

# Design and Development of a Fuzzy Logic Implementation of a Microcontroller Based FACTS Employing Thyristor Controlled Reactor/ Thyristor Switched Reactance for Power Quality Management

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## Abstract

The main power quality eccentricities are occurred by Ferranti effect, short-circuits, voltage sparks, voltage swells harmonic distortions, voltage sags and transients occur by switching of load. The fundamental sinusoidal waveform of current will change when we are using a non-linear load in a power system. Power quality are modify reactive power problem such as power factor lagging due to inductive load or voltage multiplication using Ferranti effect by Thyristor Switched Reactance (TSR) and Thyristor Controlled Reactor (TCR) are two of shunt FACTS(flexible AC transmission system) devices have been used as an alternative to fixed shunt capacitors and fixed reactors in power systems. Application Fuzzy logic on 8 bit microcontroller to sense power quality and employ corrective action and system is designed using fuzzy logic controller and MAT Lab coding.

**Keywords:** Capacitive load, FACTs, Ferranti effect, Inductive load, PWM, TSR, TCR

## Introduction

The power era and transmission is an unpredictable procedure that requiring the working of various segments of the power framework pair to amplify the yield. In the present era, PQ has turned out to be a standout amongst the most critical issues. Because of the utilization of various sorts of touchy electronic supplies, PQ issues have drawn generous consideration from both utilities and clients. The primary PQ deviations are occurred by short circuits, consonant bends, scoring, voltage lists, voltage glimmers, voltage swells and homeless people because of exchanging of load.<sup>1</sup> Actualities devise has been proposed for the utilization of strong state gadgets to control mass power stream in transmission framework. The vital of FACTS gadget is enhancing transmission capacity, expanding the adaptability of force stream control and controlling voltage.<sup>2</sup> These possibility emerge through the capacity of FACTS controller to control the predictable parameters that coordinate the operation of transmission framework including shunt impedance, arrangement impedance, current, voltage, stage edge and the damping of swaying at various frequencies under the evaluated recurrence.<sup>3</sup>

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### Power Quality Issues

When we are utilizing a non-direct load in a power framework, the essential sinusoidal waveform of current will change.<sup>4</sup> Because of this non-sinusoidal voltage drop happen over the different system components associated with the framework bringing about mutilated waveform spread all through the framework.<sup>5</sup> There are diverse sorts of PQ aggravations in an electrical power framework. A current research by PQ specialists found that half of all PQ issues are identified with establishing, ground bonds, and fair to ground voltages, ground circles, ground ebb and flow or other ground related issues.<sup>6</sup> A portion of the power quality issues are voltage droop, voltage swell, sounds, voltage glimmer and so on.

### Power Quality Improvement

FACTS devise has been recommended for the utilization of strong state gadgets to control mass power stream in transmission framework. The chief of FACTS gadget is enhancing transmission capacity, expanding the adaptability of force stream control and controlling voltage.<sup>3</sup>

The FACTS gadget innovation discharges new events for controlling force and improving the working limit of present, and additionally new and redesigned transmission lines.<sup>7</sup> The open door that current and in

this manner control over a line can be controlled permits a substantial capability of developing the limit of existing lines. Certainties TCR/TSR framework to exhibit control quality actualizes in experiment of Ferranti impact counteractive action and utilization of Thyristor control reactor or thyristor switch reactance (TCR/TSR) by era of Pulse width modulation(PWM) signals from microcontroller utilizing fluffy rationale for terminating of thyristor.<sup>8</sup> Thyristor control reactor or thyristor switch reactance (TCR/TSR) FACTs gadget in execution of a dynamic power calculate control utilizing static variable compensator or change capacitor innovation to accomplish dependable power consider as shut to solidarity.

