

# Asymmetrical RNSIC Converters Simulations Of The AC-DC Conversion Performance

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## Abstract

In this analysis, we present a technique to minimize the reactive components (capacitors and inductances) of rectifiers with near sinusoidal input currents (RNSIC) by 15%–25%. Two RNSIC converters of the same kind, dimensioned for half of the converted nominal power and whose entrance currents are phase-shifted with an angle of 30° to 40° by carefully selecting the inductances on the AC portion, are connected in parallel in this approach. Therefore, lowering the capacitors and inductances of the two rectifiers results in an adequate compensation of the type 5 current harmonics created in the power grid.

A reduction of the holding current (the idle current)  $I_{min}$  by the same percentage is achieved in this way. The new converter, named asymmetrical RNSIC, is economically and technically more competitive compared to the three-phase six-pulse full-bridge diode rectifier with passive filters.

**Keywords:** Power converters, AC-DC power conversion, asymmetrical converter, power quality, power electronics.

Date of Submission: 19-05-2026

Date of Acceptance: 29-05-2026

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## I. Introduction

In fact, as the number of power electronics systems increases, AC-to-DC rectifiers play an increasingly significant role. These kinds of three-phase rectifiers are used in the majority of power electronics applications [1]–[3]. A common circuit arrangement is the three-phase, six-pulse full-bridge diode rectifier shown in Fig. 1(a). There are two alternative variations.

The first alternative, a three-phase rectifier with constant DC current, has a practically zero value for the side inductances  $L_S$ . A  $L_f C_f$  filter is connected on the DC side of the rectifier. Fig. 1(b) shows the waveform of the  $i_R$  current. The intensities of harmonic components  $I_{(n)}$  of the phase current can be ascertained in terms of the fundamental frequency component  $I_{(1)}$  as  $I_{(n)} = I_{(1)} / n$ , where  $n$  is the harmonic order  $n = 5, 7, 11, 13, \dots$ . The  $I_d$  constant current has the advantage of increasing the life time of the capacitors used in the DC link [2].

The second alternative, the three-phase rectifiers with supplementary AC side inductances  $L_S$  and without any DC link inductance, has the waveform of the  $i_R$  shown in Fig. 1 (c). The total harmonic line current distortion (THD) factor of the current is higher than the equivalent one in the first alternative, this being the reason why the second alternative is used for inferior powers. The rectifier is considered to have a practically constant DC voltage if the capacitor  $C_f$  has a sufficient capacitance. To sum up, normal AC currents are not at all like a sinusoid. The main line current's harmonic contents also contribute to the extremely low power factor. Additionally, these harmonics could result in electrical resonance, which could create significant overvoltages, and increase harmonic losses in the power grid [1].

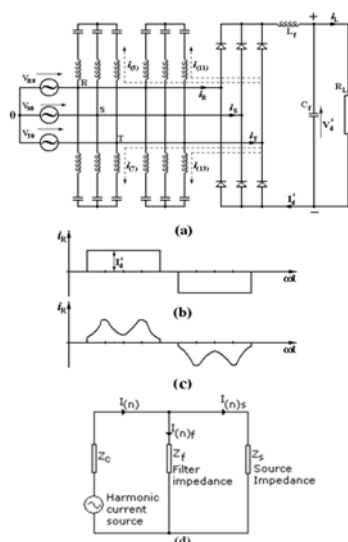


Fig.1 Three-phase six-pulse full bridge diode rectifier with passive filters, (a) Classical configuration; (b) Current waveform  $i_R$  with additional inductance  $L_f$  in DC link and  $L_s=0$ ; (c) Current waveform  $i_R$  without any DC link inductance  $L_f$  and with AC inductance  $L_s$ ; (d) Equivalent circuit for harmonic injection

The first option to lower current harmonics is to use normal passive filters (CPFs) made of LC series circuits. But these passive filters may have some important disadvantages [1]-[4]:

The use of an active power filter (APF) consisting of voltage – or current – source pulse width – modulated harmonics present in the AC lines is one way to surmount the disadvantages of the passive filter, by injecting the corresponding current into the AC side. But the active filters have the following disadvantages: (1) Impediments in obtaining larger rated current source with a fast current response and (2) Increased initial and operational costs [3]-[5].

