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Fuzzy Logic Based iUPQC for Grid Voltage Regulation at Critical Load Bus

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***Abstract:** This paper exhibits another association for an UPQC called interline UPQC (IUPQC). The enhanced controller of IUPQC accommodates all functionalities of these previous ones, alongside the voltage bearing at the stack perspective transport, and now provide additionally voltage guidance at the structure viewpoint transport, like a STATCOM to the framework. the execution of the IUPQC and the UPQC was seen when filling in as UPQCs. The significant complexity between these compensators is the kind of source duplicated through the affiliation and shunt controlconverters. The structure, control and ability of the IUPQC are examined in this paper with the fluffy rationale controller. The productivity of the proposed arrangement has been confirmed through reenactment thinks about utilizing MATLAB/Simulink.*

***Index Terms*: iUPQC, microgrids, power quality, static STATCOM, Fuzzy Logic**

I. INTRODUCTION

Electric power quality might be characterized as a proportion of how well electric power administration can be used by clients. Power Quality issue is an event showed as a nonstandard voltage, current or recurrence that outcomes in a disappointment or a misoperation of end client hardware. To repay music regular Passive Filters are utilized for explicit number of sounds. To pack complete consonant substance Active Power Filters are utilized. For a wide range of intensity quality arrangements at the dissemination framework voltage level DFACTS additionally called as Custom Power Devices are acquainted with enhance Power Quality. Conversely, control equipment pushed masses for the most stage require flawless sinusoidal outfit voltage in order to work fittingly, in spite of the fact that they are the most solid ones for conventional symphonious streams degree in the movement system. In this circumstance, contraptions that can alleviate these risks have been delivered for the length of the years. A component of the plans envelop a versatile compensator, known as the delivered collectively strength first-rate conditioner (UPQC)

The STATCOM has been utilized widely in transmission structures to manipulate the voltage with the aid of methods for dynamic receptive strength remuneration. These days, the STATCOM is to a top notch extent utilized for voltage control [9], although the UPQC and the iUPQC have been picked as answer for progressively unequivocal applications. Moreover, these staying ones are used just exceptionally cases, the spot their somewhat staggering costs are legitimized by method for the power pleasant upgrade it can give, which would be unfeasible by methods for utilizing typical game plans. By joining the additional convenience like a STATCOM in the iUPQC device, a more prominent tremendous circumstance of employments can be come to, predominantly if there be a rate of appropriated age in insightful lattices and as the coupling framework in network tied micro grids.

II. CUSTOM POWER DEVICES

A Custom power gadget gives "wide region" control quality insurance: in other words a solitary gadget can ensure the majority of a plant's basic burdens, instead of securing a solitary burden like an UPS item. The Custom Power items are suitable for vast vitality touchy to the nature of power supply. Custom Power is an innovation driven item and administration arrangement which grasps a group of gadgets which will give control quality capacities at dispersion voltages. It has been made conceivable by the now across the board accessibility of financially savvy high power strong state switches, for example, GTO's and IGBT's. The quick reaction of these gadgets empowers them to work progressively, giving ceaseless and dynamic control of the supply including: sub-cycle exchange of basic burdens, voltage and responsive power direction, symphonious relief and end of voltage droops. Custom Power grasps a group of gadgets, which together make up a tool kit to give control quality arrangements at the appropriation framework voltage level. There are three rule components to the Custom Power idea, these are:

- Dynamic Voltage Restorer (DVR)
- Distribution Static Compensator (D-STATCOM)
- Unified Power Quality Conditioner(UPQC)

Every single Custom gadget are fit for giving various power quality capacities which can be utilized specifically or at the same time. Two of the gadgets - D-STATCOM and the DVR share a comparable design. Both depend on the voltage source inverter and the fundamental life structures of the gadget. DVR is connectedin arrangement with the line where as DSTATCOM is in shunt withthe line over the load.Using a converter, the gadgets show up as completely synchronoussources which are equipped for retaining and infusing reactivepower on a power framework at circulation voltages. UPQC is another Custom Power Device having both arrangement and shunt associated Active Power Filters regular coupled at the DC side of the two converters.

