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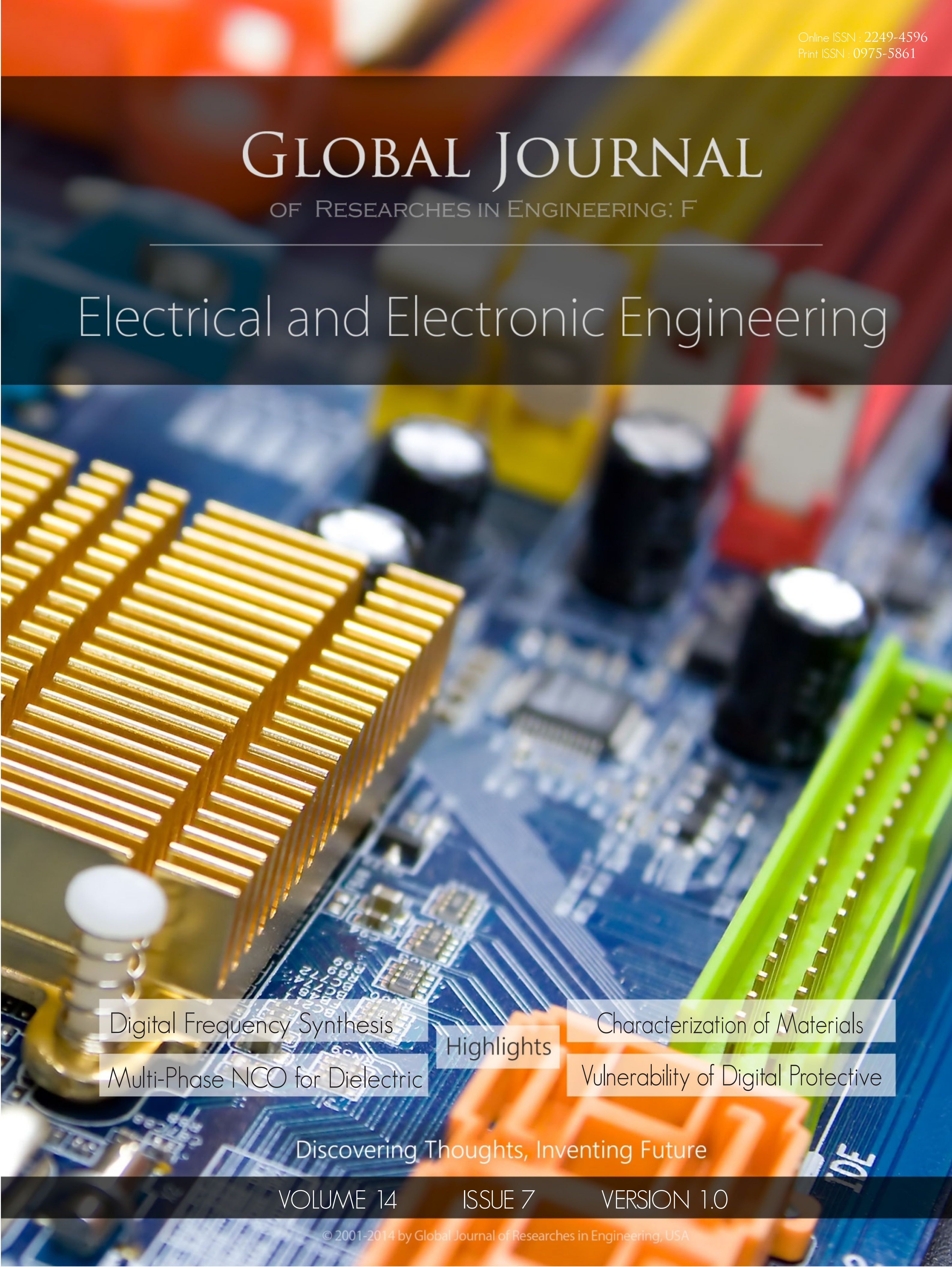

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Multi-Phase NCO for Dielectric

Highlights

Characterization of Materials

Vulnerability of Digital Protective

Discovering Thoughts, Inventing Future

VOLUME 14 ISSUE 7 VERSION 1.0

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Electronically Tunable Third-Order Switched-Capacitor Filter with Feedforward Signal to Minimize Overshoot

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Abstract- The study proposes an Electronically Tunable Third-Order Switched-Capacitor Filter with Feedforward Signal to minimize Overshoot Configuration. This circuit is designed for center frequency f_0=15 KHz. The proposed circuit discusses a new configuration to realize third-order with three filter functions low-pass, band-pass, and high- pass simultaneously in single circuit. The circuit uses OP-AMP and MOSFET with Capacitor as Switched-Capacitor. The response of circuit is studied for different circuit merit factor Q and center frequency f_0=15 KHz. The filter circuit can be used for both narrow as well as for wide bandwidth, Also, this circuit works for electronically tunable bandwidth. The gain roll-off for this circuit is close to the ideal value of 18 dB / octave (40dB/ decade) as for third order filters. This filter configuration shows better response for Q ≥ 0.4. Also, stabilization of gain for High - pass filter function can be achieved at 0dB for Q≥0.4. In the proposed circuit configuration, the peak gain for overshoot is minimizing from 44dB to 5dB due to the feedforward input signal. The Low-pass filter function works practically only for higher merit factor Q. The circuit shows better response for Q≥ 0.4 and f_0 =15 kHz.

Keywords: electronically tunable, third-order switched-capacitor, pass band, merit factor q, cut-off frequency.

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Electronically Tunable Third-Order Switched-Capacitor Filter with Feedforward Signal to Minimize Overshoot

Adnan Abdullah Qasem [α] & G. N. Shinde [σ]

Abstract- The study proposes an Electronically Tunable Third-Order Switched-Capacitor Filter with Feedforward Signal to minimize Overshoot Configuration. This circuit is designed for center frequency f_0=15 KHz. The proposed circuit discusses a new configuration to realize third-order with three filter functions low-pass, band-pass, and high- pass simultaneously in single circuit. The circuit uses OP-AMP and MOSFET with Capacitor as Switched-Capacitor. The response of circuit is studied for different circuit merit factor Q and center frequency f_0=15 KHz. The filter circuit can be used for both narrow as well as for wide bandwidth, Also, this circuit works for electronically tunable bandwidth. The gain roll-off for this circuit is close to the ideal value of 18 dB / octave (40dB/ decade) as for third order filters. This filter configuration shows better response for Q ≥ 0.4. Also, stabilization of gain for High- pass filter function can be achieved at 0dB for Q≥0.4. In the proposed circuit configuration, the peak gain for overshoot is minimizing from 44dB to 5dB due to the feedforward input signal. The Low-pass filter function works practically only for higher merit factor Q. The circuit shows better response for Q ≥ 0.4 and f_0 =15 kHz.

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I. Introduction

Conventional analog circuits use the ratio of resistances to set the transfer function of filter circuits. The values of RC product determine the frequency responses of these circuits [1-2]. A switched-capacitor can replace a resistor [2]. MOSFET technology can be used for designing switched-capacitor circuits [3]. The filter circuits using Switched-Capacitor allow very sophisticated, accurate and tunable analog circuits to be manufactured. Many of the circuits proposed the working of only one type of operation [5- 10]. The Switched-Capacitor concept can be used to realize wide variety of universal filter that have the advantage of compactness and tenability [5]. Switched capacitor techniques have been developed so that both digital and analog functions can be integrated on a single silicon chip. Switched-Capacitor filters have the advantage of better accuracy in most cases. Typical center frequency accuracies are normally on the order of about 0.2% foremost Switched-Capacitor ICs, and worst-case numbers range from 0.4% to 1.5% (assuming, of Course, that an accurate clock is provided) [6]. This Paper of Electronically Tunable Third-Order Switched-Capacitor Filter with Feedforward Signal to minimize Overshoot has been studied for different values of circuit merit factor Q and f_0=15 KHz .

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II. Basic Switching Operation

The essence of the Switched-Capacitor is the use of Capacitors and analog Switches to perform the same function as resistors. This replacement of resistor, analog with op. amp based integrator, and then forms an active filter. Furthermore, the use of the Switched-Capacitor will be seen to give frequency tenability to active filters. Filter using Switched-Capacitor technique overcome a major obstacle of filter on a chip fabrication—the implementation of resistors by simulating resistors with high speed Switched-Capacitors using MOSFETs. The switching function of the MOSFET produces a discrete response rather than a continuous response from the filter [14]. The operation of switched-capacitor can be explained with the help of following circuit diagram.

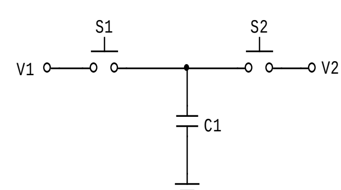

Figure 1 : Circuit diagram for operation of the switched-capacitor

Since the charge q on a capacitor C_1 is given by

$$q = C_1 V$$

Where V is the voltage across the capacitor C_1.

Therefore, when S_2 closes with S_1 open, then S_1 closes with S_2 open a charge q is transferred from V_2 to V_1 with

$$\Delta q = C_1 (V_2 - V_1)$$

If this switching process is repeated N times in time (t), then the amount of charge transferred per unit time is given by

$$\frac{\Delta q}{\Delta t} = C_1(V_2 - V_1)\frac{N}{\Delta t}$$

L.H.S. is current and number of cycles per unit time is switching frequency.

$$\therefore i = C_1(V_2 - V_1)\, f_{clk}$$

$$\therefore \frac{(V_2 - V_1)}{i} = \frac{1}{C_1 f_{clk}} = R$$

Thus the switched-capacitor is equivalent a resistor.

III. Proposed Circuit Configuration

The proposed circuit configuration for Electronically Tunable Third-Order Switched-Capacitor Filter with Feedforward Signal to minimize Overshoot is shown in Figure 2. The circuit consists of three op–amps (µA 741) with wide identical gain bandwidth product (GB) and four Capacitors with MOSFET, which form Switched-Capacitor. Switched-Capacitor can replace resistors, which was proposed earlier [2]. The input sinusoidal voltage is applied to the inverting terminal of the first op-amp through switched capacitor (SC). The non-inverting terminal is grounded. SC is used in the feedback circuit. The output of the first op-amp is supplied as non-inverting input of the second op-amp. The feedforward input signal is given to the inverting terminal of the second op-amp. SC is used as feedback. The output of the second op-amp is supplied as non-inverting input of the third op-amp. The inverting terminal is grounded. SC is used as feedback. Low-pass function is observed at the output of the third op-amp. The output of the second op-amp gives Band-pass function. The High-pass function is seen at the inverting input of the first op-amp.

