‘Fractional-order-PID-controlled QZSI-Fed Induction-Motor-Drive-System with OTT-Filter’

D. Himabindu, G. Sreenivasan,R. Kiranmayi

Abstract--- ***QZS(Quasi-Z-Source) is an upright choice amid rectifier & TPIM(three-phase-induction-motor) since QZSI can boost the low voltage to the entailed-level. This effort deals with enhancement in dynamic-response of QZSI-fed IM-framework. The purpose of this effort is to plan a closed-loop-controlled-QZSI-fed-IMS(-induction-motor–system) that affords a steady-rotor-speed. This has been comprehended using closed-loop-controlled-QZSI-IMD-system. The Alternating-Current(AC)gets converted into Direct-Current(DC)by utilizing a rectifier. The ‘QZSI’ is exploited to switch it to TPAC(three-phase-AC). The yield of TPI(three-phase-inverter) is filtered before it is applied to a ‘TPIM(three-phase-Induction-motor)’. The ‘FOPID-controller’ is recommended to keep-constant value-of-speed. The outcomes attained using PI-controlled QZSI-IMD framework is evaluated with FOPID-controlled-QZSI-IMD framework. The recommended-FOPID-controlled QZSI-IMD-system has benefits like diminished settling-time &diminished- peak –over-shoot.***

Keywords--- ***‘QZSIFIM’,’ FO-PID’, ‘OTT- filter’, ‘THD’.***

I. INTRODUCTION

"-Currentfed-QZSI(quasi-Z-source-inverter)-with-voltage-buck-boost&-regeneration-capacity" was bestowed by Lei. The usual-CSI had 2 issues: unidirectional power-stream &voltage boost-operation, which made it complicated to be utilized as an element of abundant-purposes, for-example, HEV (hybrid-electric-vehicles) &generally helpful variable-speed-engine-drives. ZSI (Z-source-inverters) can take care of the 2concerns.QZSI’s were as of late proposed as a critical change to traditional-ZSI’s. Other than the preferences acquired from ZSI’s, QZSI’s had their very own little good points [1].

'-Innovative-type-LCCT-ZSI' was presented by Rub. ZSI were appropriate for relevance’s which require a vast scope of increase, for-ex, in sustainable-power source. ‘Trans-Z-source-inverters’ (TZSIs) &‘T-source-inverters ‘(TSIs) portrayed augment in voltage with the utilization of CI which can turns proportion higher than one. The present paper broadens the idea of ‘Trans-Z-source’ (T-source) inverters. Two-novel impedance organizes: the LCCT (‘inductor-capacitor-capacitor-transformer’) Z-source impedance arrange and the LCCT-QZ-source impedance arrange were presented[2].“-SSBI(Single-stage-boost-inverter) with CI(coupled-inductor)” was introduced by Huang. By-presenting ‘impedance network’, including ‘CI(coupled-inductor) into the-TPBI(3-phase-bridge-inverter)’, and altering the ‘forbidden-shoot’ through zero-express, the converter can appreciate a elevated-boost-pick-up& yield a ‘steady-ac-voltage’[3]. ‘-Switched-inductor-QZSI’ was suggested by Nguyen [4]. ‘The-extended-boost-ZSI(Z-source-inverters)’ was bestowed by Luo [5].

'-Step-up-DC/DC-converters with fell-QZSI” were given by Roasto. The-cascaded(2stage)-QZS could be concluded by including 1diode, 1inductor &2capacitors to the customary-QZSI. The recommended-cascaded-QZSI obtained every one of the-upside of the customary-series(voltage-boost&-buck-operates in a solitary-stage,-continuous-input-current&-enhanced-reliability)[6].