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Utilizing an inverter, the gadgets show up as completely synchronous sources which are fit for retaining and infusing receptive power on a power framework at conveyance voltages. The quintessential venture fashionable of the DVR is toinject a becoming voltage in association with the supplythrough infusion transformer at some thing point voltage grasp orvoltage swell is recognized. Notwithstanding voltage sagsand swells pay, DVR can likewise operate othertasks, for example, consonant pay and Power Factorcorrection. Contrasted with the different Custom Powerdevices, the DVR evidently offers the pleasant economicsolution to its dimension and abilities.

The fundamental activity standard of the DSTATCOM is to infuse a suitable current in parallel with the supply. The VSC associated in shunt with the air conditioner framework gives a multifunctional topology which can be utilized for up to three very unmistakable purposes like, voltage control and pay of receptive power, rectification of intensity factor and disposal of current sounds.

III. Interline Unified Power Quality Conditioner (IUPQC)

The IUPQC showed up in Fig.1 underneath contains of two VSCs (VSC-1 and VSC-2) that are connected successive through an ordinary essentialness amassing dc capacitor. Give us a danger to be given that the VSC-1 is connected in shunt to Feeder-1 while the VSC-2 is connected in relationship with Feeder-2. All of the two VSCs is recognized through three H-interface inverters. In its structure, each change addresses a quality semiconductor machine (e.g., IGBT) and a foe of parallel diode. All of the inverters are outfitted from a standard single dc capacitor Cdc and each inverter has a transformer related at its yield. The total structure of a three-stage IUPQC with two such VSCs is seemed in figure. The auxiliary (dissemination) aspects of the shunt-associated transformers (VSC-1) are related in famous person with the nonpartisan factor being associated with the heap unbiased. The auxiliary twisting of the arrangement related transformers (VSC-2) are specially related in association with the transport B-2 and burden L-2. The air conditioner channel capacitors Cf and Ck are moreover associated in each stage to hold the stream of the symphonious ebbs and flows produced due to the fact of exchanging. The six inverters of the IUPQC are managed autonomously. The exchanging exercise is acquired using yield input control. An IUPQC related with a movement structure is appeared in the figure. In this figure, the feeder impedances are implied by methods for the units (Rs1, Ls1) and (Rs2, Ls2). It all around pleasantly might be viewed as that the two feeders supply the hundreds L-1 and L-2. The store L-1 is foreseen to have two separate fragments—an unequal part (L-11) and a non-direct part (L-12). The streams drawn by method for these two weights are demonstrated by il1 and il2, independently. We likewise acknowledge that the stack L-2 is a sensitive weight that requires persistent and oversaw voltage. The shunt (VSC-1) is connected with transport B-1 towards the completion of Feeder-1, while the affiliation (VSC-2) is connected at transport B-2 toward the completion of Feeder-2. The voltages of transports B-1 and B-2 and over the touchy burden terminal are meant via Vt1, Vt2 , and Vl2, separately.

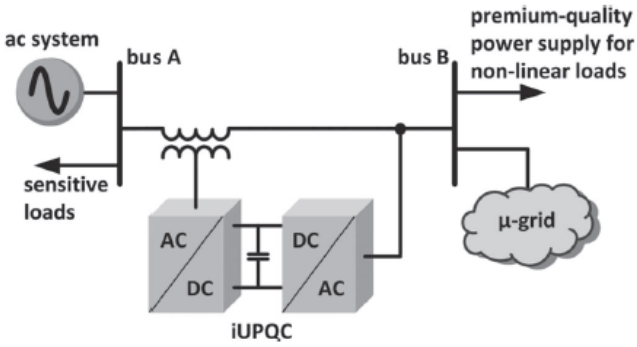

Fig. 1 Electrical System with two buses.