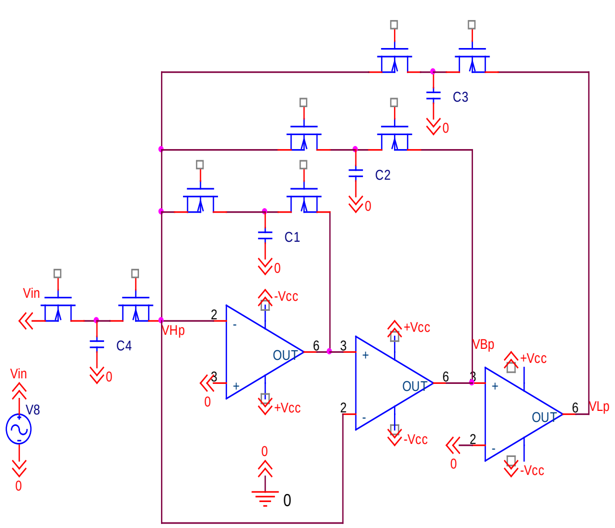

Figure 2 : Proposed Circuit diagram for Electronically Tunable Third Order Switched-Capacitor filter

IV. Circuit Analysis and Design Equations

Op-amp (µA 741) is an internally compensated op-amp, which represented by "Single pole model",

$$A(s) = A_0\omega_0 / (S + \omega_0) \tag{1}$$

Where,

A_0 = open loop d.c. gain, ω_0 = open loop -3dB bandwidth, GB = $A_0\,\omega_0$ = gain bandwidth product of op-amplifier.

$$A(s) = A_0\omega_0 / S = GB/S, \tag{2}$$

Where, $S >> \omega_0$

This shows that the op-amplifier is an "integrator", Thus Electronically Tunable Third-Order Switched-Capacitor Filter transfer function at three different terminals are given below. The voltage transfer function for low-pass filter:

$$T_{Lp} = \frac{-GB_1GB_2GB_3C_4}{X_1S^3+X_2S^2+X_3S+X_4} \tag{3}$$

The voltage transfer function for band-pass filter:

$$T_{Bp} = \frac{-SGB_1GB_2C_4}{X_1S^3+X_2S^2+X_3S+X_4} \tag{4}$$

The voltage transfer function for high-pass filter:

$$T_{Hp} = \frac{S^3C_4}{X_1S^3+X_2S^2+X_3S+X_4} \tag{5}$$

Where

$X_1 = C_1 + C_2 + C_3 + C_4$

$X_2 = GB_1C_1 + GB_2C_2$

$X_3 = GB_1GB_2C_2 + GB_2GB_3C_3$

$X_4 = GB_1GB_2GB_3C_3$

The circuit was designed using coefficient matching technique i.e. by comparing these transfer functions with General Third-order transfer functions [10]. The general Third-order transfer function is given by

$$T(S) = \frac{\alpha_3 S^3 + \alpha_2 S^2 + \alpha_1 S + \alpha_0}{S^3 + \omega_0\left(1+\frac{1}{Q}\right)S^2 + \omega_0^2\left(1+\frac{1}{Q}\right)S + \omega_0^3} \tag{6}$$

By comparing (3), (4), and (5) with (6), we get the design equation as

$$C_1 + C_2 + C_3 + C_4 = 1 \tag{7}$$

$$GB_1C_1 + GB_2C_2 = W_0\,\{1+1/Q\} \tag{8}$$

$$GB_1GB_2C_2 + GB_2GB_3C_3 = W_0^2\,\{1+1/Q\} \tag{9}$$

$$GB_1 GB_2 GB_3 C_3 = W_0^3 \tag{10}$$

So that Values of C_1 , C_2 , C_3 and C_4 can be calculated using these equations for different values of Q and f_0 =15 KHz (table1).

Table 1 : Capacitance values for different values of Q

Q	C_1(µf)	C_2(µf)	C_3(nf)	C_4(µf)
0.1	286.8	7.9	19.2	705.3
0.4	91.3	2.5	19.2	906.2
0.8	58.7	1.6	19.2	939.7
1	52.2	1.4	19.2	946.4
4	32.6	0.9	19.2	966.5
8	29.3	0.8	19.2	909.8
10	28.7	0.77	19.2	970.5

V. Sensitivity

The sensitivities of ω_0 and Q in this Electronically Tunable third-order Switched-capacitor Filter are as follows.

$$S_{C_1}^{W_0} = -\frac{1}{3} C_1$$

$$S_{C_2}^{W_0} = -\frac{1}{3} C_2$$

$$S_{C_3}^{W_0} = -\frac{1}{3}\{C_3 - 1\}$$

$$S_{C_4}^{W_0} = -\frac{1}{3} C_4$$

$$S_{GB_1}^{W_0} = S_{GB_2}^{W_0} = S_{GB_3}^{W_0} = \frac{1}{3}$$

$$S_{C_1}^{Q} = -\frac{1}{3}(1+Q)C_1$$

$$S_{C_2}^{Q} = -(1+Q)C_2\left\{\frac{1}{(C_2+C_3)} - \frac{1}{3}\right\}$$

$$S_{C_3}^{Q} = -(1+Q)\left\{\frac{1}{(C_2+C_3)} - \frac{1}{3} - \frac{2}{3C_3}\right\}$$

$$S_{C_4}^{Q} = -\frac{1}{3}(1+Q)\,C_4$$

$$S_{GB_1}^{Q} = -(1+Q)\left\{\frac{C_2}{C_2+C_3} - \frac{2}{3}\right\}$$

$$S_{GB_2}^{Q} = -\frac{1}{3}(1+Q)$$

$$S_{GB_3}^{Q} = -(1+Q)\left\{\frac{C_3}{C_2+C_3} - \frac{2}{3}\right\}$$

VI. Experimental Set Up

The circuit consists of three op–amps (µA 741) with wide identical gain bandwidth product (GB) and four Capacitors with MOSFET, which form Switched-Capacitor. The circuit performance is studied for different Values of circuit merit factor Q with center frequency f_0=15 KHz. The general operating range of this filter is 10 Hz to 1.2 MHz The value of GB (GB_1=GB_2=GB_3) is ($2\pi \times (5.6) \times 10^5$ rad/sec). The table1 shows the capacitor values for different circuit merit factor Q. MOSFETs are driven by two non-overlapping clocks. The input voltage of 0.5mV is applied. The table1 shows the capacitor values for different circuit merit factor Q.

VII. Result and Discussion

Following observations are noticed for Low-pass, Band-pass and High-pass at corresponding terminals.

a) Low-Pass Response

The figure 3 shows the low pass response for different values of circuit merit factor Q.

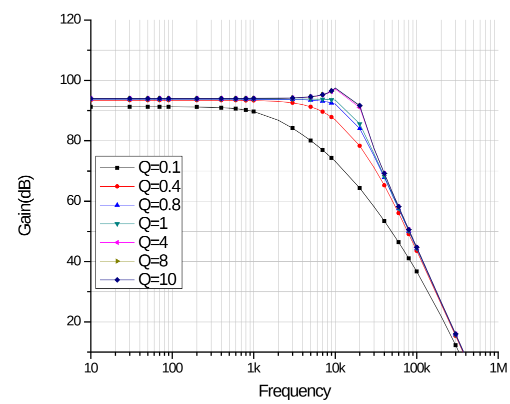

Figure 3 : Low-pass (LP) responses for different values of Q

Table 2 : Analysis of Low Pass Response for Graph (Fig. 3)

Q	Max. Passband Gain (dB)	f_{0L} (kHz)	$f_0 \sim f_{0L}$ (kHz)	Gain Roll-off in stop band	
				dB/Octave (kHz)	Octave starting at (kHz)
0·1	91.3	20	5	17	215
0·4	93.4	38	23	17.7	90
0.8	93.6	43	28	18	60
1	93.8	43	28	18	60
4	94	44	29	18	60
8	94	44	29	18	60
10	94	44	29	18	60

The maximum pass-band gain varies between 91.3dB to 94dB and the gain roll-off per octave varies between 17 to 18dB/octave. But in previous reported configuration maximum pass-band gain varies between 82dB to 87dB. Also, the gain roll-off per octave in stop-band varies between 14 to 19dB/octave [14]. The maximum pass-band gain increase with increase in values of circuit merit factor Q but after Q≥4 this value gets stabilized at the maximum pass-band gain. The Gain roll-off values are close to ideal value of 18dB/octave for third order switched-capacitor filter. The response shows no overshoot for all the values of circuit merit factor Q where as the previous reported configuration shows overshoot with increase in Q (for Q=10, the overshoot is 14 dB) [14].

b) High-pass response

The figure 4 shows the High pass response for different values of circuit merit factor Q.

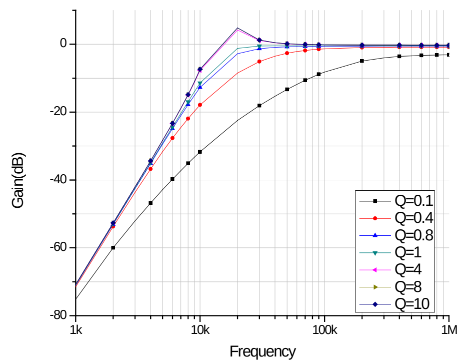

Figure 4 : High-pass (HP) responses for different values of Q

Table 3 : Analysis of High Pass Response for Graph (Fig. 4)

Q	f_{0H}(kHz)	$f_0 \sim f_{0H}$(kHz)	Gain Roll-off in stop band		Gain Stabilization		Peak Gain of overshoot (dB)
			dB/Octave	Octave Starting at (kHz)	(dB)	f_S(kHz)	
0.1	158	143	17.4	2	-3	460	0
0.4	37	22	18	3.5	0	170	0
0.8	19	4	18	5	0	46	0
1	13	2	18	5	0	46	0
4	13	2	18	5	0	40	3
8	13	2	18	5	0	40	5
10	13	2	18	5	0	40	5

The Gain roll-off in stop-band varies between 17.4dB to 18dB/octave which is close to the ideal value of 18 dB /octave for third order Switched-Capacitor filter .Also, the gain is stabilized for all values of circuit merit factor Q ≥ 0.4 . But in previous reported Configuration, the Gain roll-off in stop-band varies between 11 to 12dB/octave. Also, the gain can't be stabilized at 0dB for all values of circuit merit factor Q [14]. The peak gain for overshoot is minimizing from 44dB to 5dB due to the feedforward input signal that's given to the second Op-amp in the proposed circuit configuration. The gain gets stabilized almost at 0 dB for all values of Q ≥ 0.4. The response shows overshoot for all the values of Q ≥ 4. The analysis for the responses are summarizes in the table 3.