The use of a PWM rectifier can equally reduce the higher order current harmonics generated by a three-phase AC-DC converter [2], [6]. Although the PWM rectifier has near sinusoidal input currents, it also has some significant drawbacks compared to the three-phase diode rectifier: larger commutation losses, increased costs, EMI - related problems and inferior dependability.

Recently, new rectifiers with a low content of superior harmonics for the input currents have been described in the works [7] – [10]. In this paper describes a new method for increasing the performance of these converters in such a manner as to make them technically and economically competitive with three-phase diode rectifiers with passive filters.

## II. Features Of The RNSIC Converters

Two variants of RNSIC (Rectifier with Near Sinusoidal Input Current) converters have been proposed, that practically eliminate the current input harmonics [7]-[10]. The operation of these converters is not influenced by the voltage or current harmonics from the power grid, thus avoiding resonance phenomena.

The RNSIC-1 variant, shown in Fig.2(a), has six DC  $C_1$ - $C_6$  capacitors with a capacity equal to  $mC$  ( $m$  is the reduction coefficient). If only one converter is used between the source and the consumer, then  $m=1$ . If two paralleled converters are used, according to Fig.3, then  $m$  can be adopted lower than 0.5 (0.4, for example) because a compensation of the type 5 and 7 current harmonics generated in the electrical line is achieved.

An economy is thus achieved in the power installed in the  $C_1$ - $C_6$  capacitors and  $L_l$  inductances. For a single RNSIC-1 converter, the following condition must be fulfilled:

$$0.05 \leq L_l C \omega^2 \leq 0.10 \quad (1)$$

to provide the practically sinusoidal  $i_R$ ,  $i_S$  and  $i_T$  phase currents [7]-[10].

where

$\omega$  signifies the power grid pulsation.

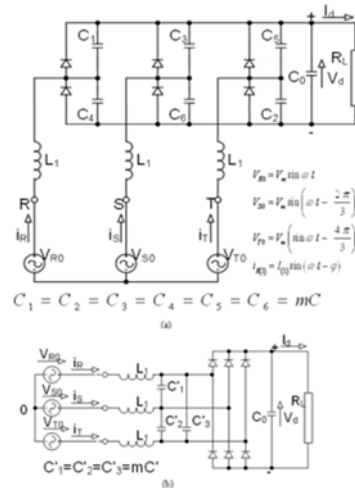


Fig. 2 Variants of RNSIC converters: (a) RNSIC – 1 with six DC capacitors connected in parallel with diodes; (b) RNSIC – 2 with three AC capacitors connected in the AC side.

In the case of passive filters, the values of the capacitors must be kept constant in time and with temperature, in order to get the tuning on a specified harmonic, objective which is quite difficult to achieve. For the RNSIC – 1 converter, it is possible that the values of the capacitors differ from one another, due to the fact that resonance is not necessary. The only condition which has to be imposed in this case is that the sums of the capacitors on the three branches to be equal. That is:

$$C_1 + C_4 = C_3 + C_6 = C_5 + C_2 = 2C$$

condition which can be easily assured by choosing the capacitors accordingly.

The variation of the  $\varphi$  angle between phase voltage (for example  $v_{R0}$ ) and the fundamental harmonic of the phase current (thus  $i_{R(1)}$ ) is shown in Fig. 4(a) for the case of a single converter. The nominal rate, indicated in the F point, is considered for  $\varphi=0^\circ$  and the loading resistance of nominal value  $R_{Lr}$ . Where  $V_d$  is the rectified average voltage, and  $V_{ref} = 3\sqrt{3}V_m / \pi$  is the reference voltage specific for three-phase rectifiers with classical diodes. The  $V_d$  voltage can be established at a certain value by the load current  $I_d$ :

$$I_d = \frac{3I_{(1)}}{2\pi} (1 + \cos \omega t_1) \quad (2)$$

where  $I_{(1)}$  is the amplitude of the phase current fundamental, and  $t_1$  is the time when the diodes of the RNSIC-1 converter begin to work. The  $\omega t_1$  angle varies between  $35^\circ$  and  $45^\circ$  for the nominal rate [8]-[13].