IV. Modified IUPQC

The adjusted iUPQC fills in as an intertie between the transports An and B. Additionally, the microgrid identified with the transport B should be a mind boggling contraption including allocated age, power the executives framework, and other control frameworks.

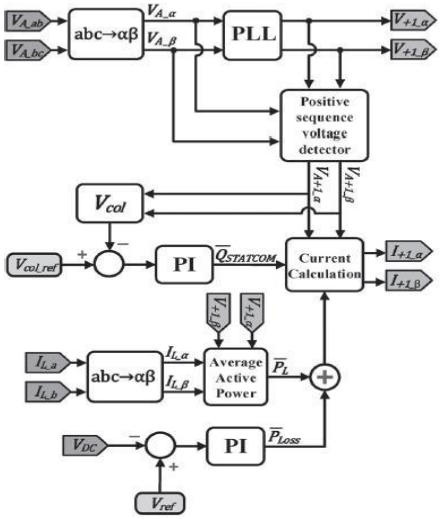

Figure 2 Improved iUPQC controller.

The iUPQC gear and the conscious devices of a three-arrange three-wire system are used in the controller. Figure 3 transport B (iL), and the voltage VDC of the basic dc interface. The yields are the shunt-voltage reference and the plan forefront reference to the beat width change (PWM) controllers. The voltage and present day PWM controllers can be basically used, or be progressively worthwhile further so as to deal higher with voltage and current abnormality and music. The voltage at transport Bis constrained by the shunt converter. Subsequently, it is indispensable to fuse sinusoidal voltages with apparent adequacy and repeat. In this way, the signs despatched to the PWM controller are the stage blasted circle (PLL) yields whose ampleness is proportional to 1 p.u. In the iUPQC approach as showed, the voltage reference of the shunt-converter can be either the PLL yields or the central positive-progression area VA+1 of the cross section voltage. The usage of VA+1 in the controller is to limitation the quality that is streaming by means of the course of action and the shunt converters, under normal action, while the plentifulness of the system voltage is put away inside an adequate extent of enormity.

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Regardless, this isn't the situation here, in the changed iUPQC controller, because of the way that the cross section voltage will moreover be made do with the guide of the balanced iUPQC. So to speak, the two transports will be controlled openly with the reason that their reference regards can be pursued.

Fuzzy Logic Controller

FLC dictated by the arrangement of etymological tenets. The scientific demonstrating isn't required in fluffy controller because of the change of numerical variable into etymological factors. FLC comprises of three section:a. Fuzzification

b. Interferenceengine

c. Defuzzification.

The fluffy controller is portrayed as; for each info and yield there are seven fluffy sets. For straightforwardness a participation capacities is Triangular. Fuzzification is utilizing constant universe of talk. Suggestion is utilizing Mamdani's "min" administrator. Defuzzification is utilizing the "tallness" strategy. FLC square chart as appeared in figure 3.

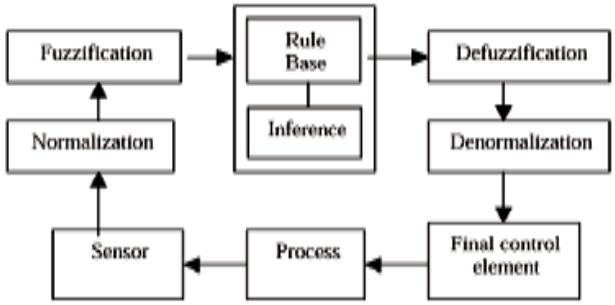

Figure.3 Fuzzy Logic-Controller

In this framework the information scaling factor is between -1 and +1 has plan. The triangular state of the participation capacity of this course of action presumes that for a specific contribution there is just a single predominant fluffy subset is shown in fig4.