Table 4 : Comparison of Overshoot

Overshoot observed in dB		
Q	Previous Reported circuit	Proposed circuit
0.1	0	0
1	0	0
5	38	3
10	44	5

c) Band-pass response

The figure 5 shows the Band-pass response for different values of circuit merit factor Q.

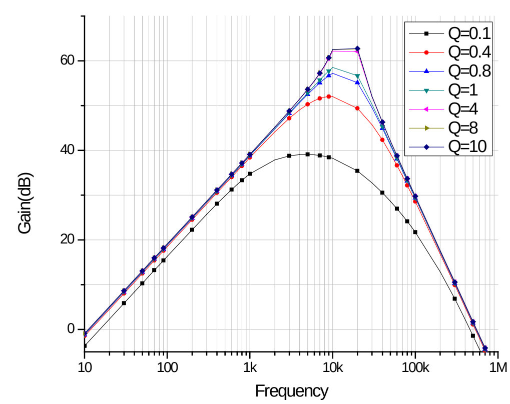

Figure 5 : Band-pass (BP) response for different values of Q

Table 5 : Analysis of Band Pass Response for Graph (Fig. 5)

Q	Max. Passband gain (dB)	f_1 (kHz)	f_2 (kHz)	BW (kHz)	Gain Roll-off / octave in stop band			
					Leading Part		Trailing Part	
					dB/ octave	Octave starting at (kHz)	dB/ octave	Octave starting at (kHz)
0·1	39	0.4	55	54.6	5.8	0.6	12	206
0·4	52	0.8	60	59.2	6	3	12	61
0.8	57	1.2	52	51.8	6	3	12	40
1	58	1.3	51	50.7	6	3	12	41

4	62	1.7	44	43.2	6	3	12	41
8	62.5	1.8	44	43.2	6	3	12	41
10	62.5	1.8	44	43.2	6	3	12	41

The maximum pass-band gain varies between 39dB to 62.5dB. Also, the bandwidth varies between 43.2 KHz to 59.2 KHz and Gain roll-off in trailing part varies between 11.6 to 12dB/octave. But in previous reported configuration the maximum pass-band gain varies between 33dB to 73dB.Also, the bandwidth varies between 59.4 KHz to 22 KHz and Gain roll-off in trailing part varies between 8dB/octave to 13dB/octave [14]. The maximum pass-band gain increases with increase in circuit merit factor Q. The bandwidth decreases with increasing in values of circuit merit factor Q but after $Q \geq 4$ this value gets stabilized at 43.2 KHz. For lower values of circuit merit factor Q, this filter can be used for wide bandwidth and for higher values of circuit merit factor Q it can be used for narrow bandwidth. There is no shift in the central frequency. It is also observed that the pass band distribution of frequency is symmetric for both sides. The gain roll-off/octave in leading and trailing part of the response is same. The circuit works better band pass response for $Q \geq 0.4$.

VIII. Conclusions

A realization of Electronically Tunable Third-Order Switched-Capacitor Filter with Feedforward Signal to minimize Overshoot has been proposed. The filter circuit can be used for both narrow as well as for wide bandwidth, so this circuit works for electronically tunable bandwidth. The gain roll-off for this circuit is close to the ideal value. The gain gets stabilized almost at 0 dB for all values of $Q \geq 0.4$.The Low pass filter function works practically only for higher merit factor Q. The circuit shows better response for $Q \geq 0.4$ and $f_0 = 15$ kHz. In the proposed circuit configuration, the peak gain for overshoot is minimizing from 44dB to 5dB due to the feedforward input signal.

References Références Referencias

1. G. N. Shinde and P. B. Patil, “Study of active-R second order filter using feedback of non-inverting terminal,” Bulletin of Pure and Applied Sciences, Vol. 21 D, No. 1, pp. 23-30, 2002.
2. M. Ghausi, “Analog active filters,” IEEE Transactions on Circuits and Systems, Vol. 31, pp. 13-31, 1984.
3. William R. Grise, Applications of Switched capacitor circuits in active filters and Instrunental Amplifiers, (3), 1523-26, 1999.
4. G. N. Shinde, P. B. Patil, A. B. Kadam and P. R. Mirkute, “Active-R biquadratic filter using positive feedforwardsignal,” BRI'S JAST, Vol. 5(I and II), pp. 7-15, 2002.
5. Avinash Kumar and S.K. Saha, MOS switched capacitor sample data filters, (554), 631-636, 1983.
6. G. N. Shide and S. R. Bhagat “tunble bandwidth third order switched-capacitor with multiple feedbacks filter for different center frequencies” Engineering, 2,179-183, 2010.
7. Jinguang Jiang and Yaonan Wang, Design of a tunable frequency CMOS fully differential fourth order Chebyshev filter ,Microelectronics Journal, 37, 2006.
8. G. J. Yu, C. Y. Huang, J. J. Chen and B. D. Liu, “Designof current mode square root domain bandpass filter withreduced voltage,” Analog-Integrated Circuit and Signal Processing, Vol. 44, pp. 239-250, 2005.
9. R. Senani and S. S. Gupta, “Low universal filter using only current followers as active elements,” International Journal of Electronics and Communication, Vol. 60, pp. 251-256, 2006.
10. J. G. Jiang and Y. N. Wang, “Design of a tunable frequency CMOS fully differential fourth order chebyshe filter, Microelectronics Journal, Vol. 37, pp. 84-90, 2006.
11. Srinivasan, “Synthesis of transfer functions using the operational amplifier pole”, Int. J. Electronics, vol. 40(1), 5-13, 1976.
12. William R. Grise “Applications of Switched capacitor circuits in active filters and Instrumental Amplifiers” VOL-3, No. 3, 1523-26, 1999.
13. Jinguang Jiang and Yaonan Wang, “Design of a tunable frequency CMOS fully differential fourth order Chebyshev filter”, Microelectronics Journal, VOL37, 84-90, 2006.
14. G. N. Shinde and S. R. Bhagat, “Feed Forward Third Order Switched Capacitor Filter for different circuit merit factor Q values”, Archives of Applied Science Research, Vol 2, No 1, 277-285, 2010.
15. Yonghyun Shim and Mina Rais-Zaden“ A high-performance continuosly Tunable Bandpass Filter” IEEE Transactions on microwave theory and Technique, vol-60.No.8, 8, 2012 .

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Adaptive Filters

By Dr. Ziad Sobih & Prof. Martin
Northeastern University, Jordan

Abstract- We know the optimum and suboptimum receiver for ISI in the transmission through band-limited non ideal channels. The optimum employ maximum likelihood detection. The sub optimum employ linear equalizer.

In our design of the equalizer we assume that we know at the receiver the impulse response of the channel or the frequency response. In most communication channels this response is varying as a function of time. In this case we use an equalizer to adapt for this change. In this paper we will automatically adjust the equalizer coefficient to adapt for channel changes. We also analyze the performance characteristics including convergence rate and computational complexity.

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ADAPTIVEFILTERS

Strictly as per the compliance and regulations of :

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Dr. Ziad Sobih [α] & Prof. Martin [σ]

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In this paper we will automatically adjust the equalizer coefficient to adapt for channel changes. We also analyze the performance characteristics including convergence rate and computational complexity.

I. Adaptive Linear Equalizer

In the case of linear equalizer we will consider two methods to adjust the coefficient values ck. One method is to minimize the peak distortion at the output. The second method is to minimize the mean square error at the output. Now we will talk about each method.

II. The Zero-Forcing Algorithm

The peak distortion D(**c**) is minimized by selecting the appropriate **c**k. In general it is not easy computation. Except for the case D0 < 1. In this case D(**c**) is minimized by forcing qn = 0 and q0 = 1. We will use the zero forcing algorithm to achieve this condition.

The zero forcing algorithm is achieved by equating the cross correlation between the error and the desired sequence to zero. We have

$$\begin{aligned} E(\varepsilon_k I^*_{k-j}) &= E\left[(I_k - \hat{I}_k)I^*_{k-j}\right] \\ &= E(I_k I^*_{k-j}) - E(\hat{I}_k I^*_{k-j}), \qquad j=-K,\dots,K \end{aligned} \tag{1}$$

We assume that information symbols are uncorrelated. And that it is uncorrelated with the estimate

$$E(\varepsilon_k I^*_{k-j}) = \delta_{j0} - q_j, \qquad j=-K,\dots,K \tag{2}$$

$$E(\varepsilon_k I^*_{k-j}) = 0, \qquad j=-K,\dots,K \tag{3}$$

This mean that q0=1 and qn=0 for n not equal to zero.

When the channel response is not known the cross correlation in equation 1 can not be found. To circumvent this problem we send a known training sequence Ik to the receiver. This way we can estimate the cross correlation by using time averages. After we send this training sequence for samples length equal or more than equalizer length we can find the equalizer coefficient that satisfy equation 3.

A simple recursive algorithm

$$c_j^{(k+1)} = c_j^{(k)} + \Delta\varepsilon_k I^*_{k-j}, \qquad j=-K,\dots,-1,0,1,\dots,K \tag{4}$$

Were c j k is the j th coefficient at time k T, e k is the error at time k T, and delta is a scaling factor for rate adjustment. This is the zero forcing algorithm. The term e(k)I(k-j) is the cross correlation estimate of E (e(k) I(j-k)). This is accomplished by recursive first order difference equation which is a simple discrete time integrator. This is due to second fundamental theory of calculus.

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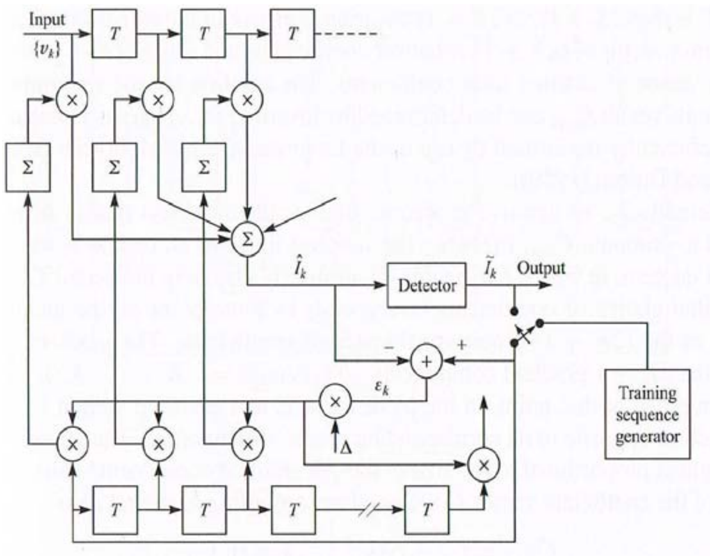

Figure 1

When we use a training sequence we are in the training mode. We do this until the coefficient of the equalizer converge to the optimal. At this point the decision of the output is sufficiently reliable. Now we go to the adaptive mode were we use the estimated output to continue adjusting the coefficients. In this case the cross correlation equation to update c is

$$c_i^{(k+1)} = c_i^{(k)} + \Delta \tilde{\varepsilon}_k \tilde{I}_{k-i}^* \tag{5}$$

This is similar to least mean square LMS algorithm. We will talk about MSE in detail next.

