## IV. WORKING DESCRIPTION

This method is used either when charging the transmission line, or, when there is very low load at the receiving end. Due to very low or no load a very low current flows through the transmission line. Shunt capacitance in the transmission line cause Ferranti Effect. The receiving end voltage may become double the sending end voltage (generally in case of very long transmission lines). To compensate, shunt inductors are connected across the transmission line. The lead time between the zero voltage pulse and zero current pulse duly generated by suitable operational amplifier circuits in comparator mode are fed to two interrupt pins of the microcontroller where the program takes over to actuate appropriate number of opto-isolators interfaced to back to back SCRs at its output for bring shunt reactors into the load circuit to get the voltage duly compensated. The microcontroller used in the project is of 8051 family which is of 8 bit. The power supply consists of a step down transformer 230/12V, which steps down the voltage to 12V AC. This is improved to DC using a Bridge rectifier. The ripples are removed using a capacitive filter and it is then regulated to +5V using a voltage regulator 7805 which is required for the operation of the microcontroller and other components.

## V. HARDWARE DESCRIPTION

### 1.1 TRANSFORMER

Transformers convert AC electricity from one voltage to another with a little loss of power. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high voltage to a safer low voltage.

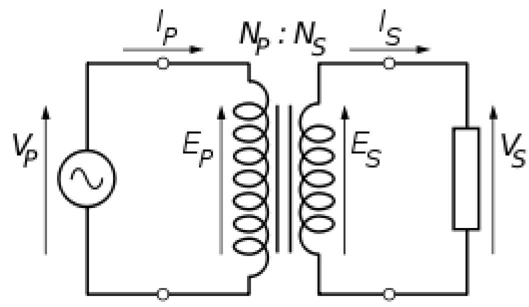
FIG 1.2: A TYPICAL TRANSFORMER

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down and current is stepped up.

$$\text{TURNS RATIO} = (Vp / Vs) = (Np / Ns)$$

Where,

Vp = primary (input) voltage.
Vs = secondary (output) voltage
Np = number of turns on primary coil
Ns = number of turns on secondary coil
Ip = primary (input) current
Is = secondary (output) current.




$$\frac{V_P}{V_S} = \frac{I_S}{I_P} = \frac{N_P}{N_S}$$

Fig. 4. ideal transformer as a circuit element

If the secondary coil is attached to a load that allows current to flow, electrical power is transmitted from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient; all the incoming energy is transformed from the primary circuit to the magnetic field and into the secondary circuit. If this condition is met, the incoming electric power must equal the outgoing power:
$P_{incoming} = I_P V_P = P_{outgoing} = I_S V_S$

## VOLTAGE REGULATOR 7805

### Features

- Output Current up to 1A.
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V.
- Thermal Overload Protection.
- Short Circuit Protection.
- Output Transistor Safe Operating Area Protection.

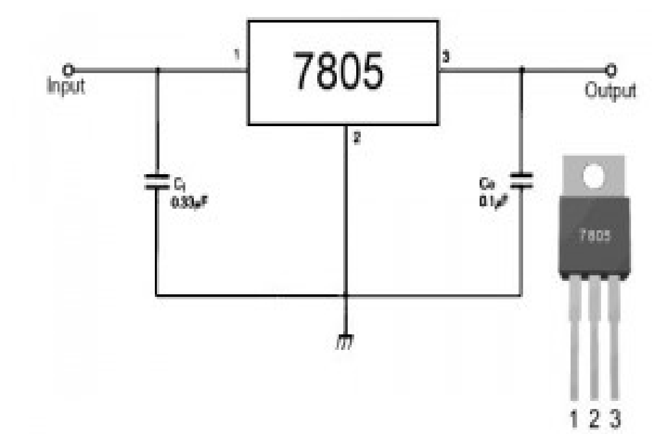



fig. 5 voltage regulator 7805

### Description

The LM78XX/LM78XXA series of three-terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a Wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output Current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

## MICROCONTROLLER IC: (89C51)

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4 Kbytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications.

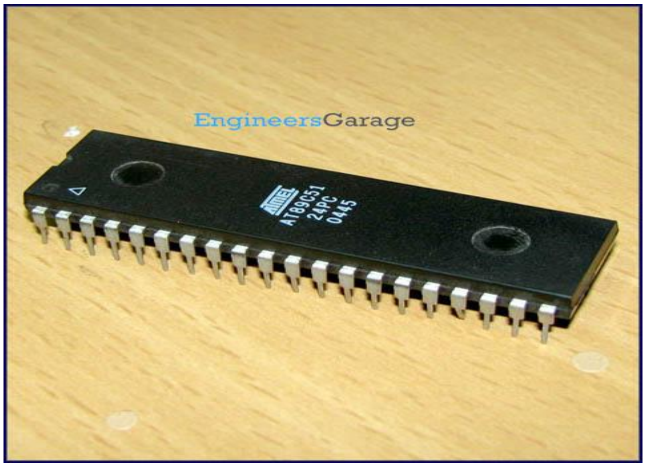



Fig6. Microcontroller

The AT89C51 provides the following standard features: 4 Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the AT89C51 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, timers/counters, serial port and interrupt system to continue functioning. The power down mode saves the RAM contents but freezes the oscillator disabling all other functions until the next hardware reset.

**LIQUID CRYSTAL DISPLAY**

This is the first interfacing example for the Parallel Port. We will start with something simple. This example doesn't use the Bi-directional feature found on newer ports, thus it should work with most, if not all Parallel Ports. It however doesn't show the use of the Status Port as an input for a 16 Character x 2 Line LCD Module to the Parallel Port. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required running them is on board.

**LCD Background**

Frequently, an 8051 program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an 8051 is an LCD display. Some of the most common LCDs connected to the 8051 are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Fortunately, a very popular standard exists which allows us to communicate with the vast majority of LCDs regardless of their manufacturer. The standard is referred to as HD44780U, which refers to the controller chip which receives data from an external source (in this case, the 8051) and communicates directly with the LCD.

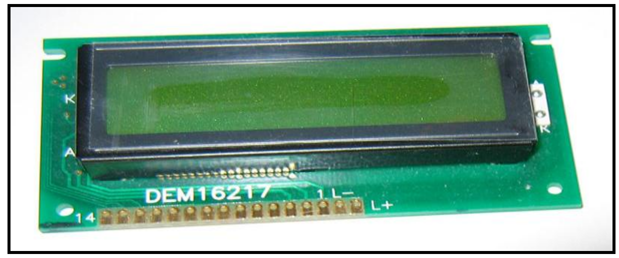



Fig 7: LCD

## VI. CONCLUSION

The main aim of this project is to study the AC Transmission system. Our main objective was to create an enhanced circuit that will improve the power factor. The Flexible AC Transmission system achieved by improving the power factor reduces the output voltage fluctuations providing us with a more efficient and stable transmission system. This proposed system increases the power factor by nearing its value to 1 with the help of the capacitor bank in the circuit. Microcontroller based thyristor driven static variable compensation gives the better results than the conventional types of compensation techniques like synchronous condensers. Due to the usage of thyristors than the conventional relay circuit makes the whole system free from contact pitting. This will also help to maintain a sustainable future in which we have limited sources of power and limited AC Transmission lines .

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