'-ZSC-based energy-reusing-zero-voltage-electronic-load' was exhibited by Roasto. Such relevance’s integrated investigating of PV-cells, power-converters, &power-supplies or recurrence-control of standalone-micro-generation. In-PV-cell execution-tests, the zero-voltage-activity, close to the short-circuit-point of the PV-cell's I-V-bend, made a test for EL-design [7]. 'SSI(Steady-state-investigation) &planning impedance system of ZSI’ was recommended by Jaya wickrama.. It demonstrated that, additional to the coveted 3unique expresses, a working cycle can contain another three static expresses that don't add to the power transformation process [8]. ‘An-efficient-topology-assessment procedure for high-density 3stage-PWM AC-AC-converters’ was given by Wang [9].

“TPDBI(-3phase-dual-buck-inverter) with-unified-PWM (pulse-width-modulation)” was introduced by Lai. The proposed-inverter did not require dead-time, &in this manner maintains a strategic distance from the shoot-through issues of customary VSIs, &prompts incredibly enhanced-framework-reliability. Despite the fact that it was a hard-switching-inverter, the topology permitted the utilization of intensity MOSFET’s as the dynamic-gadgets rather than IGBT’s regularly utilized by conventional-hard-switching-VSI’s [10].

The literature conferred above does not deal with FOPID-controlled-QZSI-IMD-system. This effort recommends FOPID-controller for augmentation of dynamic-response of ‘QZSI-IMD.

II. SYSTEM DESCRIPTION

The ‘-block-diagram of-PI-controlled-Q.Z.S.I -system’ is exposed in Fig-1. DC is converted to TPAC utilizing QZSI. The yield of QZSI is given to TPIM. The speed is normalized utilizing a PI controller.

Manuscript received February 01, 2019

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The ‘-block-diagram of proposed-FOPID-Q.Z.S.I-system’ is exposed in Fig-2 .The-speed is evaluated with the reference-speed & the error is directed to a FOPID-controller. The ‘yield of FOPID’ controls the pulse-width of the rectifier.

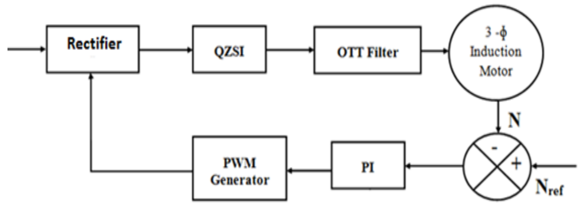

Fig. 1: ‘-Block-Diagram of PI-controlled QZ-SI -System’

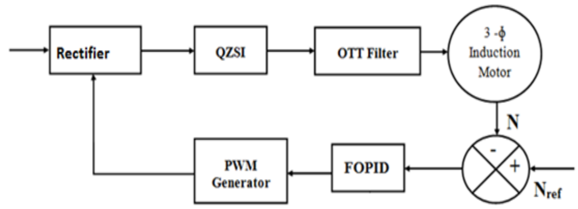

Fig. 2: ‘-Block-diagram of Proposed-FOPID-QZSI-IMD-System’

III. SIMULATION-RESULTS

‘-Closed-loop-PI-controlled-QZSI-system’ is delineated in Fig-3.1. Speed of the TPIM is sensed &it is evaluated with the reference-speed. The yield of PI is given to 2comparators to generate pulses-shifted by 180^0. The ‘-Input-voltage’ of CLQ ZSI-TPIM with PIC is delineated in Fig-3.2 & its value is 240V. The‘-Output-voltage of CLQ ZSI-TPIM with PIC is delineated in Fig-3.3 &its value is 300V.

