IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

Volume 13, Issue 12, December 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.514

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE)

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

Evaluation of Harmonics in Industrial Consumer HT Side for Solutions

Deepak Baghel[1], Dr Shailendra Verma[2], Sujit Kumar Singh[3], Atul Choudhary[4]

M.Tech Scholar, Department of EE, CCET, CSVTU, BHILAI, C.G, India[1]

Head of Department, Department of EE, CCET, CSVTU, BHILAI, C.G India[2]

M.Tech Scholar, Department of EE, CCET, CSVTU, BHILAI, C.G, India[3]

M.Tech Scholar, Department of EE, CCET, CSVTU, BHILAI, C.G, India[4]

ABSTRACT: Over the past few decades the digital inclusion in the industry sector has been increased rapidly. This rapid growth in industries has been increased the challenges in the field of technologies for controlling non-linear loads the reason for distorted voltage, current and power factor. Many filters has been designed for the reduction of harmonics. The specific evaluation of THD percentage should be calculated and according to the values one can decide the filters to be installed as per the voltage and current compensation. A power analyser has been used in the system and connected in an industrial transformer to find out various parameters during operation. In this work parameters analysed and can get the best solution reduce the THD in parameters. The parameters can be compared with standard IEEE limits and to perform well according to system and reduce the losses as well as equipment damage.

KEYWORDS: Total harmonic distortion, non-linear loads, distribution transformer, passive power filter, active power filter, facts devices.

I. INTRODUCTION

From the rapid developments of semiconductor technologies in industries results to automation and power saving strategies. Basically industrial loads are driven by power converters with control systems for efficient operation, like Variable Frequency drives (VFD), Adjustable Speed Drives (ASD) and other power converters. These drives also allows for dynamic response for any variation in the voltage magnitude and phase angle of the loads, thus improves the reliability in the system .However ,because of the non linear properties of the loads ,it draws non linear currents from the sources ,which results in the production of harmonics. The main problems with harmonics include energy inefficiency ,power losses ,temperature increases in the motor windings ,system failure, mistakes in the measurement of metering equipment ,interference in the telecommunication lines ,and malfunction[1].To minimise the distortion in the system, this is the main focus of the power engineers and utility engineers. As the harmonics currents injected by these loads have a very small impact on the system but all these equipment used in the large numbers will make a severe impact. Commercial and industrial consumers make a huge impact at the point of common coupling. Various teams of industrial electronics studied the impacts of harmonics in the power system and gave certain guidelines to maintain harmonics in within acceptable level. Maximum permissible harmonic limits in the system and their control laid down by IEEE.

The IEEE harmonic limits decided by the experts are very important as all these harmonics produce disturbances in the power distribution network at the point of common coupling and produce hazardous effects on the power factor and other parameters that produce heavy losses and wear and tear of the connected instruments also in both the side of utility and consumer.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

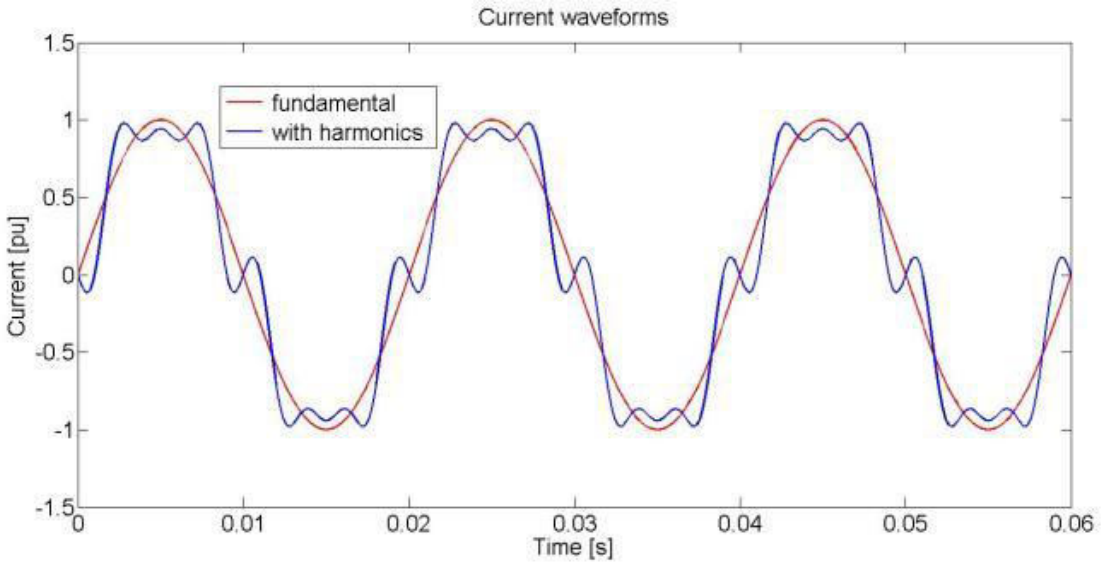


Fig 1 Harmonic effects on waveforms

II. PARAMETERS FROM THE ANALYSER

Table 1 Voltage, current, Power of Transformer 1 HT side

V1 (5 min)	V2 (5 min)	V3 (5 min)	I1 (5 min)	I2 (5 min)	I3 (5 min)	P1+ (5 min)	P2+ (5 min)	P3+ (5 min)
						W	W	W
6509.4	6468.6	6488.7	9.6222	7.7421	7.7658	62441	49436	49517
6523.6	6478.6	6500.9	9.2237	7.4153	7.261	60012	47345	46381
6520.3	6476.9	6496.4	9.0127	7.3112	7.0474	58571	46778	44881
6520.4	6479.6	6498.9	9.0027	7.1482	7.0211	58419	45812	44328
6526.5	6485.4	6503.1	10.0966	8.334	7.9994	65675	53325	51186
6519.1	6475.9	6495	9.0072	7.7423	6.9513	58482	49283	44647
6507.3	6467.9	6486	8.5591	7.1353	6.7456	55403	45658	42897
6501.8	6460.8	6479.1	8.648	7.3548	6.7068	56012	46750	42929
6506.5	6467.6	6482.6	9.5482	8.1294	7.3564	61910	51386	47264
6508.2	6469.8	6484.7	8.8348	7.3671	6.2898	57225	46481	40121
6499.3	6460	6475.6	8.4616	7.0359	6.11	54718	44546	38852
6493.5	6455.3	6472	8.7651	7.2743	6.5889	56658	46057	41934
6493.4	6453.6	6471.4	8.134	6.7168	6.2001	52606	42797	39375
6483.2	6441.6	6458.8	9.4967	8.2586	7.3317	61359	52334	46907
6477.7	6438.6	6456.1	8.6099	7.4359	6.6143	54669	46185	41632