III. THE LMS ALGORITHM

First we calculate the error. We find that to minimize the error C has to satisfy the set of linear equations.

$$\boldsymbol{\Gamma C} = \boldsymbol{\xi} \tag{6}$$

Were T is the covariance metric of the input v k. C is the quantizer coefficients and E is the input times d the desired response.

An iterative algorithm can be used that avoid metric inversion to calculate C opt. the simplest is the method of steepest decent. In which we choose any C to start and it will converge by time to C opt. our start C will correspond to some point on the MSE surface curve. The gradient G is computed at this point. Using this gradient we move to the next estimate closer to the minimum.

$$\boldsymbol{C}_{k+1} = \boldsymbol{C}_k - \Delta \boldsymbol{G}_k, \qquad k = 0, 1, 2, \dots \tag{7}$$

The gradient is

$$\boldsymbol{G}_k = \frac{1}{2}\frac{dJ}{d\boldsymbol{C}_k} = \boldsymbol{\Gamma C}_k - \boldsymbol{\xi} = -E\left(\varepsilon_k \boldsymbol{V}_k^*\right) \tag{8}$$

Were Ck is the coefficients at the k iteration. E k is the error at k iteration. V is the vector of the input. Delta is a small positive number that will ensure convergence of the iterative process. If the minimum MSE is reached at some k then Gk=0 so that Ck stay constant. This method is slow but it is good to explain things.

The basic difficulty of this method is the lack of knowledge of the gradient vector G. G depend on the covariance metric T and the vector E of cross correlation. These depend on the coefficient of the equivalent discrete channel model in which the receiver do not know. To overcome this difficulty an estimate of G is used. The coefficient can be found using this estimate as

$$\hat{\boldsymbol{C}}_{k+1} = \hat{\boldsymbol{C}}_k - \Delta \hat{\boldsymbol{G}}_k \tag{9}$$

Were we have an estimate of the gradient and an estimate of the coefficients

We find that

$$\hat{\boldsymbol{G}}_k = -\varepsilon_k \boldsymbol{V}_k^* \tag{10}$$

The equation is

$$\hat{\boldsymbol{C}}_{k+1} = \hat{\boldsymbol{C}}_k + \Delta \varepsilon_k \boldsymbol{V}_k^* \tag{11}$$

This is the basic LMS algorithm for recursively adjusting the weight coefficients described by Widrow (1966). It is figure 2

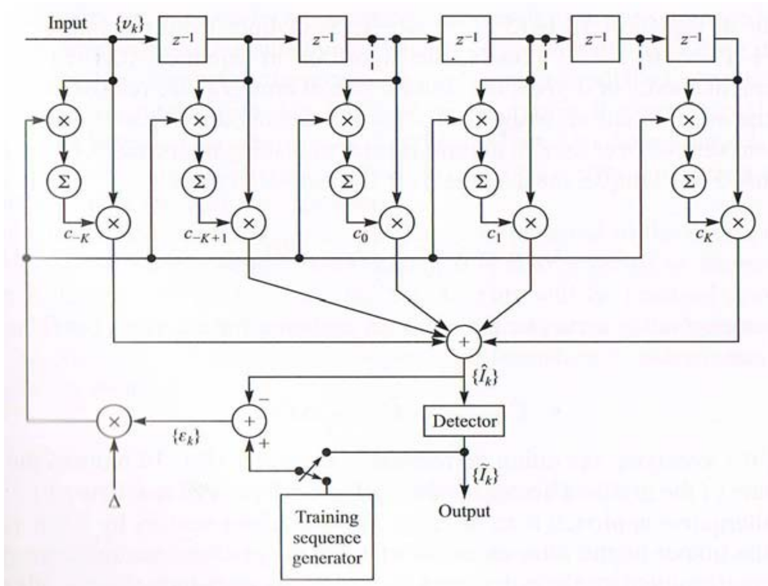

Figure 2

Equation 11 has been used in commercial adaptive equalizers that are used in high speed modems. Three versions are used using only the sign information.

$$c_{(k+1)j} = c_{kj} + \Delta \operatorname{csgn}(\varepsilon_k) v^*_{k-j}, \qquad j = -K, \ldots, -1, 0, 1, \ldots, K$$

$$c_{(k+1)j} = c_{kj} + \Delta \varepsilon_k \operatorname{csgn}(v^*_{k-j}), \qquad j = -K, \ldots, -1, 0, 1, \ldots, K$$

$$c_{(k+1)j} = c_{kj} + \Delta \operatorname{csgn}(\varepsilon_k) \operatorname{csgn}(v^*_{k-j}), \qquad j = -K, \ldots, -1, 0, 1, \ldots, K$$

where $\operatorname{csgn}(x)$ is defined as (12-13-14-15)

$$\operatorname{csgn}(x) = \begin{cases} 1 + j & [\operatorname{Re}(x) > 0, \operatorname{Im}(x) > 0] \\ 1 - j & [\operatorname{Re}(x) > 0, \operatorname{Im}(x) < 0] \\ -1 + j & [\operatorname{Re}(x) < 0, \operatorname{Im}(x) > 0] \\ -1 - j & [\operatorname{Re}(x) < 0, \operatorname{Im}(x) < 0] \end{cases}$$

Equation 14 is the most easy to implement. It has the slowest convergence relative to the others.

Several other LMS algorithms are obtained by averaging the gradient vector over several iteration points before we adjust c.

$$\bar{\hat{G}}_{mN} = -\frac{1}{N} \sum_{n=0}^{N-1} \varepsilon_{mN+n} V^*_{mN+n} \qquad (16)$$

now the equation is

$$\hat{C}_{(k+1)N} = \hat{C}_{kN} - \Delta \bar{\hat{G}}_{kN} \qquad (17)$$

this reduce the noise

A good approach is to low pass filter the noisy gradient vector to have a good estimate. A simple way to do that is

$$\bar{\hat{G}}_k = w\bar{\hat{G}}_{k-1} + (1 - w)\hat{G}_k, \qquad \bar{\hat{G}}(0) = \hat{G}(0) \qquad (18)$$

Where $0 < w < 1$ determine the band width of the low pass filter. If w is close to unity the filter bandwidth is small. On the other hand if w is small the filter has a large band width. With this filtered quantity the LMS equation is

$$\hat{C}_{k+1} = \hat{C}_k - \Delta \bar{\hat{G}}_k \qquad (19)$$

In the training mode we have the detected sequence and the transmitted sequence at the receiver to adjust the weight of the coefficients of the equalizer. After training we can start the adaptive mode. The length of the training sequence has to be equal or more to the number of coefficients.

The training sequence is usually used to be periodic. The period is N=2k+1. In this case the gradient is averaged over the period length as in equation 17. The weights adjustment can be by making a decision on the received data and use this decision to calculate the error. As long as the receiver operate at low error rate the convergence algorithm will be ok. The second algorithm is to compare the received data with the transmitted data assuming it is provided by a probe initially for training.

If the channel response changes, the error will change. This mean that the weights will change according to equation 11. We will also have a change if the information sequence or the noise statistics change. Thus, the equalizer is adaptive.

a) Convergence Properties of the LMS Algorithm

The convergence properties given in equation 11 is governed by the step size parameter. We will choice the step size parameter to ensure convergence of the steepest descent algorithm equation 7 using the exact value of the gradient.

We have

$$\begin{aligned} \boldsymbol{C}_{k+1} &= \boldsymbol{C}_k - \Delta \boldsymbol{G}_k \\ &= (\boldsymbol{I} - \Delta \boldsymbol{\Gamma})\boldsymbol{C}_k + \Delta \boldsymbol{\xi} \end{aligned} \quad (20)$$

This can be modeled by the closed loop control system in figure 3. The autocorrelation matrix in 20 is coupled. In order to solve the equations in 20 we have to decouple this matrix. This is also done to find the convergence property. The appropriate linear transformation to decouple this matrix is

$$\boldsymbol{\Gamma} = \boldsymbol{U}\boldsymbol{\Lambda}\boldsymbol{U}^H \quad (21)$$

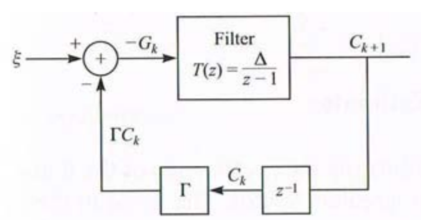

Figure 3

This form has a matrix with diagonal equal to the Eigen values of the system.

We put 21 into 20 and we have

$$\boldsymbol{C}^o_{k+1} = (\boldsymbol{I} - \Delta \boldsymbol{\Lambda})\boldsymbol{C}^o_k + \Delta \boldsymbol{\xi}^o \quad (22)$$

Now the system is decupled and the solution is

$$\boldsymbol{C}^o_{k+1} = (\boldsymbol{I} - \Delta \boldsymbol{\Lambda})\boldsymbol{C}^o_k \quad (23)$$

This mean that the system will converge if

$$|1 - \Delta\lambda_k| < 1, \qquad k = -K, \ldots, -1, 0, 1, \ldots, K \quad (24)$$

The inequality that insure convergence is

$$0 < \Delta < \frac{2}{\lambda_{\max}} \quad (25)$$

We have an upper bound on the max Eigen value

$$\begin{aligned} \lambda_{\max} &< \sum_{k=-K}^{K} \lambda_k = \operatorname{tr} \boldsymbol{\Gamma} = (2K+1)\Gamma_{kk} \\ &= (2K+1)(x_0 + N_0) \end{aligned} \quad (26)$$

The convergence is fast if (1-deltaΛ) is small. This mean that the pole is far from the unit circle. As we can see from the equations λ max/λ min determine the convergence rate.

IV. Excess MSE Due to Noisy Gradient Estimates

The receiver when adjusting the coefficients use a noisy estimate of the gradient vector. the noise result in random fluctuation from the optimal value. So we have j = j min +j delta were j delta is the variance of noise.