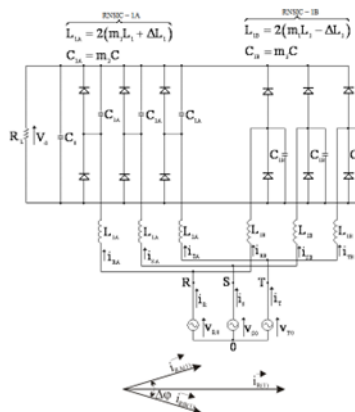


Fig. 3 Configuration of asymmetric RNSIC

Two extreme cases can be pointed out in the operation of the RNSIC-1 converter. In the first case, if the load resistance  $R_L$  is null ( $V_d=0$  and  $\omega t_1=0^\circ$ ), the  $C_1-C_6$  capacitors are short-circuited, and the angle  $\varphi = +90^\circ$  angle is inductive. In this case, the phase currents are also sinusoidal and have a maximum

amplitude equal to  $I_{max}$ . In the second case, if the  $V_d$  function exceeds the value  $\sqrt{3}V_m/(1-2L_1C\omega^2)$  the diodes of the RNSIC-1 converter stop conducting and the angle  $\varphi = -90^\circ$  is capacitive (thus  $R_L = \infty$  and  $\omega t_1 = 180^\circ$ ). In this second case, the phase currents are equally sinusoidal and their amplitude has a minimum value  $I_{min}$ , called holding current. The  $I_{max} / I_{min}$  ratio has the value [9].

$$\frac{I_{max}}{I_{min}} = \frac{(1 - 2L_1C\omega^2)}{2L_1C\omega^2} \quad (3)$$

The second variant of RNSIC converter, abridged as RNSIC-2 in work [10]-[13], has three  $C'_1-C'_3$  capacitors on the AC part with capacities equal to  $mC'$ , according to Fig. 2(b). The nominal  $P_{dr}$  power of a RNSIC converter has inverse variation with the reactance  $L_1\omega$  and direct variation with susceptance  $C\omega$  and  $C'\omega$ .

The equivalent and asymmetrical converters are smaller in size as compared with the classic rectifier with passive filters according to Fig. 1(a). This statement can be proved taking into account the value of the total parameters  $LC\omega^2$  associated to one phase, which characterizes the rectifiers in Figs. 1 and 3. For the case of the proposed method, the parameter  $2L_{eq}C_{eq}\omega^2$  is equal to 0.0830. For the assembly with four passive filters (for the 5<sup>th</sup>, 7<sup>th</sup>, 11<sup>th</sup> and 13<sup>th</sup> harmonics) one must fulfill the tuning condition:

$$L_{(n)}C_{(n)}(n\omega)^2 = 1 \quad (4)$$

in which  $L_{(n)}$  and  $C_{(n)}$  represent respectively the inductance and capacitance of the passive filter tuned for the n-th order harmonic.  
So:

$$\sum L_{(n)}C_{(n)}\omega^2 = \frac{1}{5^2} + \frac{1}{7^2} + \frac{1}{11^2} + \frac{1}{13^2} = 0.07462 \quad (5)$$

value which is closed to the parameter  $2L_{eq}C_{eq}\omega^2$  met at the equivalent and asymmetrical converters, designed for the same rated power as for the classical rectifier in Fig. 1(a). It is important to stress that, unlike the RNSIC -1 converter (of standard type, equivalent or asymmetrical), at which the voltages across the capacitors do not exceed the value  $V_d$ , in the case of the passive filters in Fig. 1(a), the voltages across the capacitors can exceed several times the value of the voltage  $V_m$  upon the increase of the higher harmonic currents which flow through the passive filters, [5]. This growth can be due to the occurrence of series or parallel resonant processes and to the connection of new deformant consumers in the utility grid. For this reason, one must choose for the passive filters capacitors with larger admissible voltages, fact which implies increasing their size, which is not the case for RNSIC converter capacitors. Much more, the AC/DC converter in Fig. 1(a) requires also a filtering inductor  $L_f$  on the DC side, fact which implies a further increasing of the size and costs as compared with the RNSIC converters.