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

Table 2 Voltage THD of Transformer 1 HT side

V1-THD (5 min)	V2-THD (5 min)	V3-THD (5 min)
%	%	%
2.21	2.22	2.6
2.22	2.26	2.42
2.35	2.39	2.64
2.28	2.25	2.45
2.32	2.43	2.52
2.17	2.25	2.43
2.27	2.26	2.34
2.45	2.47	2.59
2.11	2.32	2.32
2.44	2.32	2.6
2.33	2.4	2.48
2.35	2.34	2.4
2.37	2.42	2.53
2.22	2.22	2.18
2.42	2.51	2.56

Table 3 Current THD of Transformer 1 HT side

I1-THD (5 min)	I2-THD (5 min)	I3-THD (5 min)
%	%	%
5.34	6.72	5.75
5.73	7.14	6.19
5.93	7.1	6.19
6.2	7.63	6.68
4.95	5.9	5.25
5.55	6.43	5.77
5.68	7.07	6.05
5.54	6.89	6.29
4.7	6.44	5.44
5.07	6.8	6.36
5.41	6.86	6.2
4.63	6.29	4.98
5.1	6.55	5.47
4.31	5.47	4.5
4.59	5.76	4.78

Table 4 Voltage, current, Power of Transformer 2 HT side

V1 (5 min)	V2 (5 min)	V3 (5 min)	I1 (5 min)	I2 (5 min)	I3 (5 min)	P1 (5 min)	P2 (5 min)	P3 (5 min)
						W	W	W
6585.3	6534.1	6552.5	8.3213	7.6416	7.6216	51564	47010	47859
6584.9	6535.9	6553.9	10.0405	8.7391	9.361	65186	56521	60956
6591.9	6546.1	6566	11.8258	10.5301	11.1848	76871	68296	73242
6595.2	6549.8	6567	12.5721	11.2169	11.8271	81852	72807	77481
6607.5	6560.2	6578	12.4008	11.0101	11.6729	80851	71582	76558

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

6599.7	6553.4	6570.7	11.7701	10.3867	11.068	76671	67499	72533
6592.5	6543.9	6562.2	11.5935	10.1708	10.9217	75380	66001	71451
6591	6538.1	6561.5	11.0994	9.5883	10.2591	72169	62150	67849
6595.5	6541.8	6564.6	10.8415	9.4957	10.2591	70568	61673	67132
6606.3	6557	6577.3	10.7272	9.3035	10.0288	69938	60506	65755
6607.9	6559.1	6576.7	10.7858	9.4664	10.1673	70350	61644	66631
6594.4	6544.3	6565	10.8777	9.4163	10.0907	70743	61010	66026
6591	6540.1	6562.1	11.021	9.7286	10.4402	71590	63100	68299
6590	6538.1	6560.9	10.9642	9.5145	10.2041	71240	61608	66747
6595.6	6544.5	6565.4	10.9952	9.6246	10.3431	71491	62462	67700
6601.7	6551.7	6570.6	10.9358	9.6296	10.2374	71240	62532	67065
6608.4	6557.1	6573.6	11.011	9.7141	10.4172	71642	63105	68239
6604.5	6552.5	6570.2	10.9831	9.5778	10.3397	71390	62149	67689

Table 5 Voltage THD of Transformer 2 HT side

V1-THD (5 min)	V2-THD (5 min)	V3-THD (5 min)
%	%	%
2.29	2.19	2.58
2.32	2.38	2.6
2.21	2.3	2.58
2.3	2.2	2.58
2.46	2.34	2.75
2.1	2.36	2.36
2.41	2.27	2.58
2.41	2.34	2.5
2.26	2.2	2.48
2.38	2.42	2.58
2.39	2.09	2.25
2.33	2.41	2.67
2.42	2.29	2.67
2.22	2.31	2.21
2.4	2.38	2.72
2.25	2.18	2.48
2.4	2.36	2.57
2.28	2.22	2.38
2.31	2.26	2.56

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

Table 6 Current THD of Transformer 2 HT side

I1-THD (5 min)	I2-THD (5 min)	I3-THD (5 min)
%	%	%
9.96	8.76	8.86
9.42	6.58	7.72
7.86	5.51	6.51
7.85	5.49	6.48
8.44	5.86	6.89
8.39	5.8	7.07
8.78	6.15	7.52
8.74	6.03	7.41
9.04	6.28	7.81
8.97	6.02	7.57
9.55	6.48	7.87
8.82	6.1	7.71
9.09	6.05	7.58
8.82	5.9	7.5
8.69	5.98	7.46
8.53	5.62	7.28
9.09	6.25	7.57
8.82	6.2	7.5
9.02	6.3	7.54