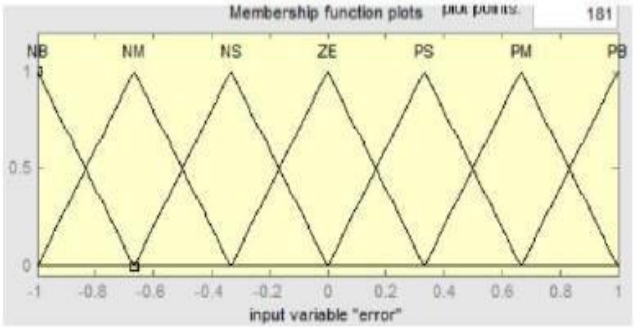

Figure.4 membership function

e / Δe	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	ZE
NM	NB	NB	NB	NM	NS	ZE	PS
NS	NB	NB	NM	NS	ZE	PS	PM
ZE	NB	NM	NS	ZE	PS	PM	PB
PS	NM	NS	ZE	PS	PM	PB	PB
PM	NS	ZE	PS	PM	PB	PB	PB
PB	ZE	PS	PM	PB	PB	PB	PB

Table 1: iUPQC Parameters

In under unusual conditions execution of DVR associated with a solitary feeder framework is explored with PI and FLC controllers. Here, with IUPQC framework worked with PI is researched first for anomalous and hazardous conditions like droops, swells, sounds, symmetrical and awry blames. At that point the equivalent IUPQC framework with Mamdani based FLC is explored for above flawed conditions. Utilizing MATLAB/Simulink programming the IUPQC associated

V. SIMULATION RESULTS

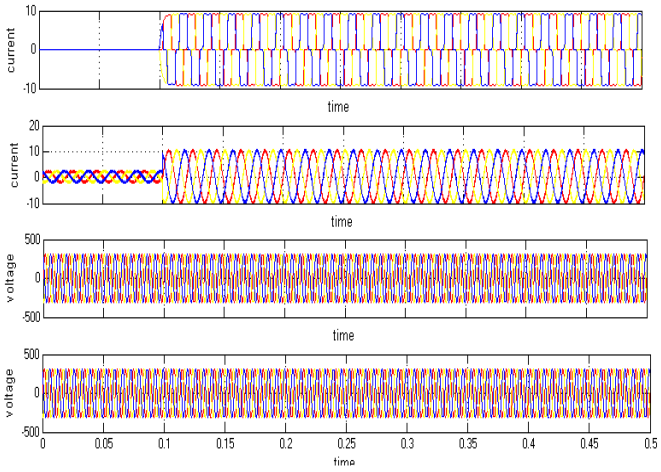

fig:5 load current, grid current, load voltage, grid voltage for iUPQC response using PI controller

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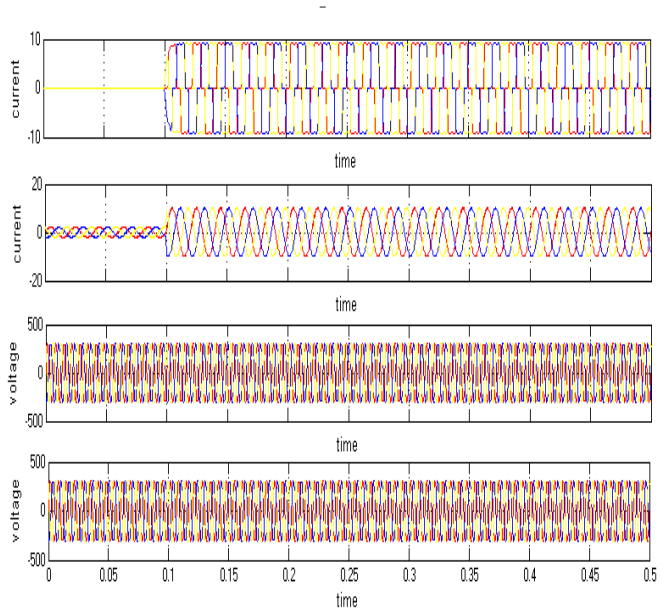

fig:6 load current, grid current, load voltage, grid voltage for iUPQC response using fuzzy logic controller

