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Generation of High Voltage DC using Diodes & Capacitors in Ladder Network

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Abstract— The project is designed& constructed to develop a high voltage DC of around 2KV from a input AC supply source of 230V using the capacitors and diodes that are constructed in the form of ladder network based on voltage multiplier concept. Generally transformers are used for stepping up of voltage in which the output of the secondary of the step up transformer increases the voltage and decreases the current. The other method for stepping up the voltage without the use of transformers is by using voltage multiplier circuit which converts AC to DC. These Voltage multipliers are primarily used to develop high voltages where low current is required. The concept of developing high voltage DC from single Phase AC is described in this project which can be enhanced up to 10KV. For safety purpose this project is restricted with a multiplication factor of 8 so that the output would be within 2KV.This concept of generation of high voltage using multiplier circuit is used in Electronic appliances such as CRT's, oscilloscopes and in industrial applications. The principle of voltage multiplier circuit is that the voltage keeps on doubling at each stage. Thus, the output of an 8 stage voltage multiplier circuit is 2KV DC which cannot be measured by using a standard multimeter. Hence a potential divider of 10:1 is used at the output such that 200V reading means 2KV.

Keywords* :Diodes, Capacitors, 250V Supply, Multiplier circuit, Multimeter.*

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INTRODUCTION

A voltage multiplier circuit is an electrical circuit which converts lower voltage alternating current (AC) into higher voltage direct current (DC) by means of capacitors and diodes in a ladder network. The output current decreases when the voltage is stepped up using transformers. Once a load is connected, the value of the output voltage decreases even though the measured value of open-circuit output voltage is several times greater than the input supply voltage. Voltage multipliers can be further classified as voltage doublers, triplers, and quadruplers etc. based on the ratio of output voltage to input voltage. For example, if the open circuit output voltage of a multiplier circuit is twice the peak of AC input voltage, it is called a voltage doubler.

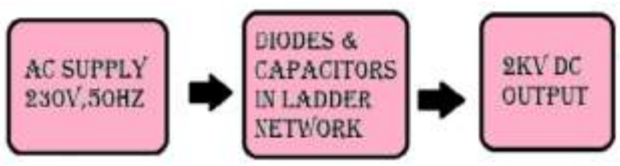
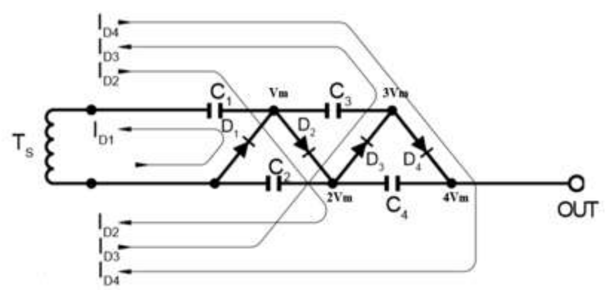


Fig 1. Block Diagram of Voltage Multiplier

HOW DOES A MULTIPLIER WORKS??



- When TS isNegative Peak - C1 charges through D1 to Vm
- When TS is Positive Peak - Vm of TS adds arithmetically to existing potential C1, thus C2 charges to 2Vm through D2.
- When TS is Negative Peak - C3 is charged to 2Vm through D3.
- When TS is Positive Peak - C4 is charged to 2Vm through D4.

Therefore, output voltage = Vm x N, Where N = the number of stages.

TYPES OF MULTIPLIER CIRCUITS

- Half wave series.
- Half wave parallel.
- Full wave parallel.
- Full wave series parallel.