III. RESULT AND DISCUSSION

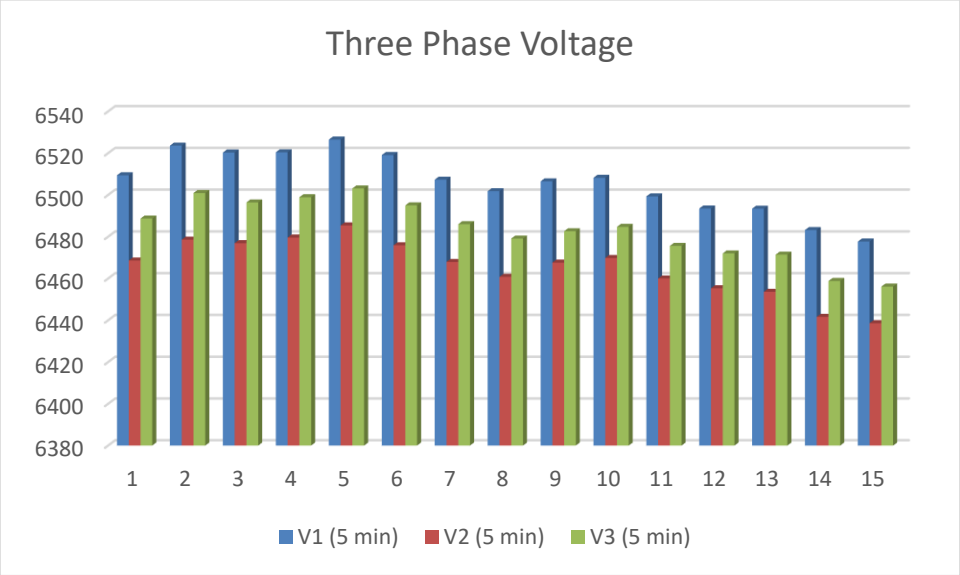


Fig 2 Three phase voltage Transformer 1 HT side

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

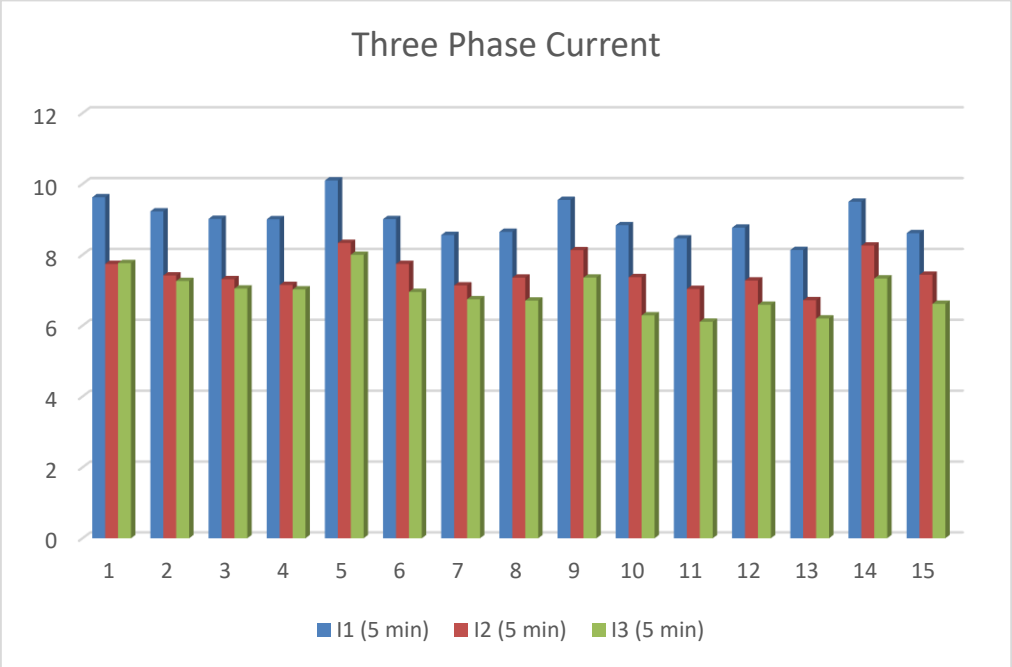


Fig 3 Three phase currents Transformer 1 HT side

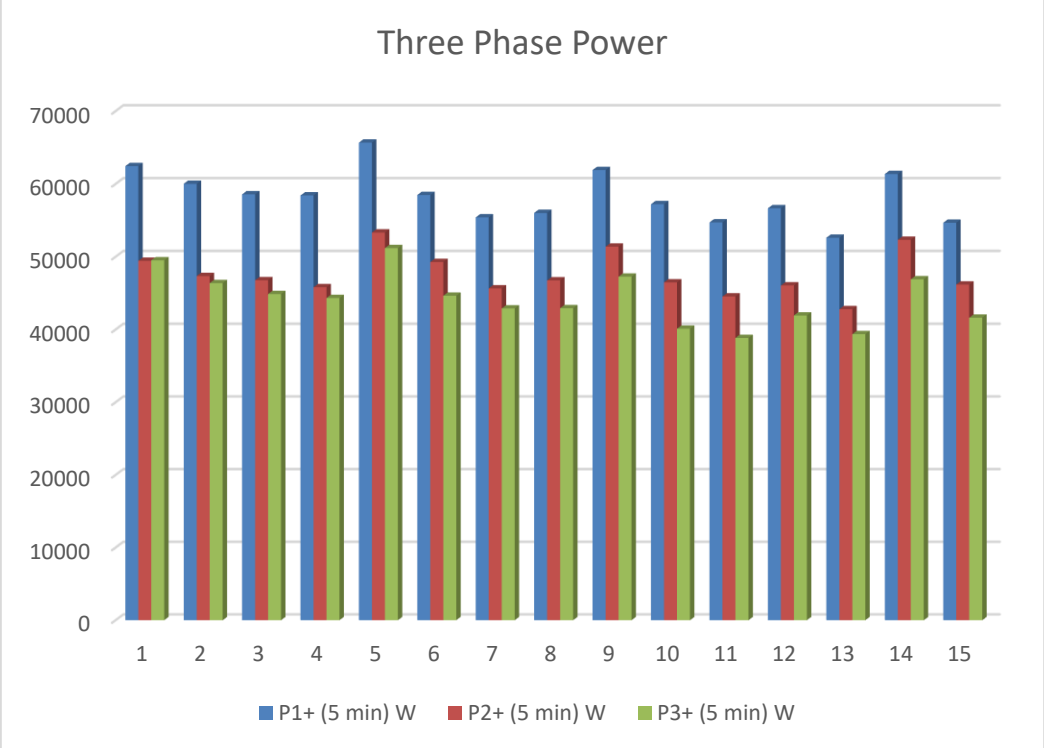


Fig 4 Three phase power Transformer 1 HT side

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

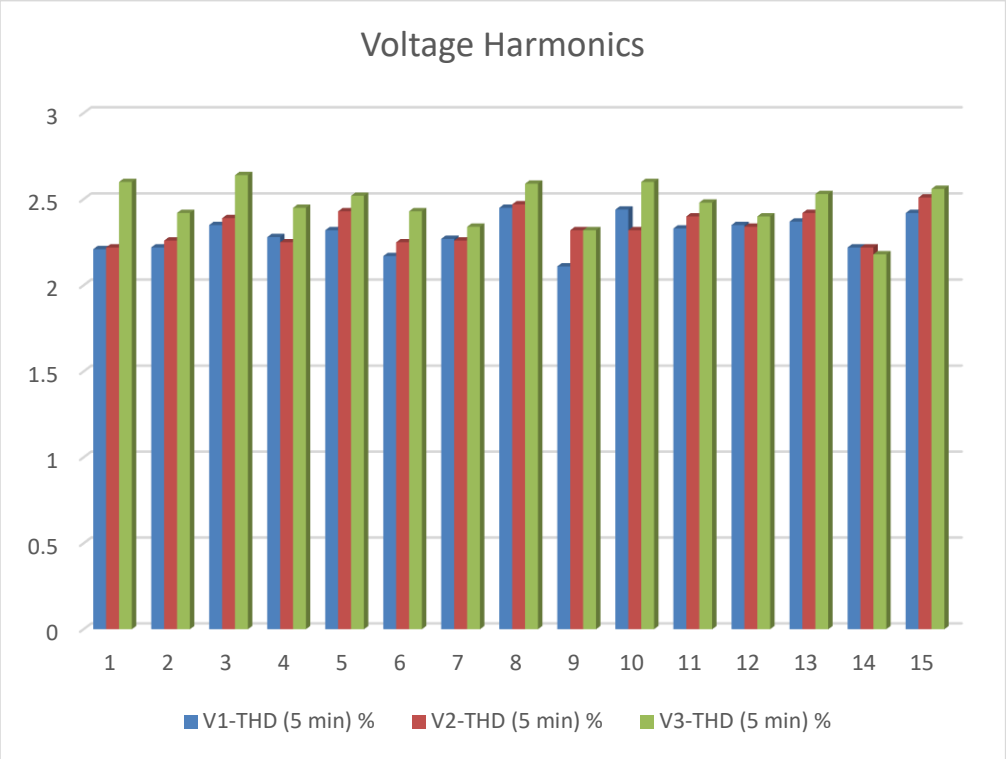


Fig 5 Voltage Harmonics Transformer 1 HT side

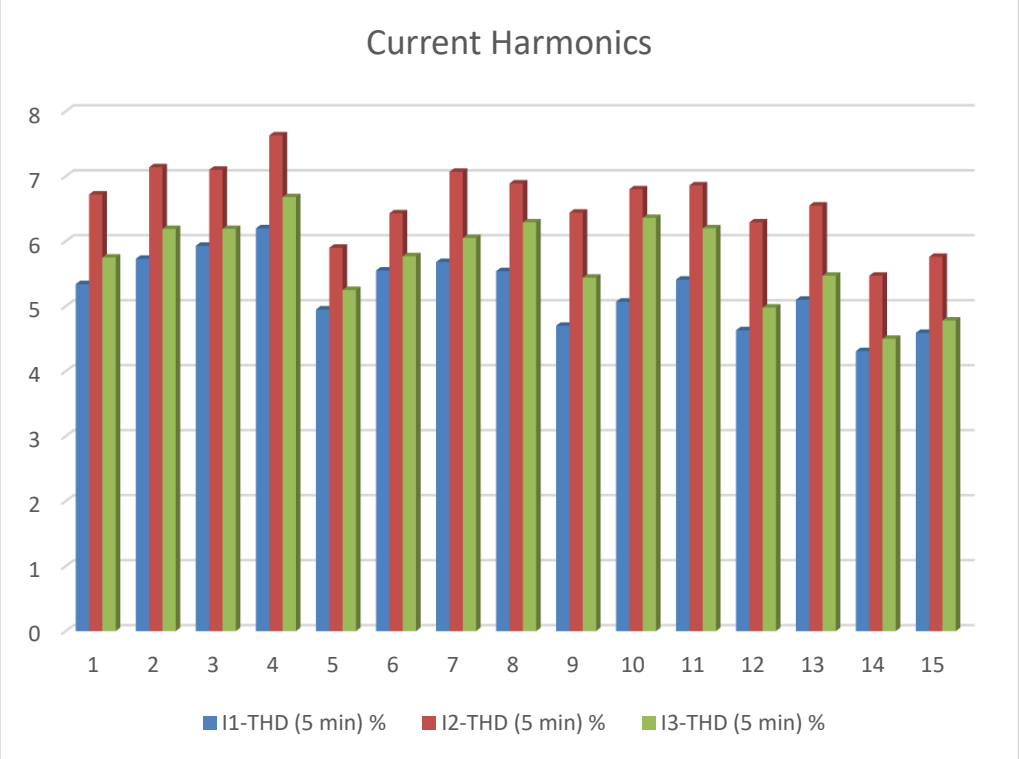


Fig 6 Voltage Harmonics Transformer 1 HT side

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

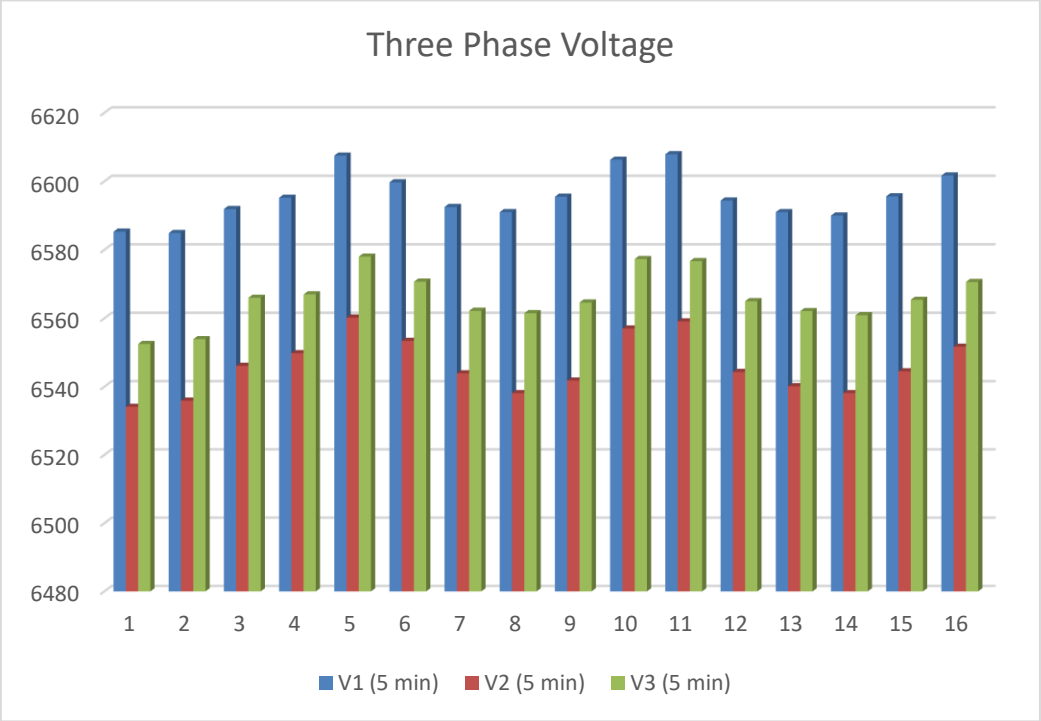


Fig 7 Three phase voltage Transformer 2 HT side

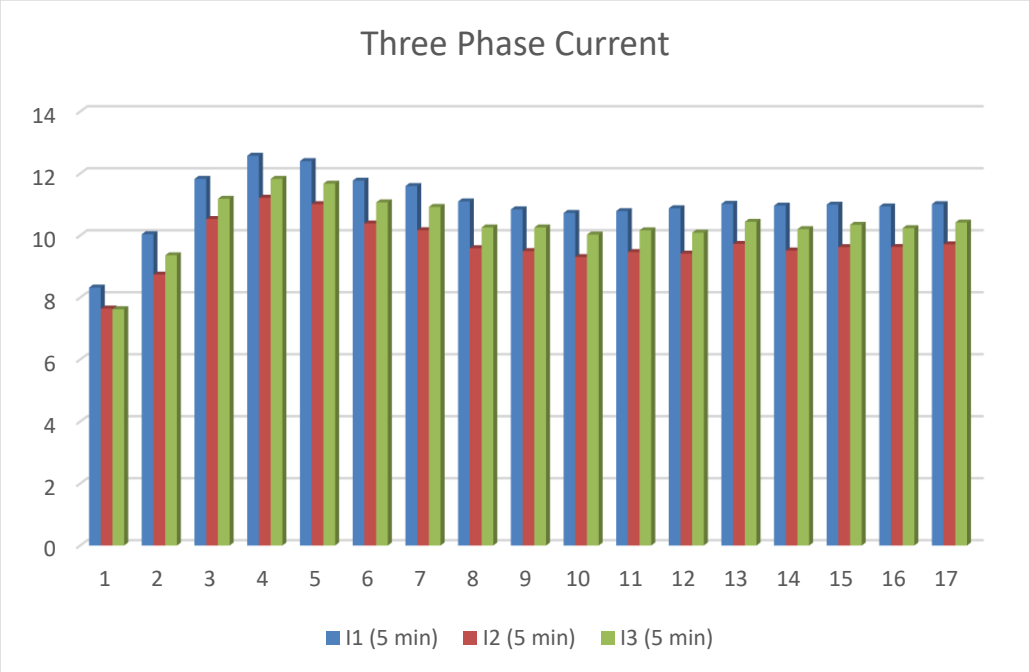


Fig 8 Three phase current Transformer 2 HT side