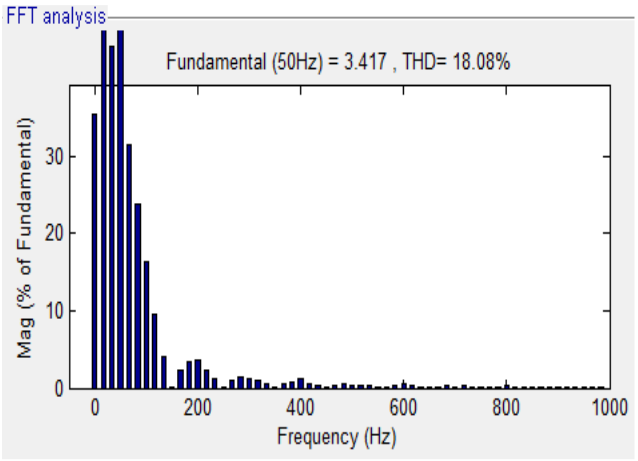

Fig: 7THD without using controller

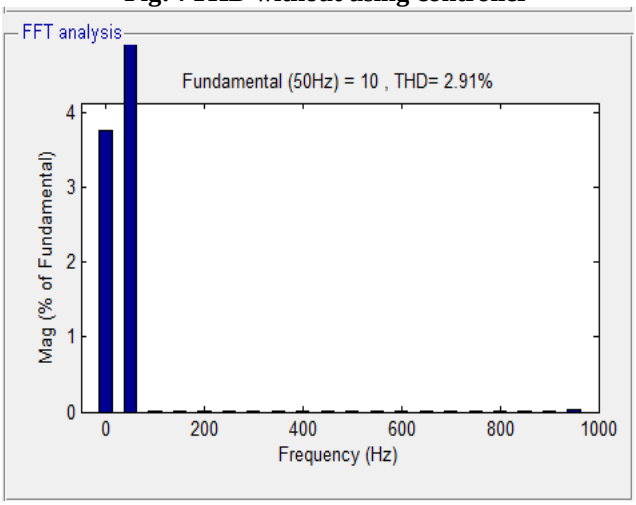

Fig 8:THD using PI controller

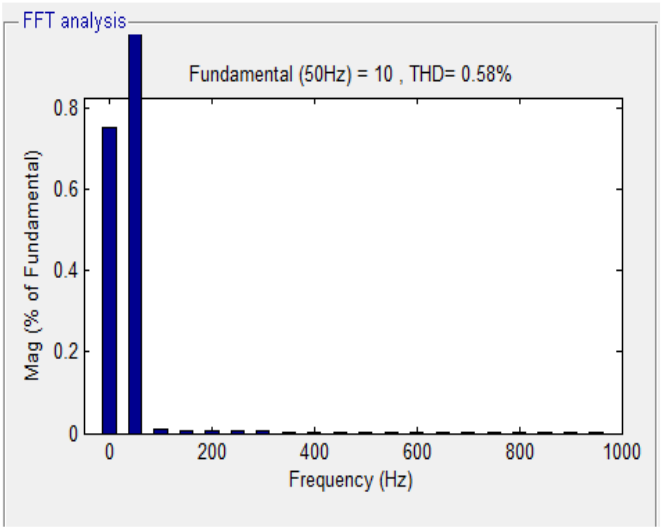

Fig 9:THD using fuzzy logic controller

Comparison Table

Type of the Controller	*THD in %*
Without controller	18.08
PI controller	2.91
Fuzzy Logic controller	0.58

VI. CONCLUSION

The reenactment of non-straight burden with iUPQC is effectively cultivated utilizing PI controller and Fuzzy rationale controllers. The fluffy rationale controller gives better reaction with THD of (0.58) % in the lattice current contrasted with THD of (2.91) % on account of PI controller and furthermore the THD of (18.08) % without controller in the framework current.In the future investigation another controller can be utilized, for example, Neuro-fluffy for better execution.

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