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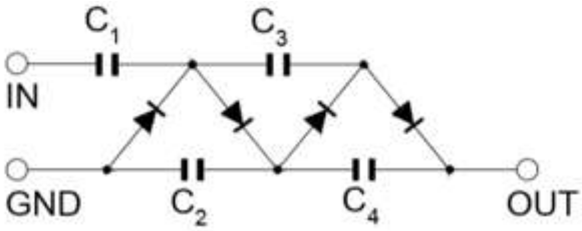
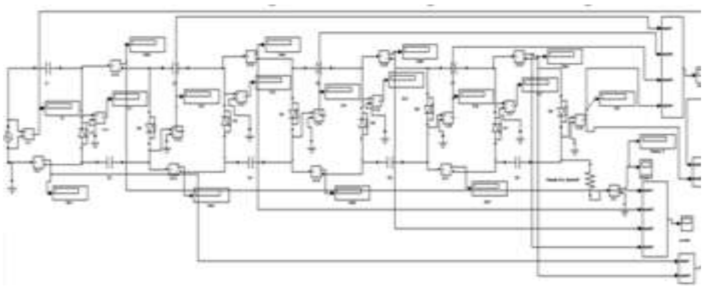
I.HALF WAVE SERIES.

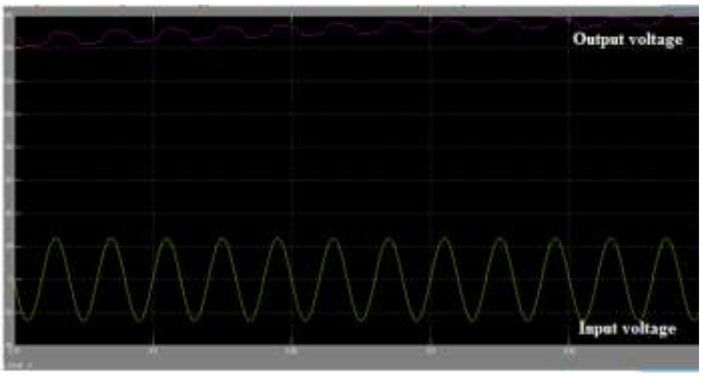


Matlab Simulated circuit of Half wave series circuit:

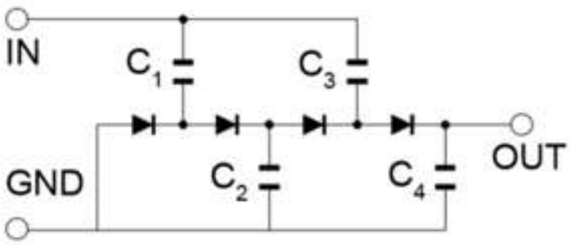


Simulated output of half wave series circuit plotted for Time v/s Voltage:

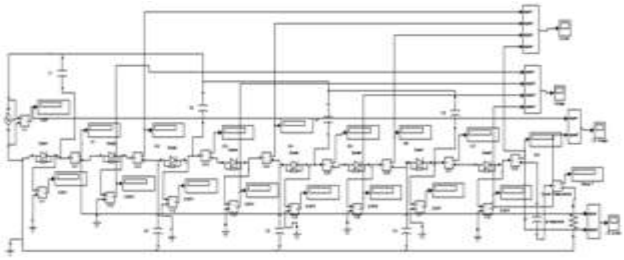
Vin=25V, Vo=155V, N=8



II. HALF WAVE PARALLEL:

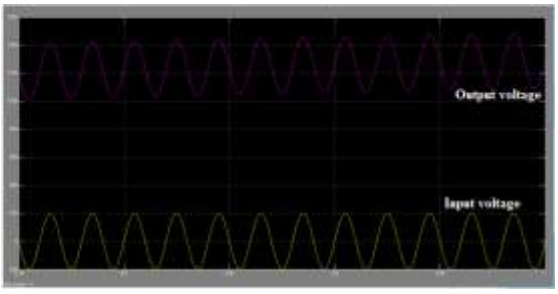


Simulated circuit of Half wave parallel circuit:

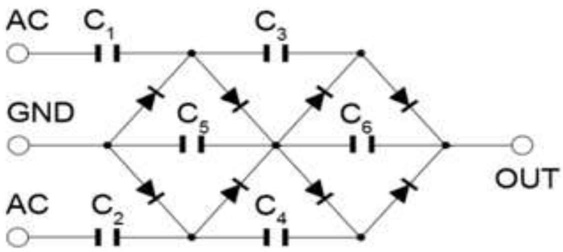


Simulated output of half wave parallel circuit plotted for Time v/s voltage:

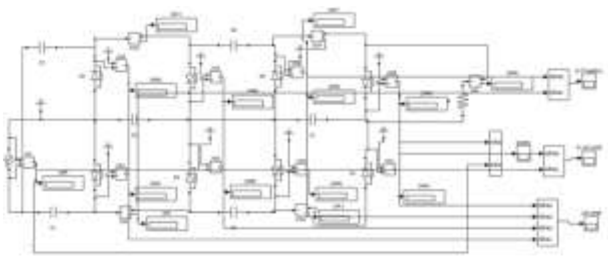
Vin=200V, Vo=1280V, N=8



III. FULL WAVE PARALLEL:



Simulated circuit of Full wave parallel circuit:



Simulated output of Full wave parallel circuit plotted for Time v/s Voltage:

Vin=250V, Vo= 1680V, N=8

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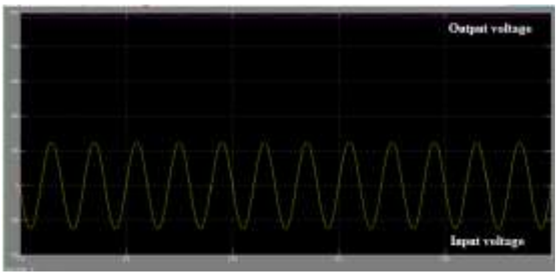
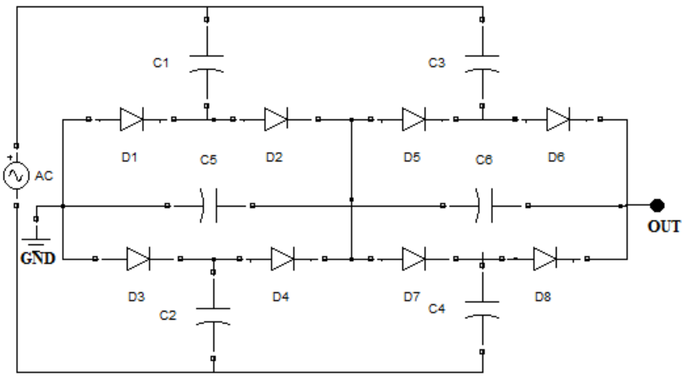
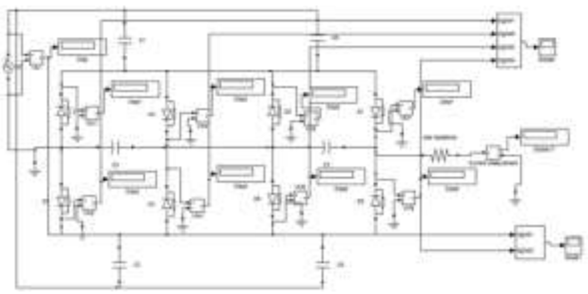


IV. FULL WAVE SERIES PARALLEL

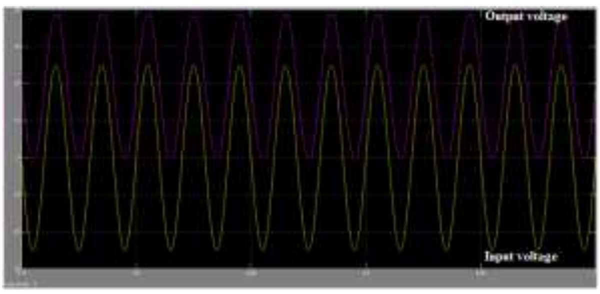


Simulated circuit of Full wave series parallel circuit:



Simulated output of Full wave series parallel circuit plotted for Time v/s Voltage:

Vin=25V, Vo=400V, N=8



MATLAB program to calculate V_{rip}, V_o, V_{reg}, X_c, P_o:

```
clc
clear all
n=input('Number of stages=');
f=input('Frequency in hz=');
c=input('Capacitance in micro farads=');
I1=input('Current in amps=');
Vp=input('Peak to peak voltage in volts=');
R=input('Resistance in ohms=');
Vrip=(I1*(((2*n*n*n)/3)+((n*n)/2)-(n/6)))/(f*c);
Vo=(n*Vp)-Vrip;
Vreg=(I1*((n*n*n)+((9*n*n)/4)+(n/2)))/(12*f*c);
Xc=1/(2*3.14*f*c);
P=(I1*I1)*R;
fprintf('\n The outut for half series & half parallel circuit');
fprintf('\n Ripple voltage=%2f V',Vrip);
fprintf('\n Output voltage=%2f V',Vo);
fprintf('\n Regulation voltage=%2f V',Vreg);
fprintf('\n Capacitive reactance=%2f ohm',Xc);
fprintf('\n Output power=%2f watts',P);
```

Programmed output of a half wave series circuit:

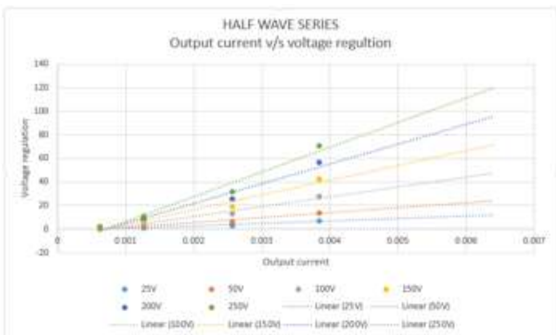
```
No of stages=8
Frequency in hz=50
Capacitance in micro farad=100E-6
Current in amps=0.00641
Peak to peak voltage in volts=250
Load resistance=250E3

 The output for half series/half parallel
 Ripple voltage=476.904000 V
 Output voltage=1523.096000 V
 Regulation voltage=70.510000 V
 Capacitive Reactance=31.847134 ohm
 Output power=10.272025 watt>> |
```

Output result:

Table showing the min. & max. Values of Half wave series circuit obtained through program:

Vin	Stages	Vprac	Vtheo	Il	I	Vrip	Vreg	Xc	Power
25	2	45	49.13	0.0006214	0.01285	0.86996	0.18642	31.847	0.0965
	4	83	93.786		0.009095	6.21400	1.05638		
	6	119	129.99		0.005423	20.00908	3.10700		
	8	156	153.76		0.001803	46.232160	6.83540		
250	2	450	491.02	0.00641	0.1285	8.974	1.923	31.847	10.272
	4	855	935.91		0.09095	64.10	10.897		
	6	1235	1293.5		0.05424	206.402	32.050		
	8	1602	1523.1		0.01803	476.91	70.51		

Various graph plotted for a half wave series circuit:



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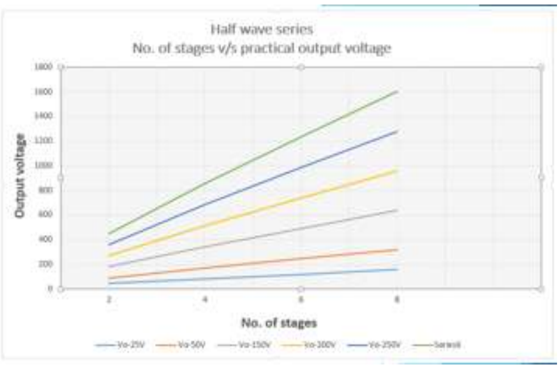
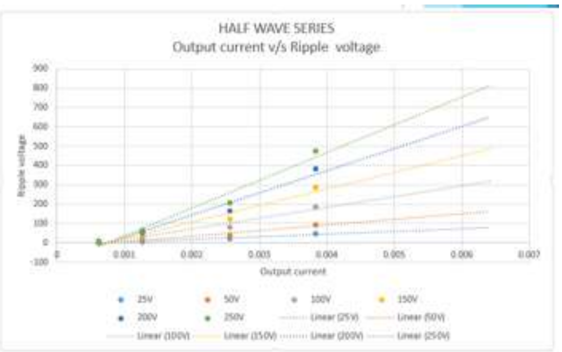