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

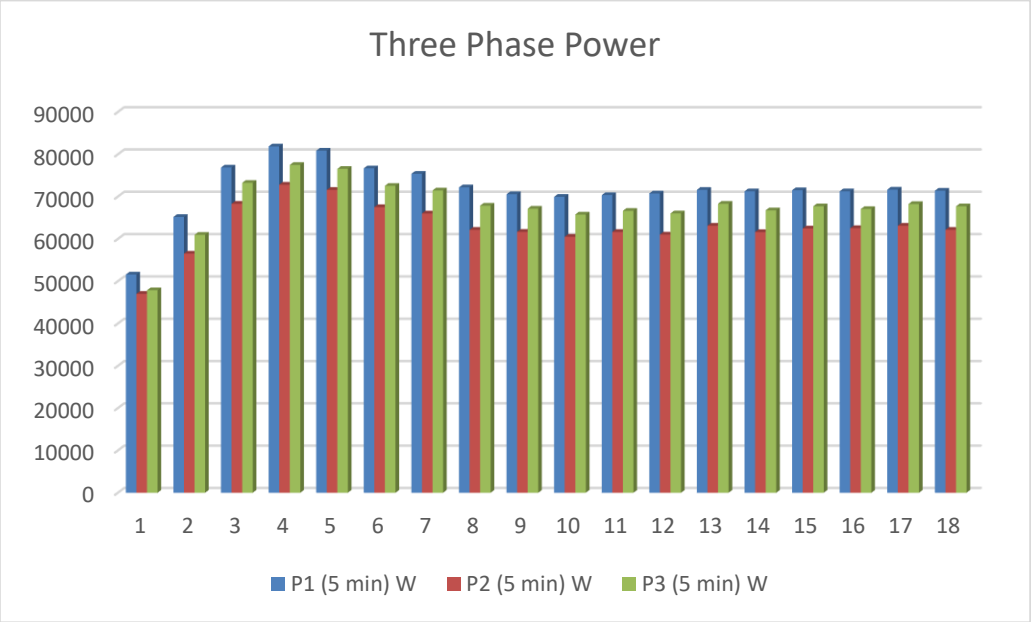


Fig 9 Three phase power Transformer 2 HT side

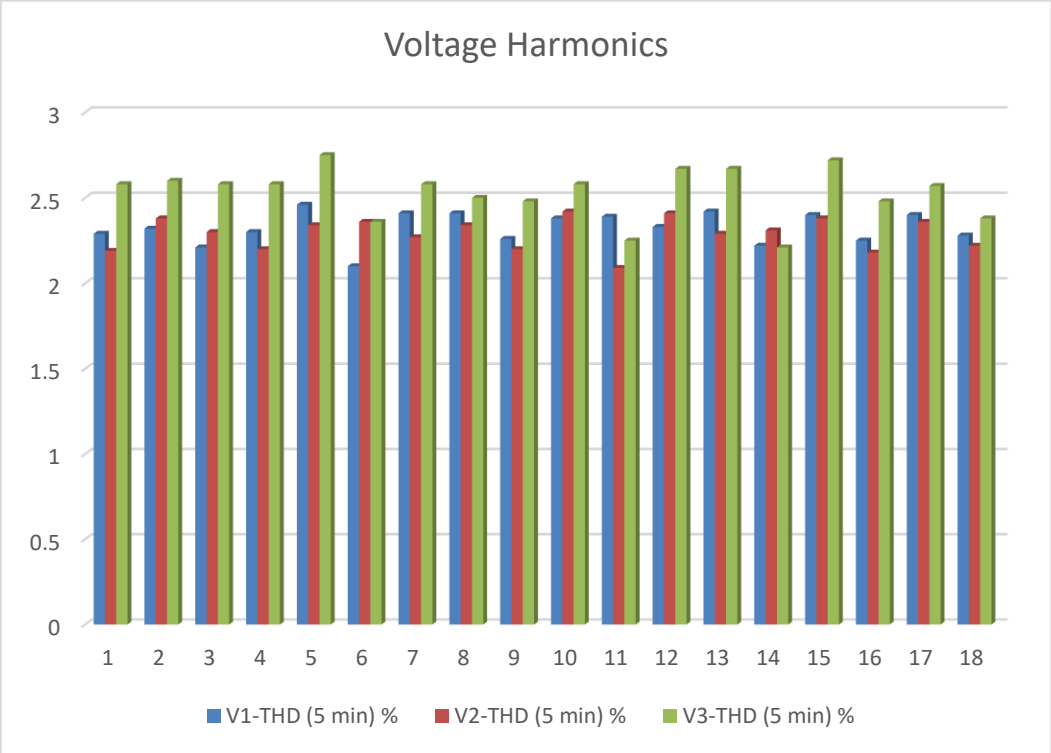


Fig 10 Voltage Harmonics Transformer 2 HT side

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

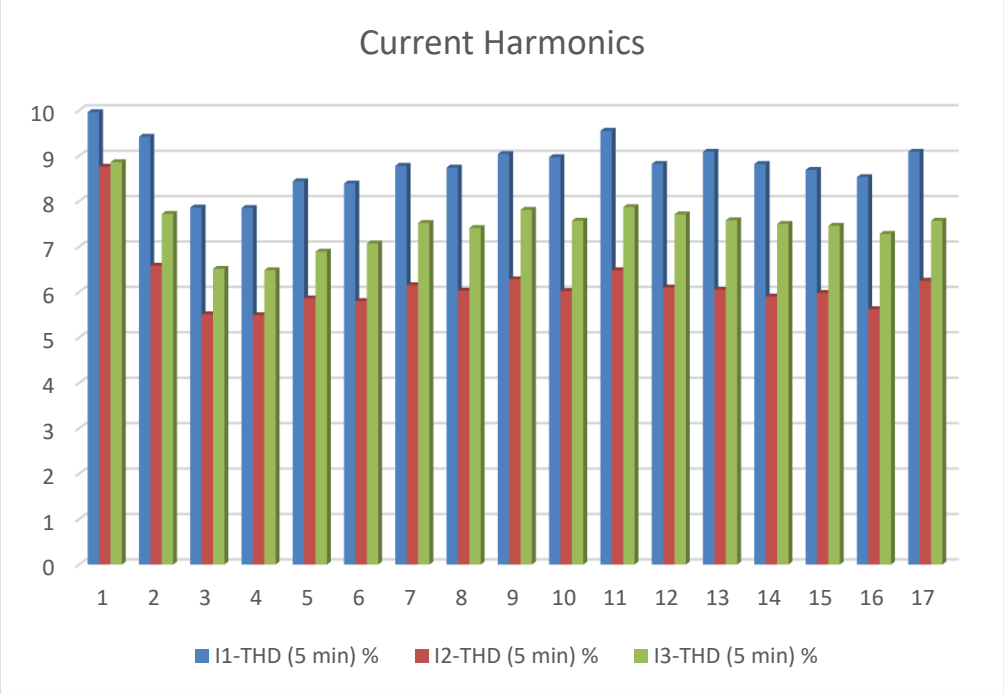


Fig 11 Current Harmonics Transformer 2 HT side

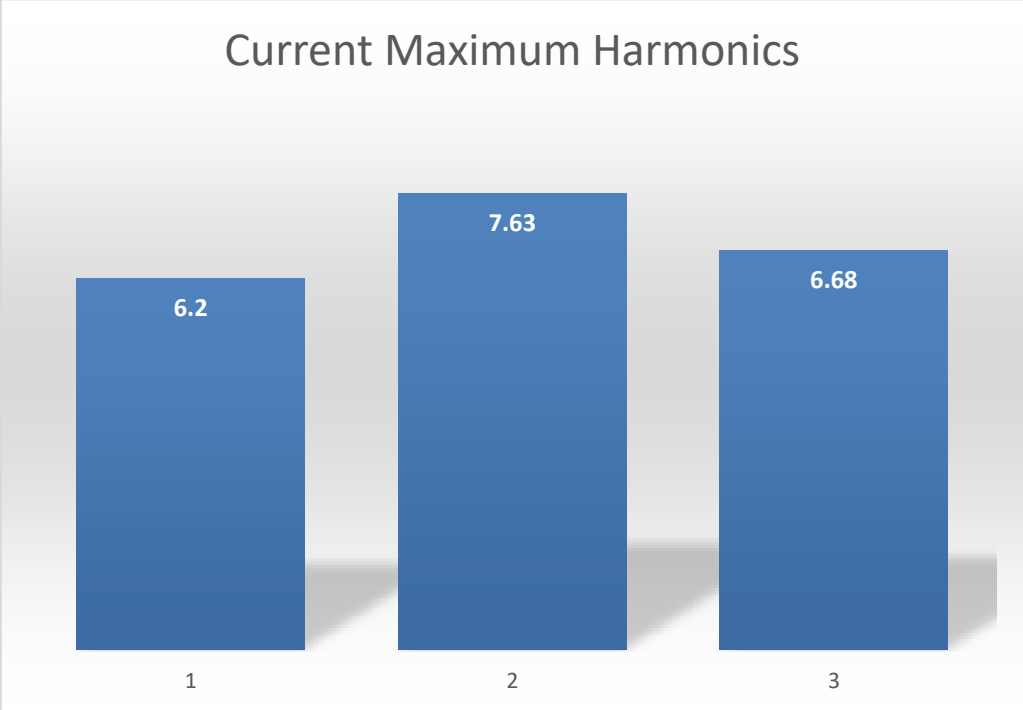


Fig 12 Maximum Current Harmonics Transformer 2 HT side

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

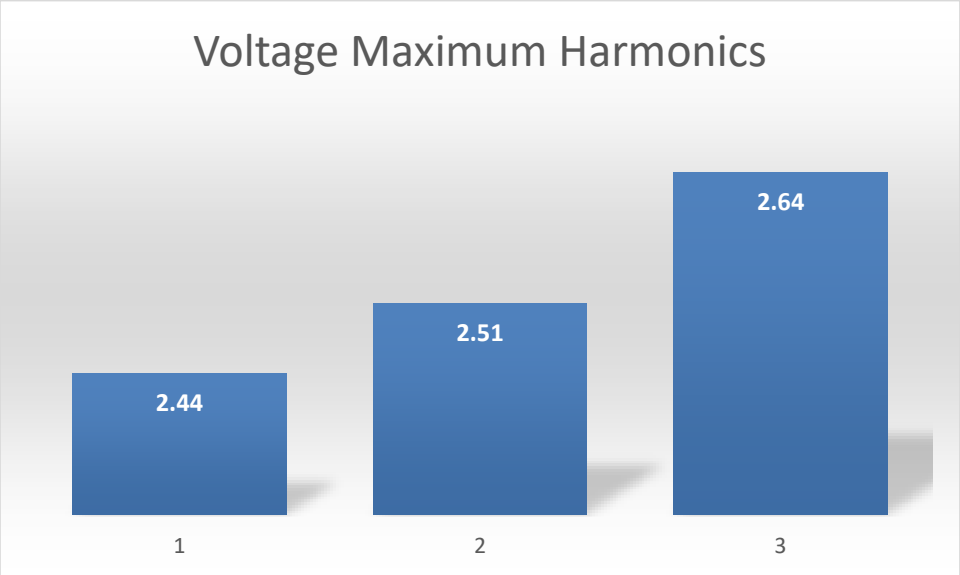


Fig 13 Maximum Voltage Harmonics Transformer 2 HT side

IV.CONCLUSION

As discussed above about this work to fulfil the compliance set by IEEE in the harmonic limits of industrial consumers, the best practice is to find the values and parameters at every section, In this work two