### TSR/TCR Static Var Compensator

A shunt-associated, thyristor-controlled reactance whose compelling reactance is assorted consistently because of fractional conduction control of the thyristor esteem. The general structure of a static var compensator (SVC) comprises of a settled shunt capacitor and a thyristor controlled reactor. A SVC is generally a shunt associated static var generator/compensator whose yield is commonplace to trade capacitive or inductive current in order to protect or control exact power framework factors. One TCR, which involves two thyristor in hostile to parallel and a reactor to be controlled, with one settled capacitor.

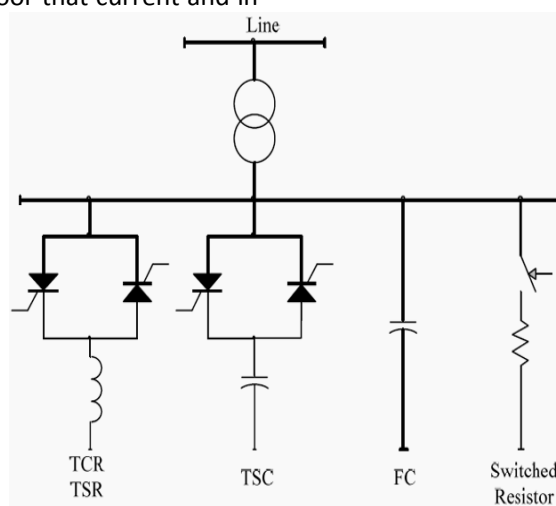


Figure 1.TCR/TSR Static var Compensator<sup>9</sup>

Thyristor switching capacitor (TSC) is a shunt-associated, TSC powerful reactance is fluctuated in a stepwise way by full-or zero-conduction operation of the thyristor esteem. At the point when a capacitor is alleviated into a sinusoidal voltage source, a high current surge moves through the capacitor if the underlying voltage transversely the capacitor is disparate than the supply voltage at the incite of exchanging.

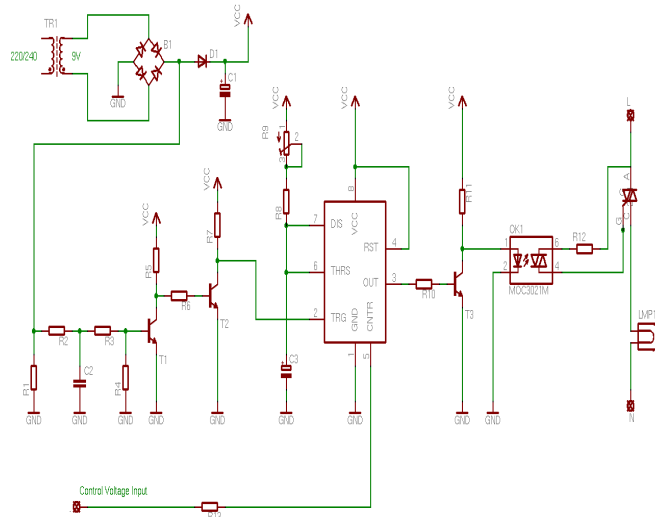
### Fuzzy Logic Controller

Fuzzy logic is the piece of computerized reasoning and machine realizing which interprets the human activity. PCs can translate just genuine or false values however an individual can reason the level of truthiness and level of falseness. Fluffy model decipher the human activities and are likewise called astute frameworks. Fuzzification