The total MSE at the output is

$$J = J_{\min} + (\boldsymbol{C} - \boldsymbol{C}_{\text{opt}})^H \boldsymbol{\Gamma} (\boldsymbol{C} - \boldsymbol{C}_{\text{opt}}) \quad (27)$$

Were C opt is the optimum value of C. simplifying we get

$$J = J_{\min} + \sum_{k=-K}^{K} \lambda_k E|c_k^o - c_{k\,\text{opt}}^o|^2 \quad (28)$$

We find j delta as

$$J_\Delta = \sum_{k=-K}^{K} \lambda_k E|c_k^o - c_{k\,\text{opt}}^o|^2 \quad (29)$$

It has been shown that

$$J_\Delta = \Delta^2 J_{\min} \sum_{k=-K}^{K} \frac{\lambda_k^2}{1 - (1 - \Delta\lambda_k)^2} \quad (30)$$

Simplifying

$$\begin{aligned} J_\Delta &\approx \tfrac{1}{2}\Delta J_{\min} \sum_{k=-K}^{K} \lambda_k \\ &\approx \tfrac{1}{2}\Delta J_{\min} \operatorname{tr} \boldsymbol{\Gamma} \\ &\approx \tfrac{1}{2}\Delta(2K+1) J_{\min}(x_0 + N_0) \end{aligned} \quad (31)$$

Were x0+N0 is the received signal plus noise

Delta should be

$$\Delta < \frac{2}{(2K+1)(x_0+N_0)} \tag{32}$$

For example

$$\Delta = \frac{0.2}{(2K+1)(x_0+N_0)} \tag{33}$$

The degradation in the output SNR of the equalizer due to excess MSE is less than 1 dB.

The analysis of the excess error is for assuming that C have converged to optimum.

The convergence has been studied by many researchers.

This is an example were we have 11 coefficients. We start with all of them are zero. We see that all of them will converge to the right value of the channel. We use MS algorithm. The Matlab code is given. As we can see the error converge to zero as the number of iteration increase. We also add noise to the input to the equalizer.

```
echo on
N=500;
K=5;
isi=[.05 -.063 .088 -.126 -.25 .9047 .25 0 .126 .038 .088];
sigma=.01;
delta=.09;
num_of_realizations=1000;
mse_av=zeros(1,N-2*K);
for j=1:num_of_realizations,
  for i=1:N,
    if (rand<.5),
      info(i)=-1;
    else
      info(i)=1;
    end;
    echo off;
  end;
  if (j==1);echo on ; end


end
noise =awgn(info,10);

  d_c=[ 0 0 0 0 0 0 0 0 0 0 0 ];

  for k=1:(N-10),
     y_kk=[noise(k:k+10)];
     out=y_kk*isi'
    z_k=d_c*y_kk.';
     e_k= out-z_k
     d_c = d_c + e_k * .115 *[ noise(k:k+10) ]
     mse(k) =e_k^2;
     echo off;
  end;
 if (j==1);echo on ;end
  mse_av=mse_av+mse;
  echo off
 echo on
mse_av=mse_av/num_of_realizations
```

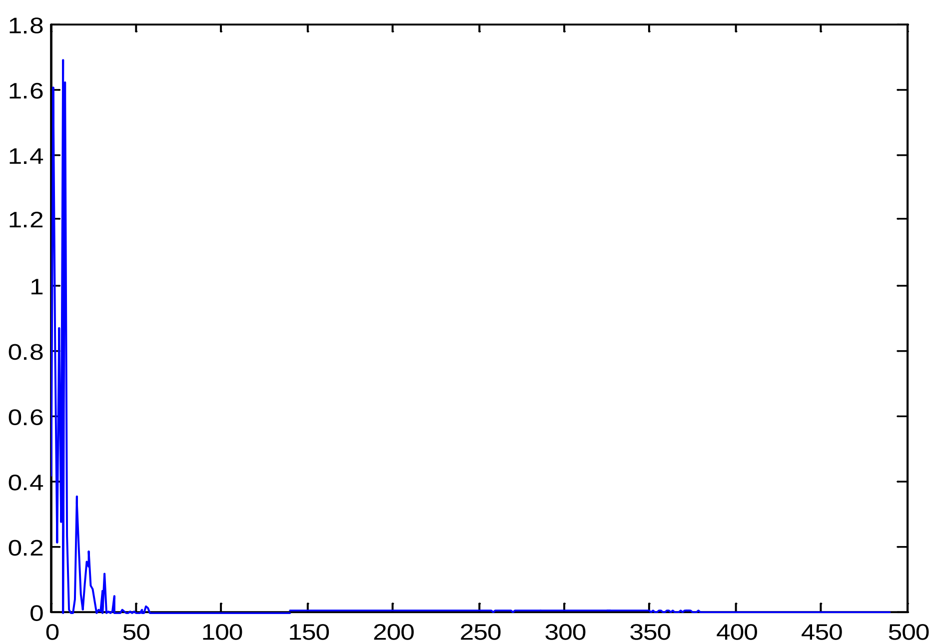

Figure 4

The choice of delta is very critical in the LMS algorithm. To be practical we design the most significant bits for an estimate of the coefficient and the least significant bits for delta so that the LMS algorithm find its way exactly to C opt.

It is important to mention that the LMS algorithm is able to track slowly time varying system. In other words j min is a function of time and the MSE surface is moving with time index n. The LMS method try to track j min but always behind it. This mean that we have another error which is the lag error. The total error is

$$J_{\text{total}} = J_{\min}(n) + J_\Delta + J_l \tag{34}$$

Where j l is the lag error.

Now we try to plot j delta and j lag as a function of delta. They will behave as in the figure below. J delta decrease and j lag increase as a function of delta. The total will have a minimum which is the optimum choice for delta.

If the time varying system is fast the j lag will dominate the error. In this case the LMS will not be appropriate and we must use recursive least squares algorithms.

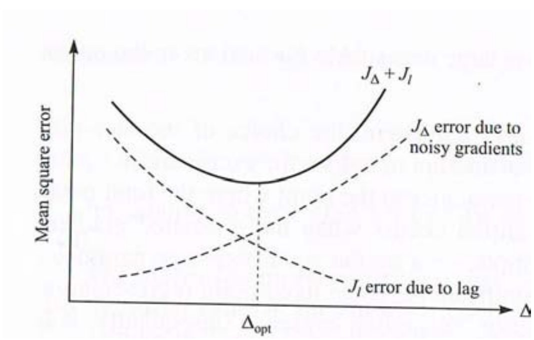

Figure 5

V. Accelerating the Initial Convergence rate in the LMS Algorithm

As we see the convergence rate is controlled by delta. It is also strongly related to the spectral characteristics of the channel. By that I mean the ratio of lambda max to lambda min. if this ratio is close to one the convergence will be fast. If not the convergence will be slow. In this case we say that the channel has poor spectral characteristics.

Researchers investigated this topic from all angels. One simple way is to start with large delta and reduce it to the optimum as time pass by.

To accelerate initial convergence methods have been studied in 1971 and 1977. One method is to replace delta by the weighting matrix W. the form is

$$\begin{aligned} \hat{C}_{k+1} &= \hat{C}_k - W\hat{G}_k \\ &= \hat{C}_k + W(\Gamma\hat{C} - \xi) \\ &= \hat{C}_k + We_kV_k^* \end{aligned} \tag{35}$$

Where W ideally is the inverse of the autocorrelation matrix of the input data. The autocorrelation can be estimated and the inverse can be found.

If the training sequence is periodic, W can be seen as a single row and the block diagram of the system will be as in figure 6.

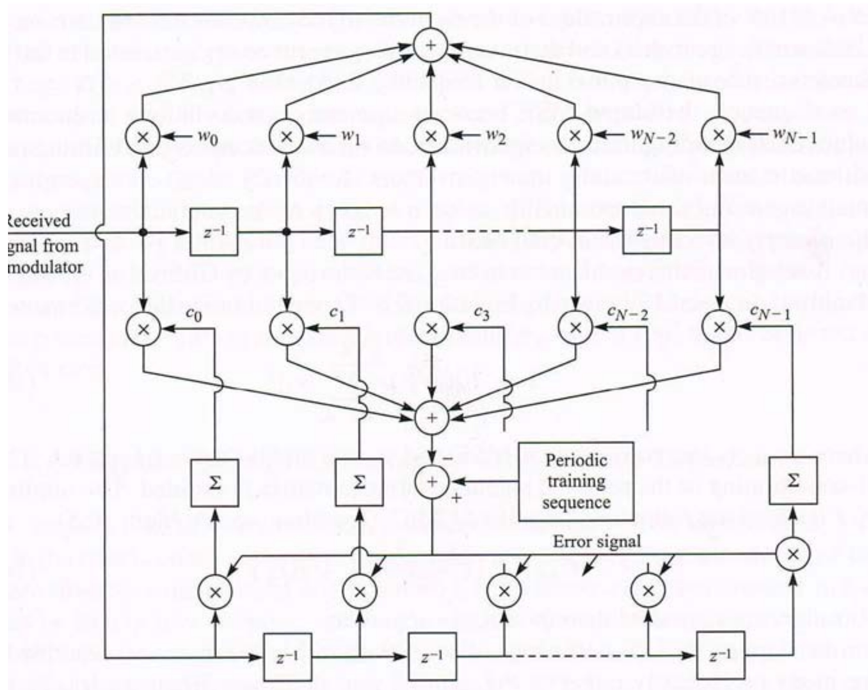

Figure 6

We can estimate the weights from the received signal. The basic steps are:

First we collect one period of N samples in the equalizer delay line. Then we compute N-point DFT (Rn). Then we compute the power spectrum (Rn^2) and we add to it N times the estimate of the noise variance. Then we compute the inverse DFT. This yields wn in figure 6. To adjust the taps we have

$$c_j^{(k+1)} = c_j^{(k)} - e_j \sum_{m=0}^{N-1} w_k v_{k-j-m}^*, \qquad j = 0, 1, \ldots, N-1 \tag{36}$$

VI. Conclusion

As in the case of linear adaptive equalizer the coefficient of decision feedback equalizer can be adjusted recursively. This is based on minimization of MSE.

(37)

We should note that this will converge and for the expected value we can use (epsilon V).

(38)

This is the LMS algorithm. First we use a training sequence then we switch to dissection mode.

References Références Referencias

1. A. Papoulis, Probability, Random Variables, and Stochastic Process, 2002.
2. J. G. Proakis, Digital Communications, 2001.
3. R. J. Schilling, Engineering Analysis, 1988.
4. H. L. Van Trees, Detection, Estimation, and Modulation Theory,1968.
5. J. G, Proakis, Inroduction to Digital Signal Processing, 1988.
6. C. Chen, Linear System Theory and Design, 1984
7. S. Haykin, Communication System, 1983.
8. T. H. Glisson, Introduction to System Analysis, 1985.
9. Martin Schetzen, Airborne Doppler Radar, 2006.
10. Martin Schetzen, The Volterra & Wiener Theories of Nonlinear Systems, 2006.
11. Martin Schetzen, Discrete System using Matlab, 2004.
12. Arvin Grabel, Microelectronics, 1987.