### AC-DC Conversion Performance Asymmetrical RNSIC Converters (RNSIC-1A)

We present hereunder a technically and economically competitive method for the AD-DC conversion, especially at average and high powers. Instead of a single RNSIC-1 converter dimensioned for nominal output power  $P_{dr} = V_d I_{dr}$ , two converters for the same type for powers equal to  $P_{dr} / 2$ , paralleled connected according to Fig.3.

The fundamental harmonic input currents in these converters from the same phase of the power supply (for example  $i_{RA(1)}$  and  $i_{RB(1)}$ ) have a phase shifting  $\Delta\varphi_r = \varphi_M - \varphi_N$  between  $30^\circ$  and  $40^\circ$  in nominal operational state at  $R_{Lr}$  load. The inductance  $L_{1A} = 2(L_1 + \Delta L_I)$  so that RNSIC-1A converter behaves inductive-resistive, and  $L_{1B} = 2(L_1 - \Delta L_I)$  and the RNSIC-1B converter behaves capacitive-resistive for the power supply. The M and N operation points are on the two characteristics, according to Fig. 4(b), for the same value  $V_d$  of the output voltage.

When the output power  $P_d$  varies between the maximum value and, corresponding to the nominal value and zero (thus for  $R_L = \infty$ ), the phase-shifting  $\Delta\varphi$  is practically constant until the RNSIC-1B converter is idle ( $\varphi_N = -90^\circ$ ). Follow-up  $\Delta\varphi$  go to 0 until the second converter RNSIC-1A is idle ( $\varphi_M = -90^\circ$ ), according to Fig. 4(b).

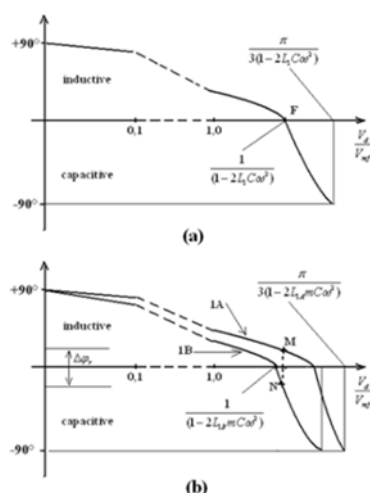


Fig. 4 Angle  $\varphi$  as a function of ratio  $V_d/V_{ref}$ ; (a) single RNSIC-1 converter,  $m=1$  according to Fig. 2(a); (b) Configuration of two RNSIC – 1 converters connected in parallel, with  $L_{1A}$  and  $L_{1B}$  inductances, according to Fig. 3 (asymmetric RNSIC).

On the entire variation range of output power  $P_d$ , the THD% factor for the phase input currents  $i_R$ ,  $i_S$  and  $i_T$  is maintained at acceptable values. The value of the phase-shifting  $\Delta\varphi$ , mentioned above, insures an important reduction of the type 5 harmonic in the power grid, knowing that the RNSIC converters have the largest input harmonic of this type. The  $\Delta L_l$  value ranges between  $0.1L_l$  and  $0.2L_l$  in order to accomplish the desired  $\varphi_M$  and  $\varphi_N$  phase-shiftings.

The amplitude of the fundamental harmonic current  $I_{(1)}$  is increased for larger load currents  $I_d$  and the ratio  $I_{SC} / I_{(1)}$  can be reduced (for example, less than 20), thus achieving a THD less than 5% for the phase currents, according to the IEEE standards 519 of 1992.  $I_{SC}$  signifies the amplitude of the short-circuit currents for terminals R, S and T. For reduced load currents  $I_d$ , the amplitude of the fundamental harmonic current  $I_{(1)}$  is lowered. The ratio  $I_{SC} / I_{(1)}$  ranges between 20 - 50 or 50 - 100, the THDs of the phase currents have to be less than 8% or 12% accordingly.

A converter equivalent to the asymmetrical rectifier from Fig.3 is defined, a single RNSIC-1 converter with the elements  $L_{eq}=(L_{1A}+L_{1B})/4$  and  $C=C_{1A}+C_{1B}=2mC$ . For the equivalent converter, the value  $L_{eq}C_{eq}\omega^2$  is lower than 0.05, thus the phase currents  $i_R$ ,  $i_S$  and  $i_T$  have an unacceptably high THD% ratio for all the variation range of the load resistance.