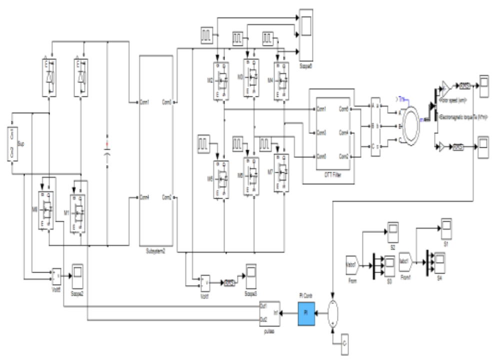

Fig-3.1 ‘-Closed-loop-QZSIsystem with PIcontroller’

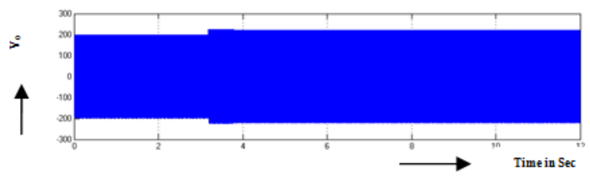

Fig. 3.2 ‘-Input-voltage’ of CLQ ZSI-TPIM with PIC

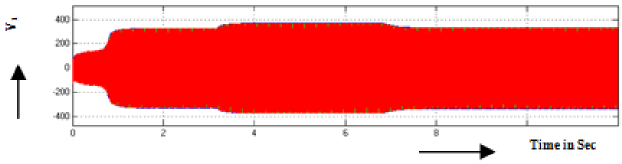

Fig. 3.3: ‘-Output-voltage of CLQ ZSI-TPIM with PIC

The -Load-current of CLQ ZSI-TPIM with PIC is delineated in Fig-3.4 & its value is 0.02A. The ‘-Motor-Speed’ of CLQ ZSI-TPIM with PIC is delineated in Fig-3.5 & its value 1300RPM. The ‘Zoomed-view of Motor-Speed CLQ ZSI-TPIM with PIC’ is delineated in Fig 3.6 & its value 1296 RPM. The speed increases due to increase in voltage. But the speed is regulated using PI-controller. The ‘Torque-Response’ of CLQ ZSI-TPIM with PIC is delineated in Fig-3.7 & its value is 0.29N-m.

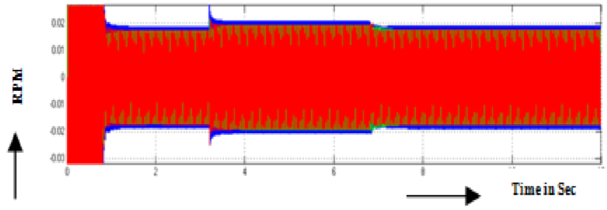

Fig. 3.4: ‘-Load-current of CLQ ZSI-TPIM with PIC’

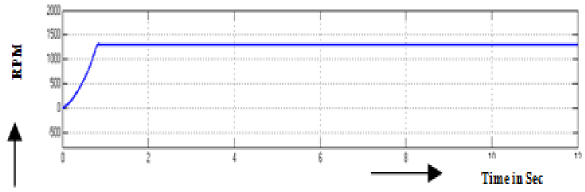

Fig. 3.5: ‘-Motor-Speed’ of CLQ ZSI-TPIM with PIC’

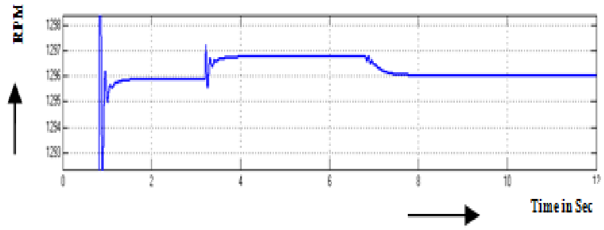

Fig. 3.6: ‘Zoomed-view of Motor-Speed CLQ ZSI-TPIM with PIC’

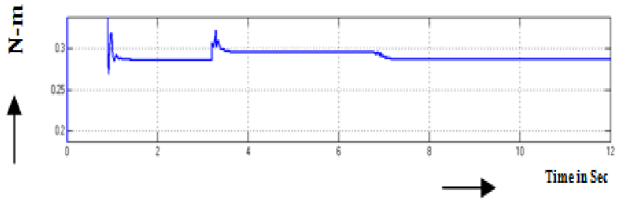

Fig. 3.7: ‘-Torque-Response’ of CLQ ZSI-TPIM with PIC’