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Digital Frequency Synthesis using Multi-Phase NCO for Dielectric Characterization of Materials on Xilinx Zynq FPGA

By M. Sandhya Rani, Dr. K. Soundararajan & Dr. K. Nagabushan Raju
Intellectual Engineering College, India

Abstract- Precise measurement of dielectric characteristics of materials is becoming necessity in several engineering applications. The dielectric constant measurement over wide frequency range for emerging applications such as PCB manufacturing, agriculture, environmental and food processing industries has several challenges. With the advancement in digital VLSI and Field Programmable Gate Array (FPGA) based processing the digital techniques for estimating the dielectric constant are feasible. In this context the digital based frequency generation techniques over wide frequency are discussed in this paper. The multi phase Numerically Controlled Oscillator (NCO) based technique for generating high frequency signals are experimented in this paper. The efficient implementation of NCO for Xilinx Zynq family FPGA, XC7Z020 device is simulated here. The realized multi phase NCO is observed to be occupying only 15% of resources and operating at 250MHz to result efficient synthesis of sine wave with sampling frequency of 1GHz. The design issues related to digital carrier generation on FPGAs, while driving high frequency Digital to Analog Converters (DACs) are discussed and simulation results are presented here.

Keywords: *dielectric measurement, digital phase, FPGA, multi phase NCO, Zynq SOC FPGA.*

GJRE-F Classification : *FOR Code: 290901p, 090609*

DIGITALFREQUENCYSYNTHESISUSINGMULTIPHASENCOFORDIELECTRICCHARACTERIZATIONOFMATERIALSONXILINXZYNQFPGA

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M. Sandhya Rani [α], Dr. K. Soundararajan [σ] & Dr. K. Nagabushan Raju [ρ]

Abstract- Precise measurement of dielectric characteristics of materials is becoming necessity in several engineering applications. The dielectric constant measurement over wide frequency range for emerging applications such as PCB manufacturing, agriculture, environmental and food processing industries has several challenges. With the advancement in digital VLSI and Field Programmable Gate Array (FPGA) based processing the digital techniques for estimating the dielectric constant are feasible. In this context the digital based frequency generation techniques over wide frequency are discussed in this paper. The multi phase Numerically Controlled Oscillator (NCO) based technique for generating high frequency signals are experimented in this paper. The efficient implementation of NCO for Xilinx Zynq family FPGA, XC7Z020 device is simulated here. The realized multi phase NCO is observed to be occupying only 15% of resources and operating at 250MHz to result efficient synthesis of sine wave with sampling frequency of 1GHz. The design issues related to digital carrier generation on FPGAs, while driving high frequency Digital to Analog Converters (DACs) are discussed and simulation results are presented here.

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I. Introduction

The dielectric properties measurement is necessary because it can provide the electrical or magnetic characteristics of the materials, which proved useful in many research and development fields [1][10]. The present work is aimed to evolve digital multi phase technique for generating high frequency sinusoid signal using FPGAs, which becomes useful in precise dielectric characterization of materials.

The work presented in this paper is part of ongoing research [1] [9] aimed for precise characterization of printed circuit board (PCB) at high frequencies (order of Hundreds of MHz). This paper discusses the multi phase NCO based technique for generating high frequency sine wave, which is required in this context.

Measurement of dielectric properties requires measurements of the complex relative permittivity (ε_r) and complex relative permeability (μ_r) of the materials [1]. The complex dielectric permittivity consists of real and imaginary parts. The real part of the complex permittivity is referred as dielectric constant and it is a measure of the amount of energy from an external electrical field stored in the material. The imaginary part is indicative of the amount of energy that gets dissipated in material when it is subjected to electric field [1]. The imaginary part is zero for lossless materials. The term loss tangent is defined as given in (1) which indicates the dissipative nature of material with respect to the energy storage nature [11].

$$\tan\alpha = \frac{\varepsilon_r''}{\varepsilon_r'} = \frac{1}{Q} \tag{1}$$

The vector diagram for loss tangent is shown in Fig.1. Loss tangent is also referred as quality factor (Q). The circuit equivalent of real and imaginary parts of permittivity can be well derived from capacitor action [1].

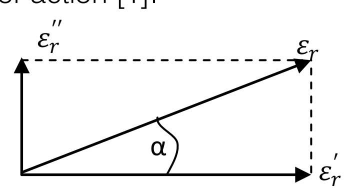

Fig 1 : Capacitor action with dielectric

The equation (2) gives capacitance value of parallel plate capacitor as function of area of the plate, distance between plates and permittivity of the medium.

$$C = \frac{\varepsilon A}{d} \tag{2}$$

Where $\boldsymbol{\varepsilon}$ is the total permittivity, which can be represented as $\boldsymbol{\varepsilon} = \boldsymbol{\varepsilon}_o \boldsymbol{\varepsilon}_r$

The C_O can be used to represent the capacitance when only vacuum is present between the capacitor parallel plates. The equation (2) can be rewritten as given in equation (3) in terms of C_O.

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$$C = \varepsilon_r C_0 \quad (3)$$

The Fig. 2. shows simple RC circuit for measuring the dielectric constant.

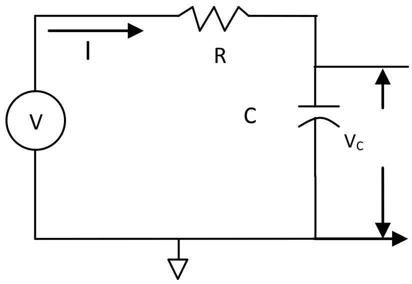

Fig. 2 : Schematic of RC circuit

The voltage across capacitor can be given as equation (4) whose phase term can be computed as in equation (5).

$$V_C = \frac{V}{1 + j\omega\, C_0\, \varepsilon_r' R} \quad (4)$$

$$\theta = -\tan^{-1}\left(\frac{1}{\omega C_0\, \varepsilon_r' R}\right) \quad (5)$$

The phase shift between V and V_C is a function of dielectric constant for all remaining being constant values. The dielectric constant measurement through digital techniques is possible, if the signal with angular frequency ω can be generated digitally and the phase shift between and V and V_C is measured accurately [2]. The FPGA based techniques for sinusoid generation using NCO is an established area and being widely used in communication applications. However the maximum synthesizable signal with NCO is limited to $F_{clk}/2$, where F_{clk} is the clock at which the NCO runs.

To enable dielectric Constant measurement up to high frequencies it is required that the FPGA based circuit should be able to generate the signal up to the desired frequency. Above in equation (4) $\omega = 2\pi f$ and f=frequency at which dielectric constants are measured. In conventional implementation of NCO the realizable frequency by NCO is given in equation (6). Fig.3. describes the basic NCO architecture.

$$\text{Output sine wave frequency} = \frac{\Delta p\, .F_{clk}}{2^N} \quad (6)$$

Where F_{clk} = clock frequency at which NCO is running

N= size of bit width phase registered

Δp = input phase increment word

Since F_{clk} and N are fixed for a particular implementation, the input phase increment word (Δp) describes the frequency of the output sine wave. The first register in the Fig.3. latches the frequency controlled word on the clock edge and the accumulator realized by added and register continuously accumulates input frequency word and generates the phase. This phase accumulator generates the digital phase, which is input to sine lookup table. The sine lookup table generates the digital amplitude samples of sine waves [3]. The digital samples of sine wave need to be supplied to DAC chip which generates corresponding analog sine wave. The analog sine wave after passing through low pass filter will be suitable for dielectric constant measurement. The low pass filter removes the spurious harmonic signals which are present in DAC output.

The present day available RF DAC [6][13] enables high frequency sine wave up to 1 GHz provided the digital part is capable of generating suitable samples. With the present day available FPGA technology the max achievable frequency F_{clock} is up to 300 MHz only which means the maximum F_o that can be generated is 150MHz only, Where as the necessity of dielectric constant measurement of PCB materials is up to few Mega Hertz to Giga Hertz frequencies.

This becomes limitation of digital based carrier generation for high frequency dielectric constant characterization of materials. The present paper implementation of multi phase NCO based architecture enables digital generation of sine wave samples [3], which can be used while interfacing with RF DACs[6][13] by which the concept of digital dielectric constant can be extended up to Hundreds of Mega Hertz to Giga Hertz frequency level.

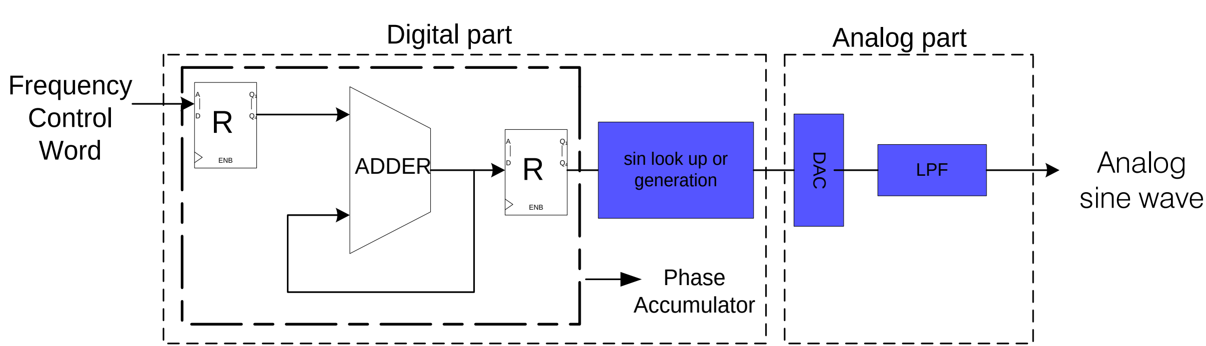

Fig. 3 : High level block diagram of NCO based SIN wave generation

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The remaining part of the paper is organized into three sections. Section 2 explains the high level architecture of multiphase digital NCO. Section 3 explains the simulation and synthesis results including the resource utilization summary for ZED board. The last section provides conclusion and future scope of the work.

II. High Level Architecture

This section presents high level architecture of proposed multiphase NCO based sine wave generation [4]. Multiphase NCO technique in principal uses the inverse concept of distributed arithmetic. The distributed arithmetic (DA) principle is an area optimization technique usually implemented in FPGAs and Application Specific Integrated Circuits (ASICs), where certain hardware is made to run at high frequency than the actual throughput required. Utilizing same resource for multiple operations in different clock cycles allows achieving area optimization. For e.g. in a digital logic the requirement is to multiply numbers at 10MHz rate. The FPGA logic employing DA technique runs at 100MHz. The multiplier input is multiplexed and output is de-multiplexed to perform 10 multiplications by using single unit.

In multiphase NCO the concept is reverse implementation of resource sharing. In the present Implementation on the ZED board [12] it is aimed to generate sine wave 400 MHz by achieving sampling frequency of 1GHz.