The amplitude of the holding current of the asymmetrical converter  $I_{minAB}$  is lower by 20%-30% compared to the  $I_{min}$  obtained from a single standard RNSIC-1 converter and can be computed with the equation:

$$\frac{I_{minAB}}{2V_m m C \omega} = \left[ \frac{1}{(1-2L_{1A}mC\omega^2)} + \frac{1}{(1-2L_{1B}mC\omega^2)} \right] \quad (6)$$

Standard converter signifies the converter that insures, just like the asymmetrical adopted converter, practically the same output power  $P_d$  and values of the THD% factor lower than 5% for high load currents. In the most case for the standard converter, the elements  $L_{st}$  and  $C_{st}$  follow the optimal condition

$$L_{st}C_{st}\omega^2 = 0.06 \quad (7)$$

The method proposed in the paper allows the renunciation of the standard converter in favor of the asymmetrical converter, achieving a reduction of the power installed in the capacitors and inductances, and a reduction of the holding current. The partial currents of fundamental harmonic (for example  $i_{RA(1)}$  and  $i_{RB(1)}$ ) that pass through the inductances  $L_{1A}$  and  $L_{1B}$  are practically equal to half of the fundamental harmonic currents that go through the  $L_{st}$  inductances of the standard converter, for normal operation status. These  $L_{st}$  elements are higher than the  $L_{eq}$  inductances, thus stating that a reduction of inductances can be achieved through the use of the asymmetrical converter. The  $L_{1A}$  and  $L_{1B}$  are sized taking into account that half of the  $i_R$ ,  $i_S$  and  $i_T$  currents corresponding to the standard and equivalent converters go through them. The reduction coefficient in the capacitors and inductances is given by the ratio r:

$$r = \frac{L_{eq}C_{eq}}{L_{st}C_{st}} \quad (8)$$

In order to convert practically equal powers from AC to DC, it results that the reactive elements (capacitors and inductances) of the equivalent converter have to be reduced by  $\sqrt{r}$  compared to the corresponding elements of the standard converter.

### III. Simulation Results

Simulation results confirm the theoretical conclusions presented in the work. In Table 1, we present as a function of  $R_L$ , the values of  $V_d$ ,  $I_{(1)}$ , phase-shifting  $\varphi$  between the phase voltages and the fundamentals of the phase currents in the grid, the THD% factor in the current and the ratio  $I_{(5)} / I_{(1)}$ % between the amplitude of the 5<sup>th</sup> harmonic and  $I_{(1)}$  for the RNSIC-1 standard converter, according to Fig.2(a)

In table 2, the same values for a RNSIC-1 equivalent converter are given, still according to Fig.2(a), whose elements  $L_{eq}$  and  $C_{eq}$  have been computed adopting a reduction coefficient  $r=0.7$ .

Table 1: The standard converter,  $L_{st}= 25\text{ mH}$ ,  $C_{st}= 24\mu\text{F}$ ,  $V_m=311\text{V}$ ,  $f=50\text{ Hz}$

$R_L[\Omega]$	$V_d[\text{V}]$	$I_{(1)}[\text{A}]$	$\varphi$ [°]	THD%	$I_5 / I_{(1)}$ [%]
20	526	31.4	+19.8	4.05	3.76
30	590	25.0	-1.8	5.15	4.92
40	612	20.7	-10.8	5.53	5.30
70	622	14.1	-32.4	5.41	5.15
100	624	11.3	-43.2	4.87	4.48
200	629	8.0	-59.4	5.23	4.85
600	648	6.02	-70.2	5.81	5.65
5k	688	5.36	-88.2	1.77	1.64
50k	702	5.32	-90	0.24	0.17

It can be seen in this table that because the parameter  $L_{eq}C_{eq}\omega^2$  is quite small compared to the value of 0.05, the THD% factor has higher values for the load currents close to the nominal operational rating.