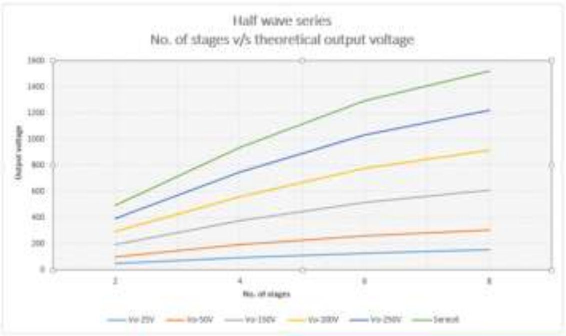
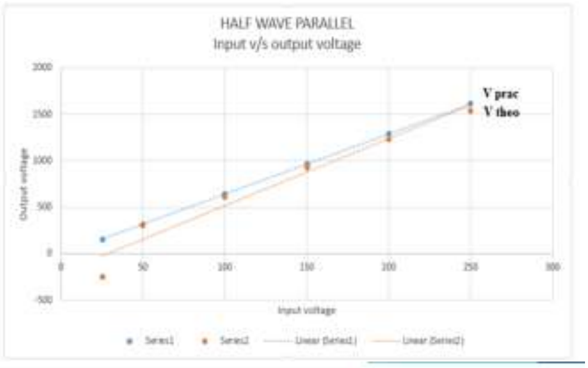
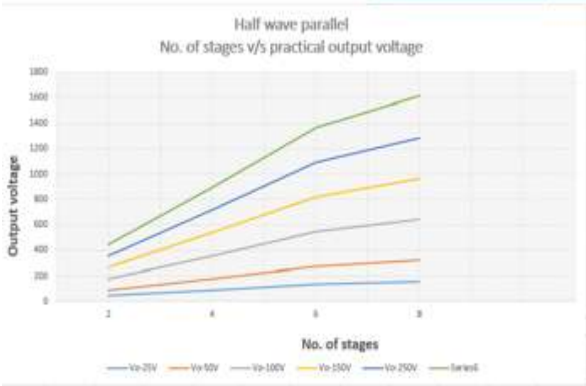


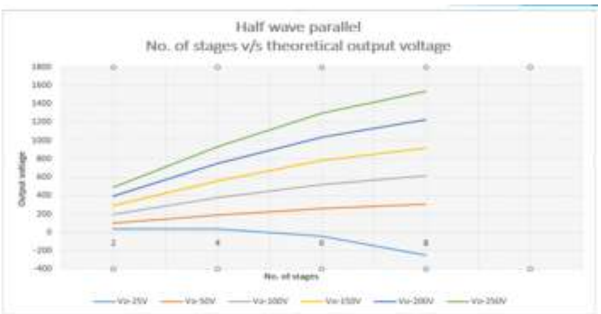
Table showing the min. & max. Values of a Half wave parallel circuit obtained through program:

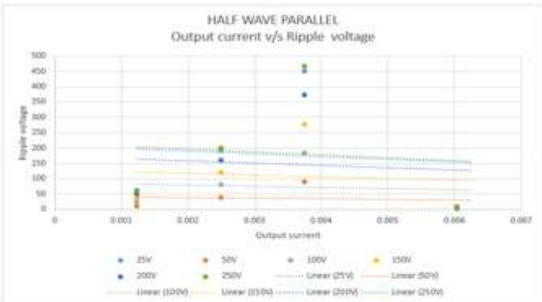
Vin	Stages	Vprac	Vtheo	Il	Vrip	Vreg	Xc	P
25	2	48	41.546	0.006038	8.4532	1.8114	31.84	9.11
	4	87	39.62		60.38	10.26		
	6	133	-44.423		194.423	30.19		
	8	155	-249.22		449.227	66.41		
250	2	445	491238	0.006258	8.76	1.87	31.84	9.79
	4	895	937.42		62.58	10.63		
	6	1365	1298.49		201.5	31.29		
	8	1612	1534.40		465.59	68.83		