In this implementation 4 NCO modules are made to run as parallel blocks which shall maintain phase offsets corresponding to their sample position. The sine wave generation [4] is illustrated in fig. 4. Scheme of multiphase NCO for high frequency digital The effective sampling rate achieved is denoted as F_s and is given at (7).

$$F_s = 4 \text{ X } F_{clk} \tag{7}$$

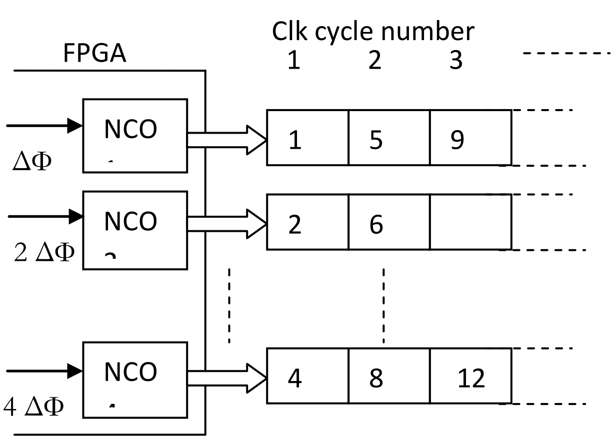

Fig. 5 : Set of 4 NCOs generating samples at F_s

The effective sampling rate achieved is denoted as F_s and is given at (7). The NCOs are fed with phase shifts such that the samples generated by all NCOs form successive samples in sine wave at higher sampling rate F_s. The figure 5 has the illustration of the same.

The initial phase shifts can be computed by a series of adders, where at each stage $\Delta\Phi$ is added [6].

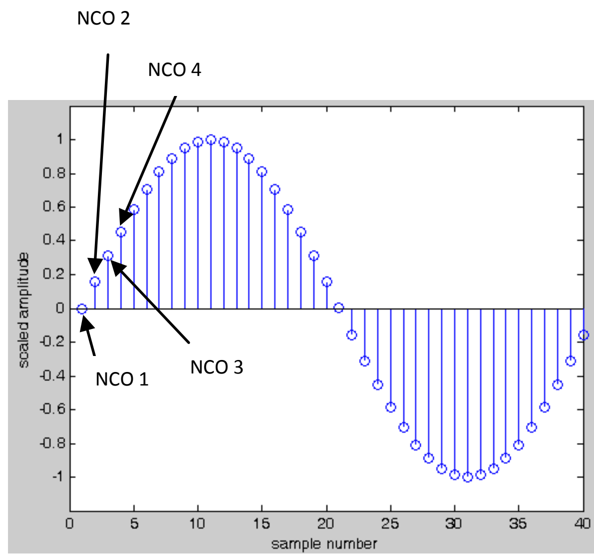

Fig. 5 : Samples generated by each NCO in the sin wave at F_s

As the uniformly sampled phase results in spurious values at the multiples of sampling frequency, the phase dithering is implemented. In the phase dithering a pseudo noise binary signal (PN) is used to produce a random number. This random numbers are added to phase accumulator output, before applying to the address inputs of SIN and COS look up tables.

III. Simulation and Synthesis Results

The simulation results for the implemented logic are given in this section. The figure (6), shows the phase outputs of each NCO. The phase shifts in each channel can be observed due to the different initial values assignment [3].

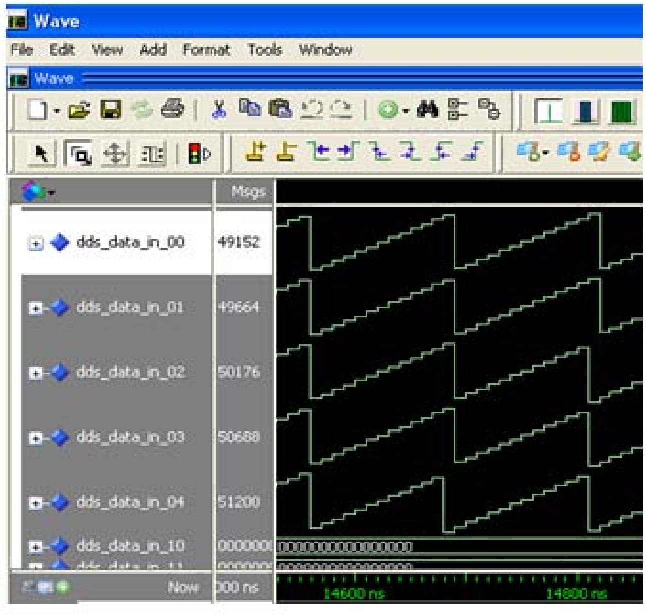

Fig. 6 : Simulation results showing phases of 4 NCOs

The simulation results showing the generated sine waves on all four channels are shown in figure 7. The resultant signal when applied to multi channel DAC is simulated by a mod 4 counter based interleaving logic, placing samples from each channel as illustrated in fig. 5. The last waveform in Fig. 7, RF_DAC_SIG shows the generated sine wave with F_s sampling rate.

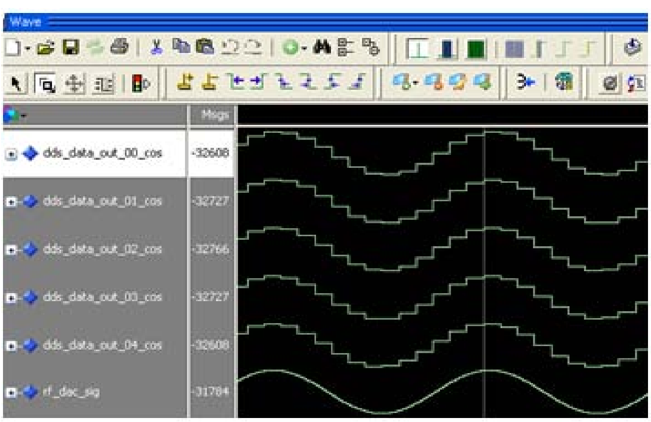

Fig. 7 : Simulation results showing sin wave samples of 4 NCOs and muxed resuling sin wave

The logic is synthesized using Xilinx's ISE 14.6 tool and the area and speed analysis are carried out. The area utilization summary and maximum clock estimate of the implemented digital logic [7] For ZED board (XC7Z020) FPGA [5], are given at fig. 8.

Device Utilization Summary (estimated values)			[-]
Logic Utilization	**Used**	**Available**	**Utilization**
Number of Slice Registers	333	18224	1%
Number of Slice LUTs	459	9112	5%
Number of fully used LUT-FF pairs	270	522	51%
Number of bonded IOBs	35	186	18%
Number of BUFG/BUFGCTRLs	2	16	12%

Fig. 8 : Area utilization summary

```
Timing Summary:
---------------
Speed Grade: -3

   Minimum period: 2.945ns (Maximum Frequency: 339.587MHz)
   Minimum input arrival time before clock: 3.021ns
   Maximum output required time after clock: 3.819ns
   Maximum combinational path delay: No path found
```

Fig. 9 : Maximum clock utilization summary

The maximum speed reports 333 MHz, which is higher than the considered 250 MHz operation for the aimed specifications.

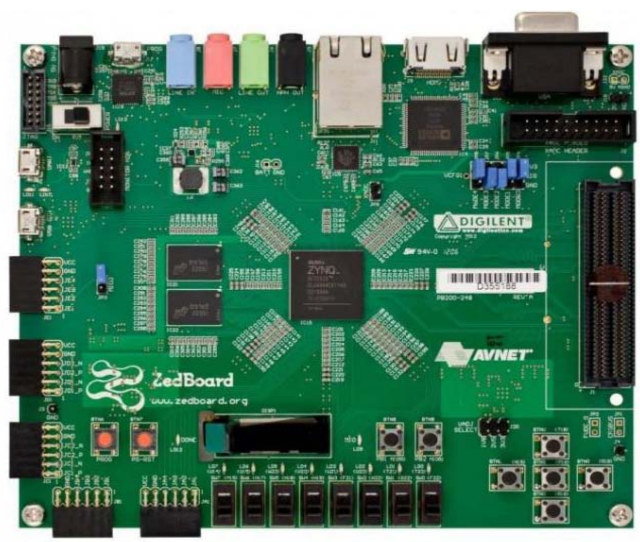

Fig.10 : Zynq Evaluation and development board

It is aimed to continue this work with hard ware integration of Digital to analog converter from Analog devices AD9122 Tx-DAC IC [13]. Hence the data and control signal generation are ensured to meet the specification of this IC and the same are verified with Xilinx Chipscope Integrated Logic Analyzer (ILA) tool.

The figure 11, has chipscope ILA obtained results for 4 channel with the multiphase technique. Since the the AD9122 is complex DAC, similar logic is implemented for generating the quadrature tones with 90 degree phase shifts.

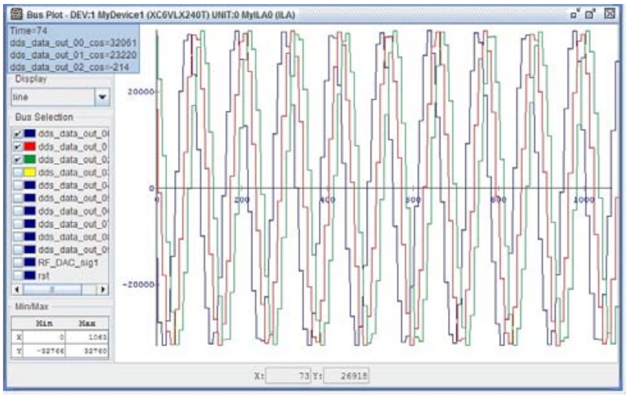

Fig. 11 : On-chip verification results with Chipscope

IV. Conclusion

The dielectric constant measurement technique with capacitance based measurement is discussed. The basic circuit and dielectric constant measurement using RC circuit principle is discussed. The need of high frequency digital signals synthesis for high frequency sin wave generation is elaborated. FPGA based techniques with multi DDS for driving RF DACs presented considering clock frequency of 250 MHz on FPGA. By employing 4 NCOs, sine wave with 1 Giga samples per second is simulated. Using Xilinx ISE tools synthesis is carried out and area utilization summary is observed. The work is aimed to continue in establishing this technique on With Xilinx Zynq FPGA and RF DAC cards for dielectric constant measurement applications.