Based on the chosen equivalent converter, the asymmetrical converter can be projected according to Fig.3(a), the elements  $C_{IA}$  and  $C_{IB}$  are equal to  $C_{eq} / 2 = mC_{st}$  ( $m$  results 0.42). The inductances  $L_{IA}$  and  $L_{IB}$  are adopted equal to 49 mH and respectively 35 mH (thus  $\Delta L_I = 3.5\text{mH}$ ) in order to obtain phase-shifting  $\Delta \varphi$  close to 40°. The simulations results obtained for the asymmetrical converter are given in table 3. It is concluded from Table 3 that, the method applied above at the asymmetrical converter is possible: (1) to lower the installed power in reactive elements (capacitors and inductances) with approx. 20%-30% and (2) from this results a same percentage reduction of the holding current  $I_{\min AB}$ , compared to the standard converter RNSIC-1.

Table 2: The equivalent converter,  $r=0.7$ ,  $L_{eq}=21\text{mH}$ ,  $C_{eq}= 20\mu\text{F}$ .

$R_L[\Omega]$	$V_d[\text{V}]$	$I_{(1)}[\text{A}]$	$\varphi$ [°]	THD%	$I_5 / I_{(1)}$ [%]
20	530	30.8	+12.6	5.72	5.29
30	565	23.1	+1.8	7.37	6.94
40	577	18.7	-10.8	8.45	8.04
70	581	12.5	-32.4	9.06	8.72
100	584	9.90	-45.0	8.26	7.81
200	592	6.78	-57.6	8.34	7.65
600	614	4.89	-72.0	10.4	10.20
5k	654	4.29	-88.2	4.02	3.84
50k	672	4.25	-90	0.62	0.51

In Fig.5, the waveforms for the partial currents  $i_{RA}$  and  $i_{RB}$  and total  $i_R$  are shown for  $R_L=30\Omega$ . Although the partial currents can have a THD% of approx. 10%-15% maximum, the  $i_R$  current has a THD% that fits within the limits set by applicable standards for the various variation intervals of the  $I_{SC} / I_{(1)}$  ratio, according to table 3.

Table 3: Asymmetrical converter  $\Delta L_I = 3.5\text{mH}$ ,  $L_{IA} = 49\text{mH}$ ,  $L_{IB} = 35\text{ mH}$ ,  $C_{IA}=C_{IB}=10\mu\text{F}$ ,  $V_m= 311\text{V}$ ,  $f= 50\text{Hz}$ ,  $C_0= 4000\mu\text{F}$ .

$R_L[\Omega]$	$V_d[\text{V}]$	$I_{(1)}[\text{A}]$	$\varphi$ [°]	THD[%]	$I_5 / I_{(1)}$ [%]
20	524	30.2	+14.4	5.07	4.77
30	550	21.7	+1.8	4.82	4.65
40	558	16.8	-3.6	4.76	4.37
70	588	11.9	27.0	7.43	6.93
100	591	9.73	-41.4	7.89	7.43
200	597	6.78	-57.6	8.96	8.35

600	618	4.91	-70.2	10.7	10.5
5k	674	4.30	-88.2	2.64	2.5
50k	684	4.27	-90	0.58	0.39

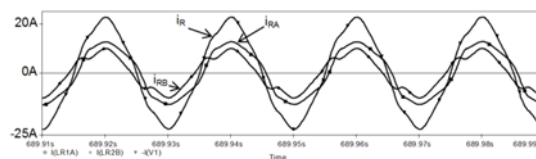


Fig. 5 Waveforms of the partial phase currents  $i_{RA}$  and  $i_{RB}$  and total phase current  $i_R$ .

It is important to notice that the classical three-phase rectifier with diodes depicted in Fig.1(a) has a holding current (idle current), when the load resistance  $R_L$  is infinite, due to the presence of passive filters at entry that behave like capacitive loads. This holding current can be even larger than that resulted at the asymmetrical converter depicted in Fig.3.

#### IV. Conclusion

The operation of asymmetrical RNSIC AC-DC converters having practically sinusoidal currents at entry is not influenced by the presence of voltage harmonics or current in the power grid.