‘-Closed-loop-FOPID-controlled-QZSI-system’ is delineated in Fig- 4.1. The yield of FOPID is applied to 2comparators to generate pulses shifted by 180^0. The ‘-Input-voltage of CLQZSI-TPIM with FOPID’ is delineated in Fig-4.2 & its value is 230V. The ‘voltage of CLQZSI-TPIM with FOPID is delineated in Fig-4.3 & its value is 300V. The ‘current of CLQZSI-TPIM with FOPID is delineated in Fig-4.4 & its value is 0.019A. The ‘-Motor-speed’ of CLQZSI-TPIM with FOPID is delineated in Fig-4.5 & its value 1350RPM. The ‘-Zoomed-view of Motor-speed’ CLQZSI-TPIM with FOPID is delineated in Fig-4.6. A step change in input-voltage is applied at t=2.5Sec. Therefore the inverter-voltage increases.

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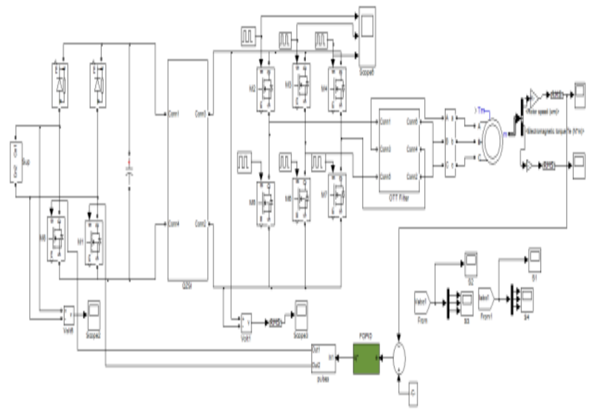

Fig. 4.1: '-Closed-loop-QZSI-system with FOPID-controller'