Various graphs plotted for half wave parallel circuit:









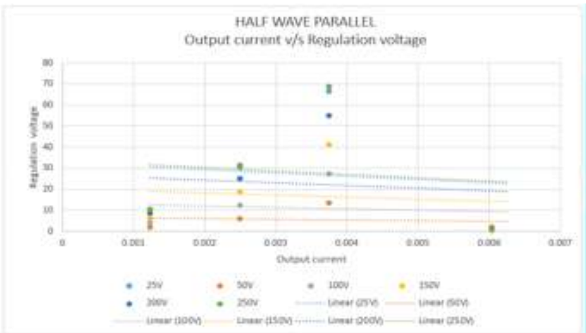


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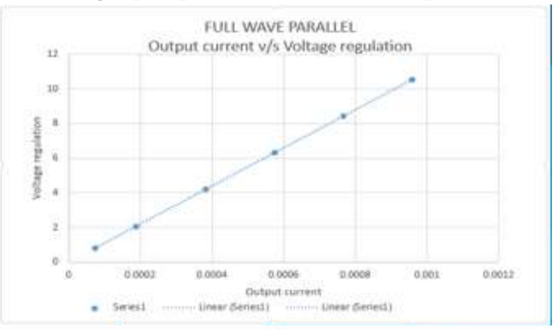
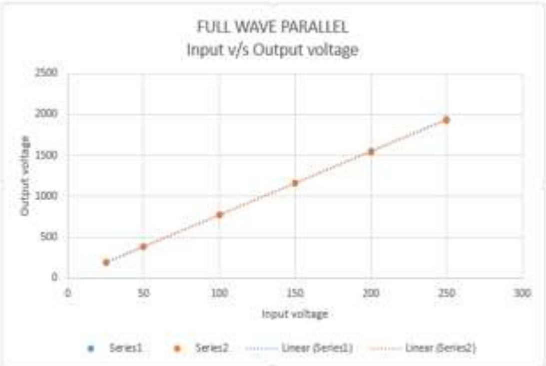
Table showing the values of a full wave parallel circuit obtained through program:

Vin	Vprac	Vth	Il	Vrip	Vreg	Xc	P
25	94.29	194.42	0.00007	5.5071	0.81422	31.84	0.00137
50	191.8	385.92	0.00018	14.0764	2.0812	31.84	0.00895
100	386.8	771.608	0.00038	28.3910	4.197	31.84	0.0364
150	581.7	1157.29	0.00057	42.705	6.314	31.84	0.08237
200	776.7	1542.97	0.00076	57.020	8.4304	31.84	0.1468
250	971.7	1928.59	0.00095	71.409	10.557	31.847	0.2303

Various graphs plotted for Full wave parallel circuit:





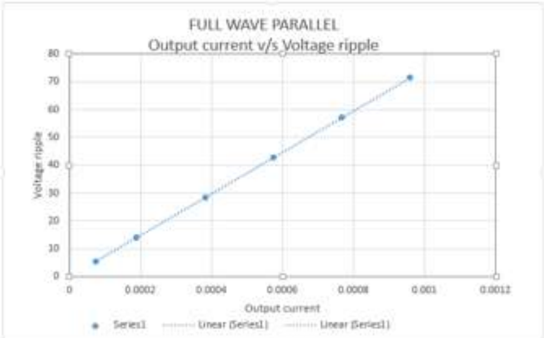
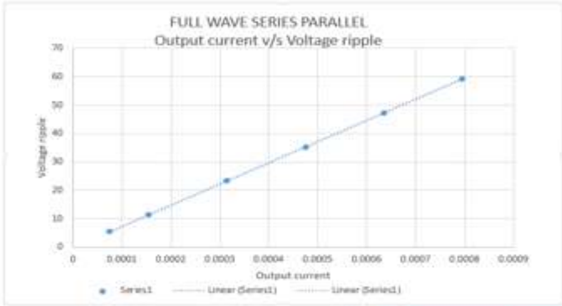
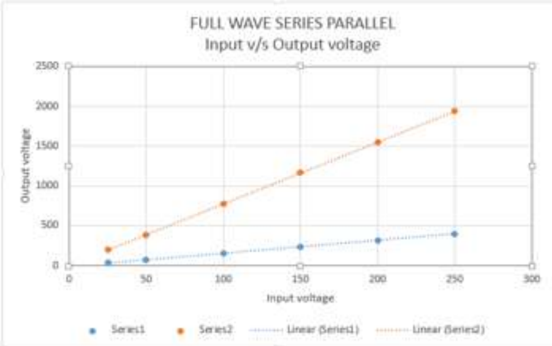


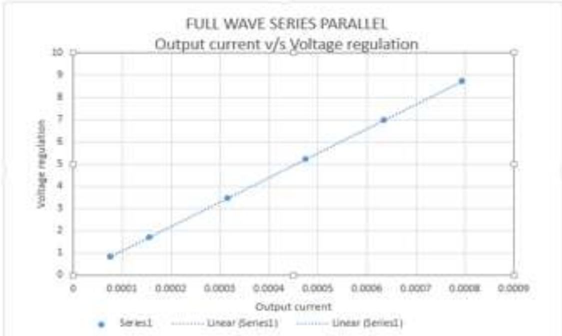
Table showing the values of a full wave series parallel circuit obtained through program:

Vin	Vprac	Vth	Il	Vrip	Vreg	Xc	P
25	37.42	194.43	0.000074	5.566	0.823	31.84	0.0014
50	76.34	388.48	0.000154	11.51	1.702	31.84	0.00599
100	157.36	776.58	0.000314	23.41	3.461	31.84	0.02475
150	237.4	1164.58	0.000474	35.31	5.2206	31.84	0.05631
200	317.2	1552.80	0.000634	47.19	6.9773	31.84	0.10057
250	397.2	1940.89	0.000794	59.11	8.738	31.84	0.1577

Various graphs plotted for Full wave series parallel circuit:







CONCLUSION:

The following conclusions are drawn from the above study: The simulation results are carried out with MATLAB/SIMULINK software and are found to be matching with theoretical calculations .Voltage Multipliers can deliver large voltages without changing the input transformer voltage. These systems are less bulky than conventional transformer rectifier sets. Different voltages can be taken at different stages without changing the input voltage. This kind of system is reliable, less complicated and light in weight. **REFERENCES:**

AUTHORS:

[1] Kwa-Sur Tam, And Eric Bloodworth , “Automated Topological Generation and Analysis of Voltage Multiplier Circuits”, ieee transactions on circuits and systems, vol. 31, no. 3, march 1990.

ISSN: 2321-8169
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[2] Kuffel, E. and M. Abdullah, 1984. High Voltage Engineering, Pergamon Press, Oxford.
[3] Saifali Dalakoti,"Design simulation and development of auxiliary power supply for standalone AMPS testing and IPPS development for LHCD system",Technical Training Program ,Institute for Plasma Research,Bhat, Gandhinagar ,2010
[4] Naidu, M.S. and V. Kamaraju, " High Voltage Engineering", Third Edition, McGraw- Hill Company Ltd, 2004.
[5] Koki Ogura, Enhui Chu, Manabu Ishitobi, Mantaro Nakamura and Mutsuo Nakaoka, Inductor Snubber-Assisted Series Resonant ZCS-PFM High Frequency Inverter Link DC-DC Converter with Voltage Multiplier , IEEE 2002

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He is currently working as an Assistant Professor in the Department of Electrical Engineering, Dr. TTIT, KGF. His research areas are Power Systems, VLSI and Power Electronics.