The ratio between the holding current (denoted  $I_{min}$  for the RNSIC converters and by  $I_{(1)tot}$  for the rectifier with passive filters) and the rated current  $I_{(1)r}$  varies between the following limits:

- 30%- 35% for the rectifiers with passive filters;
- 20% - 25% for standard RNSIC – 1;
- 18% - 20% for asymmetrical RNSIC – 1.

The asymmetrical RNSIC converters, with DC or AC capacitors, have lower dimensions, costs, holding currents and power losses and provide increased safety conditions compared to the three-phase six pulse full-bridge diode rectifiers with classical passive filters.

Another significant feature of the new converter is that it has an increased voltage that is 15%-25% higher than the DC voltage obtained from a three-phase classical diode rectifier, which makes more suited for different uses.

#### References:

- [1]. N. Mohan, T. Undeanland, W. Robbins: Power Electronics – Converters, Applications And Design, John Wiley & Sons Inc., 1995, 200 – 248.
- [2]. M. Kazmierkowski, R. Krishnan And F. Blaabjerg: Control In Power Electronics Selected Problems, Academic Press, 2002, 89 – 208.
- [3]. Candidus U. Eya, Ayodeji Olalekan Salau, Sepiribo Lucky Braide, S. B. Goyal, Victor Adewale Owoeye, Oluwafunso Oluwole Osaloni : “Assessment Of Total Harmonic Distortion In Buck-Boost De-Ac Converters Using Triangular Wave And Saw-Tooth Based Unipolar Modulation Schemes”, Wseas Transactions On Power Systems, Volume 17, 2022, Pages: 324-338.
- [4]. J. Arrilaga And N. Watson: Power Systems Harmonics, 2<sup>nd</sup> Ed., New York, Wiley, 2003.
- [5]. H. Akagi, Trends In Active Power Conditioners, Ieee Transactions On Power Electronics, 1994, 9, 263-268.
- [6]. J.R. Rodrigues, J.W. Dixon, J.R. Espinoza, J. Pontt And P. Lazana: Pwm Regenerative Rectifiers. State Of Art, Ieee Trans. On Industr. Electronics, Vol. 52, No.1, Pp. 5 – 22, Jan. 2005.
- [7]. D. Alexa: Three-Phase Rectifier With Almost Sinusoidal Input Current, Electronics Letters, 2001, 37, 1148 – 1150.
- [8]. Alexa D., Sirbu A., Pletea I. V., Filote C., Ionescu F., Analysis Of The Two – Quadrant Converter With Rectifier With Near Sinusoidal Input Currents, Iet Power Electronics, Vol. 1, No. 2, Pp. 224 – 234, June 2008.
- [9]. Alexa D., Sirbu A., Pletea I. V., Filote C., Chiper R., Variants Of Rectifier With Near Sinusoidal Input Currents – A Comparative Analysis With The Conventional Diode Rectifier, Iet Power Electronics, Vol. 4, No. 6, Pp. 632 – 641, July 2011.
- [10]. Alexa D., Sirbu A., Pletea I.V., And Goras T.C., Hybrid Rectifier With Near – Sinusoidal Input Currents, Ieee Trans. Ind. Electron., Vol. 59, No. 7, Pp. 2947-2958, Jul 2012.
- [11]. M. Pletea, I. V. Pletea, D. Alexa, D. D. Cepareanu, A. Petrichei And A. Serediuc. „An Analysis And Simulations Of The Tow – Quadrant Converter With Rnsic”. Setit 2012: Sciences Of Electronic, Technologies Of Information And Telecommunications, From 12 To 15 May 2012, Tunisia.
- [12]. M. Pletea, N.R. Buzatu, A. Serediuc, C. Nedelcu And I.V. Pletea: “Variants Of Rectifiers With Near Sinusoidal Input Currents”. Symposium On Signals, Circuits And Systems Isscs 2011, Iași, Pp. 1 – 4, Isbn 978-1-61284-944-7.
- [13]. M. Pletea (Moisa), I. V. Pletea, D. Alexa & D. D. Cepareanu: „Two – Quadrant Converter With Rnsic – Analysis And Simulations”. International Journal Of Research And Reviews In Applied Sciences. Vol 9, Issue 1, 2011, Pp. 57-62. Issn: 2076-734x, Eissn: 2076-7366