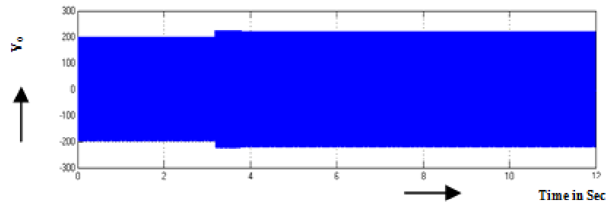

Fig. 4.2: 'Input-voltage of CLQZSI-TPIM with FOPID

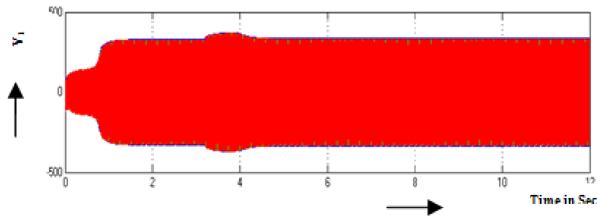

Fig. 4.3: 'Voltage of CLQZSI-TPIM with FOPID

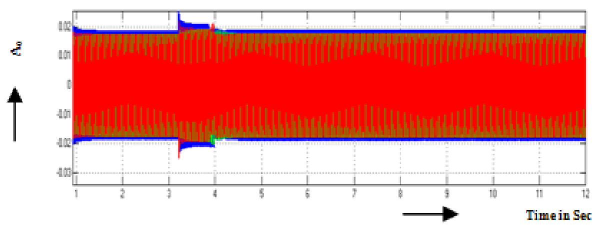

Fig. 4.4: 'current of CLQZSI-TPIM with FOPID

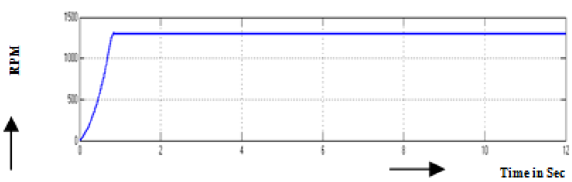

Fig. 4.5: '-Motor-speed' of CLQZSI-TPIM with FOPID

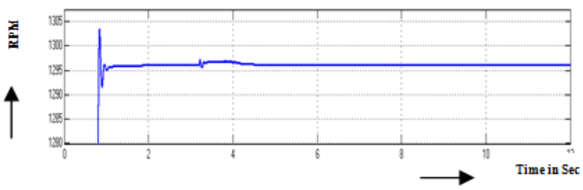

Fig. 4.6: '-Zoomed-view of Motor-speed' CLQZSI-TPIM with FOPID

The speed enhances due to increase in voltage. But the speed is regulated utilizing FOPID-controller. 'The-Torque of CLQZSI-TPIM with FOPID' is delineated in Fig-4.7 & its value is 0.3N-m.

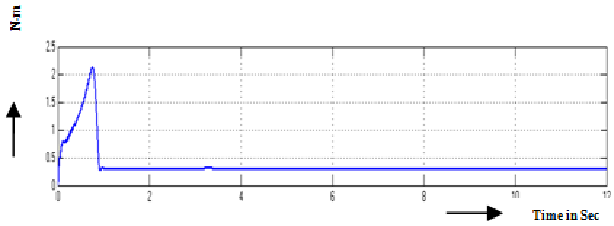

Fig. 4.7: "-Torque of CLQZSI-TPIM with FOPID"

"-The-Comparison of time-domain- parameters (Vref=1200)" is given in Table 1. The 'rise-time' is diminished from 3.9 sec to 3.9 sec; the 'peak-time' is diminished from 5.9 to 4.1 sec; the 'Settling-time' is diminished from 7.2 to 4.9 sec &'steady-state-error' is diminished from 7.1 to 5.2 volts by replacing PI controller with FOPID controller. Dynamic-response is also enhanced by utilizing FOPID-controller.

Table 1: 'Comparison of Time-domain-Parameters (Vref=1200)'

Controllers	Rise-time (s)	Settling-time (s)	Peak-Time(s)	Steady-state- error (rpm)
PI	3.9	7.2	5.9	7.1
FOPID	3.6	4.9	4.1	5.2

"-The-Comparison of time-domain-parameters (Vref=1300)" is given in Table 2. The rise-time is diminished from 3.8 sec to 3.4 sec; the peak- time is diminished from 5.6 to 3.8 sec; the Settling-time is diminished from 6.8 to 4.6 sec &steady-state-error is diminished from 6.4 to 4.1 volts by replacing PI--controller with FOPID- controller. Dynamic response is also enhanced by utilizing FOPID-controller.

Table 2: "Comparison of Time-domain-Parameters (Vref=1300)"

Controllers	Rise time (s)	Settling time (s)	Peak Time(s)	Steady state error (rpm)
PI	3.8	6.8	5.6	6.4
FOPID	3.4	4.6	3.8	4.1

The Comparison of time domain parameters (Vref=1400) is given in Table 3. The rise time is diminished from 3.7 sec to 3.5 sec; the peak time is diminished from 5.7 to 3.9 sec; the Settling time is diminished from 7.0 to 4.7 sec and steady state error is diminished from 6.8 to 5.0 volts by replacing PI controller with FOPID controller. Dynamic response is also improved by using FOPID controller. The simulation Parameter is given in Table-4.