transformer HT side has been targeted and power analyser connected for few hours and try to find out the readings obtained during operation, we find that the voltage, current and active powers are in the desirable range. The voltage harmonics are also in the set values decided by IEEE but the current harmonics are up to 8 % which is slightly higher side from the desired value and will impact the system and increase losses. Filter like passive filters or Statcom should be connected to reduce the harmonics.

V. FUTURE WORKS

In the future work we will establish a model and connect it with shunt active filters or statcom type of devices to see the outcomes during operation and the values of percentage THD. The filter should be current compensating device in this case and if further the model will give some voltage distortions also we can provide hybrid filters for the compensation of voltage and currents both.

REFERENCES

[1].ICECMSN 2023,G. Shreeramalu Mahesh " Saustainable and optimised harmonic filter design for industrial loads".Procedia computer science 230(2023) 780-787.
[2].JianZheng (2000) "Transformer ac winding resistance and derating when supplying harmonic-rich current" "M.Sc. A thesis in electrical engineering in Michigan Technological University".
[3]. K.C. Umeh, A. Mohamed, R. Mohamed,(2003) "Determining harmonic characteristics of typical single phase non-linear loads", Proc. Student Conference on Research and Development (SCORED), Putrajaya, Malaysia.
[4]. Ahd H. Gheeth (2012)"Analysis Of Power Transformers Feeding Variable Frequency".
[5]. Ulinuha, Agus. (2016b). The impact of harmonic filter locations on distortion suppression. 2016 International Seminar on Intelligent Technology and Its Applications (ISITIA), 503
https://doi.org/10.1109/ISITIA.2016.7828711.
[6]. Ulinuha, A. (2017). The impact of harmonic _lter locations on distortion suppression. Proceeding - 2016 International Seminar on Intelligent Technology and Its Application, ISITIA 2016: Recent Trends in Intelligent Computational Technologies for Sustainable Energy. https://doi.org/10.1109/ISITIA.2016.7828711.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.514 | A Monthly Peer Reviewed & Refereed Journal |

|| Volume 13, Issue 12, December 2024 ||

| DOI:10.15662/IJAREEIE.2024.1312008 |

[7]. Dao, T., Phung, B. T., & Blackburn, T. (2015). Effects of voltage harmonics on distribution transformer losses. 2015 IEEE PES Asia-Paci_c Power and Energy Engineering Conference (APPEEC), https://doi.org/10.1109/APPEEC.2015.7380953.