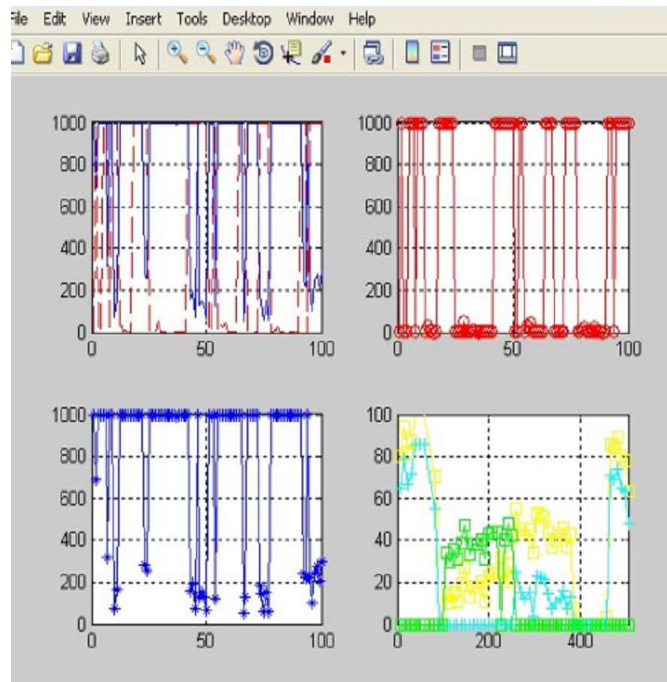
is the way toward changing a genuine scalar incentive into a fluffy esteem. This is achieved with the diverse sorts of fusilers. Fluffy rationale is a control based

framework. These tenets are put away in the information base of the framework. The contribution to the fluffy framework is a scalar esteem that is fuzzified.

**Results**



**Figure 2.Firing Angle Controller**



**Figure 3.Observation Graph**

**Table 1.Observation Time Line Table**

S. No.	Time	Current crossing Peak (r)	Condition detect	Inductive PWM	Capacitive PWM
1	0- 90	78-89	Inductive load	0	62-72
2	90-220	13-23	Capacitive load	36-42	0
3	220-380	34-45	Mixed load	0	17-21
4	380-500	0-0	No load	0	0

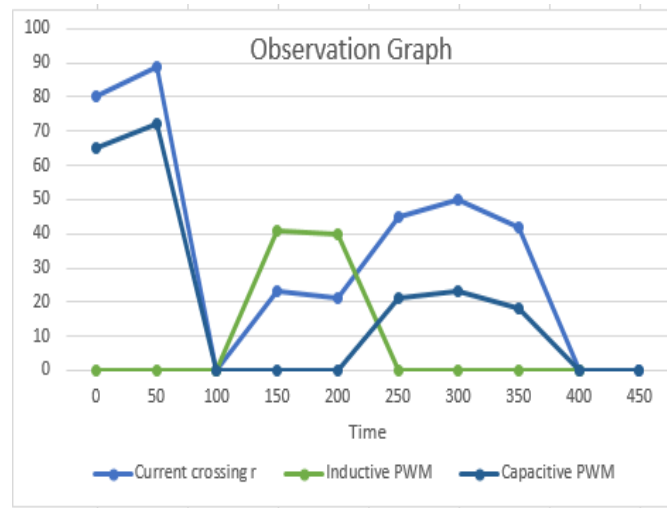


Figure 4. Observation Time Line Table

- Mode 1. No-load condition

In the observation recognized by the chart starting estimation of current stage are from 0 to 1 simply compare to no heap condition as outlined by the framework, the framework are not working any inductive or capacitive redress in light of the fact that there is no heap. In thus inductive and capacitive PWM are off.

- Mode 2. Inductive load condition the present stage are from 78 to 89 simply relate to inductive load condition as outlined by the framework. The frameworks are working at capacitive amendment.
- Mode 3. Capacitive load condition the present stage is from 13 to 23 than inductive PWM are ON and keep up the heap.
- Mode 4. Blended load condition the present stages are from 34 to 45 and that time inductive load are high so capacitive.

## Conclusion

As per the results the desired efficient PWM base FACT system has been developed which can implemented on both inductive and capacitive line loading condition using thyristor switching reactance and thyristor switching capacitance respectively. In the above results It is experimented that, when the capacitive load is increased the inductive PWM starts and when inductive load is increased the capacitive PWM starts. When both types load mixed load the capacitive load is negligible but inductive load is so high that capacitive PWM starts. Hence the overall system senses the power and minimizes the reactive power problem such as power factor lagging due to inductive load or voltage multiplication by Ferranti effect.

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