Table 3: Comparison of Time domain Parameters (Vref =1400)

Controllers	Rise time (s)	Settling time (s)	Peak Time(s)	Steady state error (rpm)
PI	3.7	7.0	5.7	6.8
FOPID	3.5	4.7	3.9	5.0

Table 4: Simulation-Parameters

QZSI	Values
Vin	230V
C1	2200µF
Lc	4.8mH
C2,C3	1600µF
MOSFET	IRF840
DIODE	1N4007
Lo	8mH
Co	500µF
Controllers	PI/FOPID
Vo	300V
N	1300Rpm

IV. EXPERIMENTAL RESULTS

QZSI-Fed-IMDS with OTT-Filter ‘Hardware-snap-shot’ is delineated in Fig 5.1

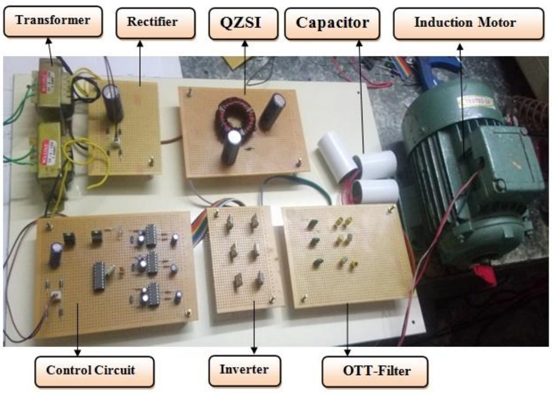

Fig. 5.1: ‘-Hardware-snap-shot of QZSI-IMDS’

The ‘input-voltage’ is delineated in Fig 5.2.

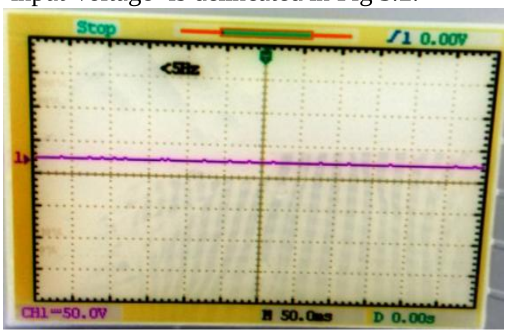

Fig. 5.2: ‘-Input-voltage of QZSI-IMDS’

‘-Output-voltage across QZS’is delineated in Fig 5.3.

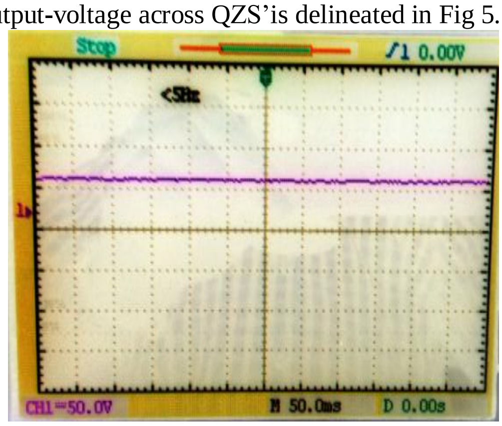

Fig. 5.3: ‘Voltage across Quasi Z-source of QZSI-IMDS’

“-Switching-pulse for inverter M1,M2 & M3, M4 and M5, M6” are delineated in Fig 5.4, 5.5 and 5.6.

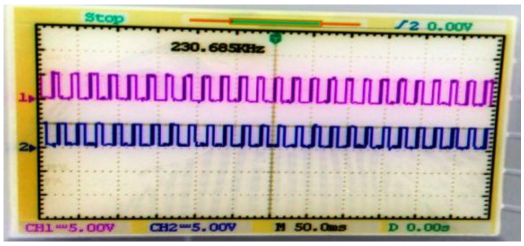

Fig. 5.4: “Switching-pulses for M1 & M2 of inverter”

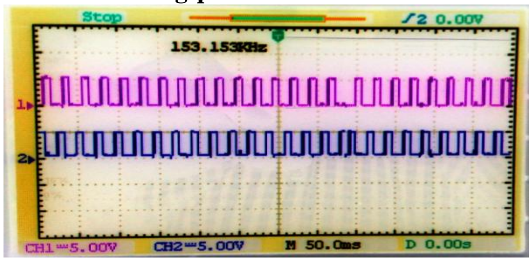

Fig. 5.5: “Switching pulses for M3 & M4 of inverter”