[8]. K. Karsai, D. Kerenyi, and L. Kiss, Large power transformers, Elsevier Publication, Amsterdam, 1987, pp. 41.

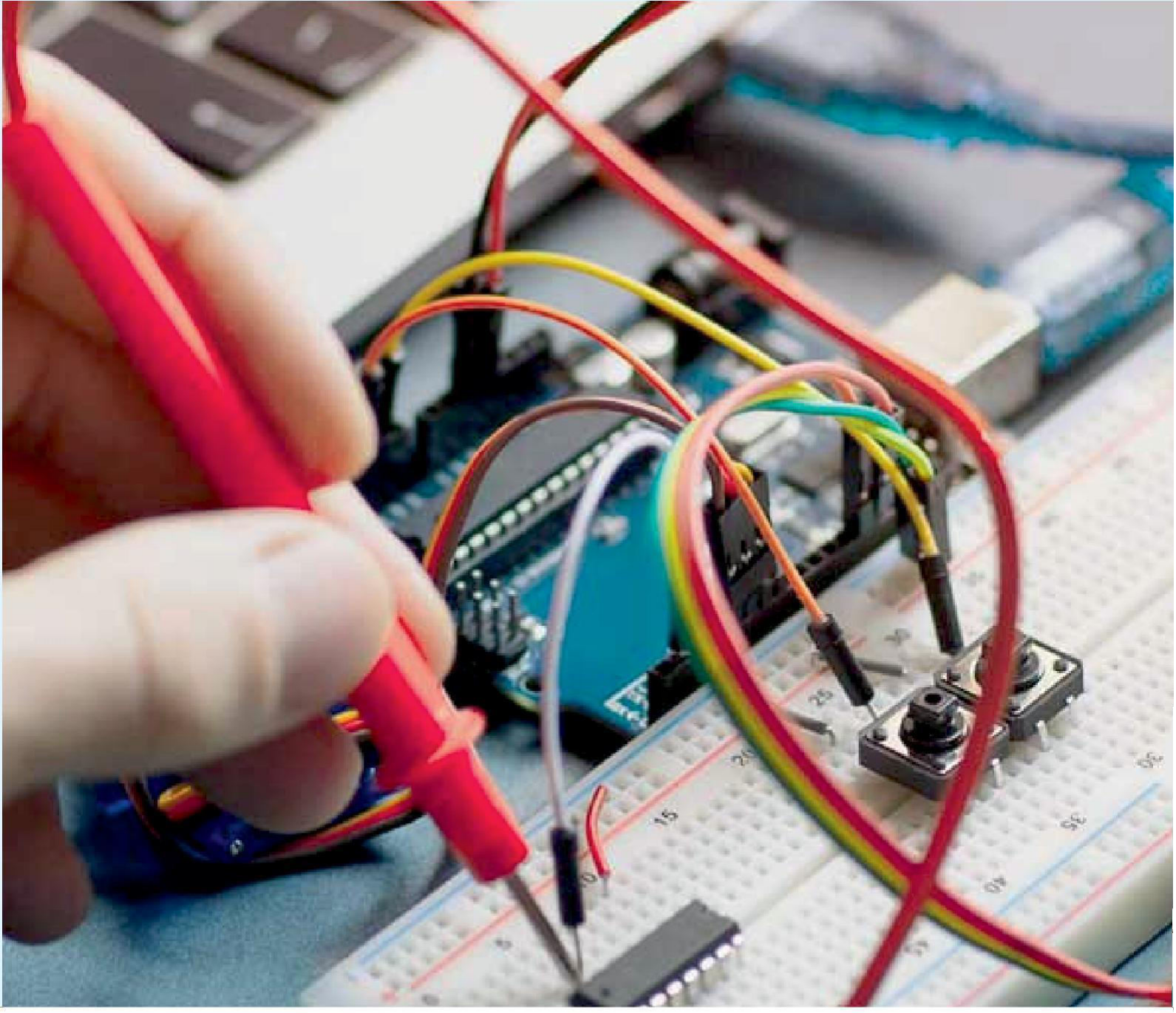
[9] .S. L.Timothy and D. W. E. William, *Electric Power and Controls*, Pearson-Prentice Hall, New Jersey, United States of America, 2004.improved power quality ac–dc converters," IEEETrans.Ind.Electron.,vol.51,no.3,pp.641–660,Jun. 2004.

[10]. G. Y. Choe, J. S. Kim, B. K. Lee, C. Y. Won, and T. W. Lee, "A bidirectional battery charger for electric vehicles using photovoltaic PCS systems," in Proc. IEEE Veh. Power Propulsion Conf.,Sep.2010,pp.1– 6.

[11]. Fuchs, E. F., Lin, D., & Martynaitis, J. (2006). Measurement of three-phase transformer derating and reactive power demand under nonlinear loading conditions. IEEE Transactions on Power Delivery, 21(2), 665{672.

[12]. Pejovski, D., Najdenkoski, K., & Digalovski, M. (2017). Impact of different harmonic loads on distribution transformers. Procedia Engineering, 202, 76{87. https://doi.org/10.1016/j.proeng.2017.09.696.

[13]. Senra, R., Boaventura, W. C., & Mendes, E. M. A. M. (2017). Assessment of the harmonic currents generated by single-phase nonlinear loads. Electric Power Systems Research, 147, 272{279. https://doi.org/10.1016/j.epsr.2017.02.028.



INNO SPACE
SJIF Scientific Journal Impact Factor

doi cross ref

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

9940 572 462 6381 907 438 ijareeie@gmail.com

Scan to save the contact details