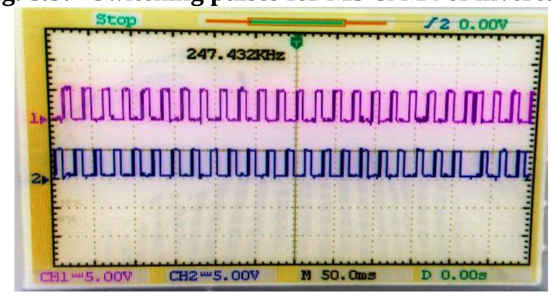

Fig. 5.6: “Switching-pulses for M5 & M6 of inverter”

“-Output-voltage across-inverter” is delineated n Fig 5.7. “List of components” is given in Table-4.

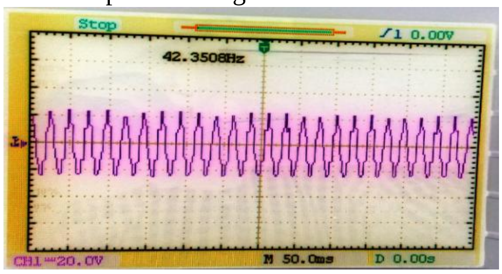

Fig. 5.7: Output voltage across inverter of QZSI-IMDS

Table 4: List of components

Name	Rating	Type
Capacitor	1000E-03	Electrolytic
Capacitor	4.70E-05	Electrolytic
Capacitor	3.30E-11	disc
Capacitor	2.20E-03	Electrolytic
Diode	1000V ,3A	PN Junction
Inductance	10uH	ferrite coil
MOSFET (IR840)	600V,8A	N-channel
Resistor	1k	Quarter watts
Regulator	12V	L7812/TO3
Regulator	5V	L7805/TO220
IC	IR2110	Opto-coupler
PIC controller	PIC16F84A	RISC
PCB	V105	General

“-Hardware-Circuit-diagram” is delineatedin Fig 5.8.

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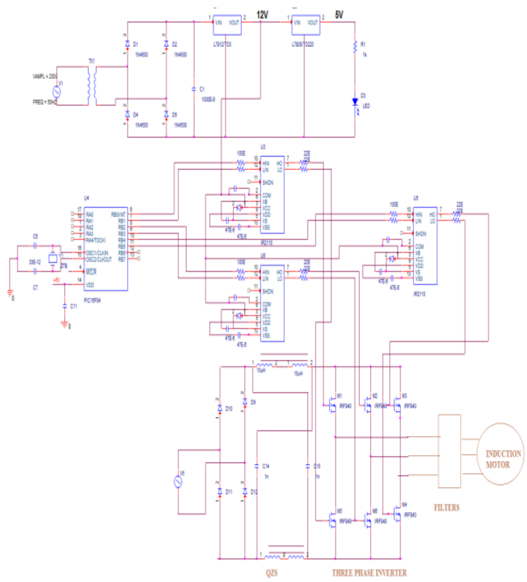

Fig. 5.8: Hardware-Circuit-diagram of QZSI-IMD-system"

V. CONCLUSION

QZSI-IMD system is successfully designed, modeled &simulated utilizing PI & FOPID-Controllers. The 'steady-state-error' is 4.1V &the 'settling-time' is 4.6 Sec. The simulation outcomes represent that the response of FOPID-QZSI is better than that of PI-QZSI. The contribution of this effort is to enhance the dynamic-response of QZSI-IMD using FO-PID. The benefits of FOPID-QZSI are elevated gain &diminished THD. The drawback is that the circuit requires 8switches. The closed-loop- system needs 2additional controlled-switches.

The present work deals with-evaluation of 'PI & FOPID-controlled QZSI'. The comparison between PI &proportional-resonant controlled FOPID-QZSI will be done in future. The FOPID-QZSI can be extended to handle high power.

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