References Références Referencias

1. M. Sandhya Rani, K.Soundararajan and K. Nagabushan Raju, "Multi-phase clocking based high precision Dielectric constant measurement for embedded applications," 2013 Nirma University International Conference On Engineering, NUICONE-2013, 28-30 November, 2013, IEEE DOI : 10.1109/NUICONE.2013.6780172
2. Dennis Trebbels, Daniel Woelki, Roland Zengerle, "High Precision Phase Measurement Technique for Cell Impedance Spectroscopy", et al 2010 J. Phys.: Conf. Ser. 224 012159 doi:10.1088/1742-6596/224/1/012159.
3. Xutian Liu Design of Digital Up-converter Based on FPGA Shenyang: Northeastern University, 2009.
4. LogiCORE IP DDS Compiler v4.0, DS558 March 1, 2011, Xilinx corporation.
5. Xilinx Spartan-6 SP-601 FPGA development board, Xilinx corporation, 2012.
6. RF-DAC AD9739A sheet, Analog devices, 2013.
7. HDL libraries guide and Simulation and Synthesis guide, Xilinx Corporation 2012.
8. Application note, "Agilent Basics of Measuring the Dielectric Properties of Materials", Agilent technologies.
9. M.SandhyaRani, K.Soundararajan and K.NagabushanRaju, "High Speed Multi-phase Clocking based Digital Method for Dielectric Constant Measurement using Xilinx FPGAs", International Journal of Scientific Engineering and Technology Research (IJSETR), ISSN : 2319-8885.
10. Umenyiora and Chidubem Andrew "Dielectric Constant of Sand Using TDR and FDR Measurements and Prediction Models" , IEEE Transactions on Plasma Science 2012, P 2408- 2415.
11. R. Weerasundam, G.G. Raju, "An Efficient Algorithm for Numerical Computation of the Complex Dielectric Permittivity using Hilbert Transform and FFT Techniques through Kramers Kroniug relation", 2004 International Conkrence on Solid Dielectrics, Toulowe. France, July 5-9, IEEE 2004.
12. Xilinx Zynq FPGA with Zedboard available at www.zedboard.org/products/zedboard
13. Dual 16 bit, 1230 Msps, Tx DAC+ Digital to Analog Converter, available at http://www.analog.com/static/imported-files/data_sheets/AD9122.pdf

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Reducing the Vulnerability of Digital Protective Relays to Intentional Remote Destructive Impacts: Continuation of the Theme

By Vladimir Gurevich

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Keywords: digital protective relays, intentional destructive electromagnetic impacts, high power electromagnetic threats, high-altitude electromagnetic pulse, intentional electromagnetic interference.

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I. Introduction

As mentioned in [1], due to the way in which digital protection relays (DPR) of electric power system facilities perform their functions they constitute dangerous entry channels for intentional remote destructive impact (IRDI) into the power systems. IRDI can be qualified as:

a) Cyber attacks;

b) High Power Electromagnetic (HPEM) Threats, including High-Altitude Electromagnetic Pulse (HEMP) and Intentional Electromagnetic Interference (IEMI);

c) Function-technological (use of normal technological functions of protection relays, which were pre-set in such a way that in case of actuation without a cyber attack, for example, by activate the discrete input, the DPR will send corresponding commands to high-voltage circuit breakers, which will interfere with the normal functioning of the electric network or even the whole power system).

The IRDI can affect the DPR in the following ways:

- Create internal damage of microelectronic components accompanied by simultaneous malfunctioning of relay protection;
- Result in latent destruction of microelectronic components, which cannot be diagnosed under standard workability checks of a DPR, but which can emerge in the course of a DPR's operation as faulty performance of a specific aggregate of logical and computation operations;
- Result in the malfunctioning of DPR by interfering with its algorithm of operation (cyber attacks);
- Result in the malfunctioning of relay protection under full physical and software-based functionality of DPR (function-technological IRDI).

According to [1] there are passive and active methods of protection of DPRs from IRDI. The passive methods of protection include special broadband filters; special metal control cabinets; double and triple shielded and twisted cables; special protective paints, lacquers, films that reflect electromagnetic waves; curtains, carpets and hangings made of metallic fiber, special construction materials, which weaken electromagnetic radiation. The active methods of protection are based on a joint use of DPR and electro-mechanic protection relays (EMPR), which are more resistant to IRDI. At the same time there are two options of connecting DPR and EMPR: parallel connection and series connection [2]. The parallel connection of DPR and EMPR requires a full set of electro-mechanical protection relays designed to perform a total complex of protective functions. Moreover, this connection does not guarantee the absence of faulty and unnecessary actuations of DPR affected by IRDI. As mentioned in [1], faulty, unnecessary and abnormal actuations of DPR (the concepts offered in [3]) can result in larger damage than failures. The series connection of DPR and EMPR does not require using a full set of EMPR; however, a simple starting unit (SU) should be available. Besides, this type of connection prevents faulty and abnormal actuations of DPR affected by IRDI. This is why this type of connection is preferable. The specific example of this type of protection based on a specially designed unit with responsive electro-mechanic elements (reed switches) is described in [4, 5], Fig. 1.

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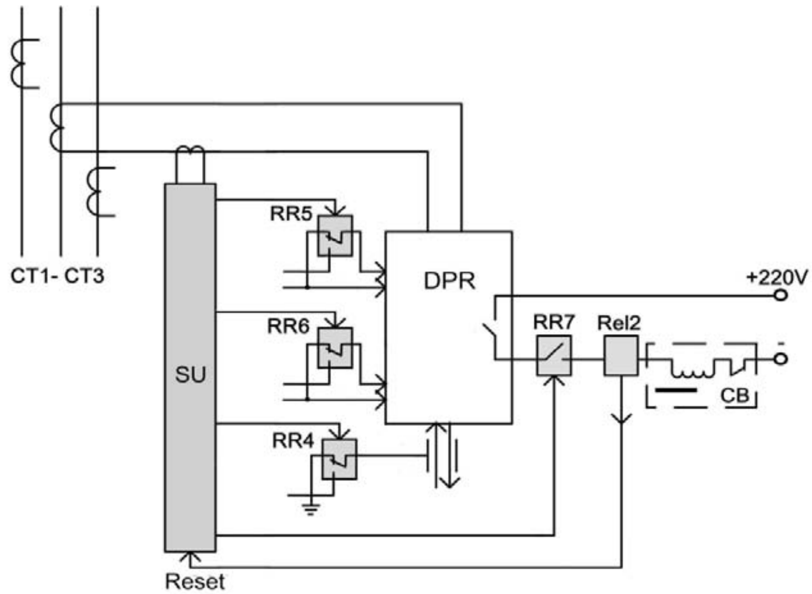

Fig. 1 : Electrical diagram of the active type unit presented in [4, 5] to protect the DPR from IRDI (SU - starting unit on the basis of a reed switch)

This device is designed to protect the DPR from function-technological IRDI – the most complicated IRDI, which cannot be controlled by any other means of protection. Obviously, the device described in [4, 5] is just an example of the concept, the purpose of which is to confirm the possibility of implementing the idea in practice, though it still needs further development, and improvement. Nevertheless, the example substantiates that the problem of DPR protection from function-technological IRDI can be successfully solved. It should be noted that the described device blocks the discrete inputs, communication and outputs of DPR in between the emergency modes, to which DPR should respond; efficiently protects it not only from function-technological IRDI, but also from internal damages, induced by powerful electro-magnetic impacts and cyber attacks affecting its sensitive inputs.

II. Protection Current and Voltage Circuits

In order to protect the DPR from internal damage related to effects of high-voltage impulses, which can get into its analogue inputs from current and voltage circuits and in order to protect the supply circuits the well known methods of improving the stability of electronic equipment to electro-magnetic impacts can be used. It should be noted that modern DPRs are already equipped with a built-in protection from these impacts, which corresponds to the requirements of the standards of electro-magnetic compatibility (EMC). However, IRDI are significantly different from electro-magnetic noises in terms of intensity and frequency range, stipulated by these standards. This is why the protection built into DPR should be significantly strengthened. This is one of the ways to improve DPR's resistance to IRDI. The other way is the use of additional external means of protection, such as passive means of protection (see above).

The elements that connect the analogue inputs of DPR with the external current and voltage circuits are the input current transformer (CT) and the voltage transformer (VT). And for this reason these elements will be affected by the powerful overloads of IRDI in the first turn. The input CT in DPR is simpler in terms of design. As a rule, this is a multi-loop secondary winding, wound on a ferromagnetic core and a primary winding, which consists of several coils of thick insulated wire, wound above insulated secondary winding, see Fig. 2.

Fig. 2 : Example of a module of analogue inputs of DPR with installed CT. You can clearly see the primary winding, which consists of 4 coils of flexible insulated black wire

The methods of improvement of the structure's resistance to impacts of powerful impulse voltage are rather simple and include the following:

- Use of grounded shield (either foil or additional single-layer winding) located between the primary and the secondary windings;
- Encapsulation of the secondary winding by pouring it with epoxy resin, which will hardened in vacuum, see Fig. 3;
- Increasing insulation level between primary and secondary windings by use a wire with high-voltage insulation as the primary winding;
- Use of additional screens and semi-conducting covers, which equalize the electric field in the CT's design;
- Use of the insulated coating of CT magnetic core

There are many types of flexible wires in high-voltage insulation made of silicone, polyethylene, PTFE and rated for 10-25 kV voltage that are produced by several companies, such as: Teledyne Reynolds, Multi-contact; Allied Wire & Cable; Wiremax; Dielectric Sciences Inc., Axon' Cable, Daburn Electronics & Cable, Sumitomo Electric, Belden, Experimental design bureau of Cabel Industry, "Redkiy Cabel" LLC amongst others.

The recommendations for the improvement of resistance of VT are similar except for the fact that instead of a flexible wire with a high-voltage insulation as the primary winding, they use a winding wire with improved insulation of Class III according to IEC 60317-0-1 "Specification for particular types of winding wires – Part 0-1: General requirements – Enamelled round copper wire made of polyimide", where both coils are capsulated in vacuum.

Fig. 3 : Encapsulated current transformers with epoxy capsulated secondary winding hardened in vacuum. You can clearly see the primary winding, which consists of a single coil of flexible insulated wire

Since the increase of the cross section of the winding wire automatically results in an increase of insulation thickness and its electric strength, it is recommended to use a larger cross section wire regardless of natural increase of VT's size. Some manufacturers are producing winding wires with insulation made of polyamide, which withstands voltage 1.5 or even double voltage compared with that rated under IEC 60317-0-1. These manufacturers are, for example, P.A.R. Insulations & Wires Ltd of England, Bemka A. S. of Turkey amongst others. In order to ensure additional protection of VT, a special protective chain can be installed inside DPR on its primary winding, see Fig. 4.

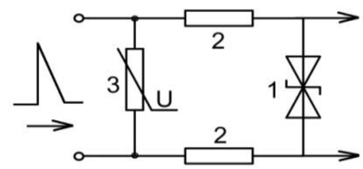

Fig. 4 : A diagram of efficient protective chain: 1 – semiconducting suppressor; 2 – current-limiting resistor; 3 – voltage depending resistor (VDR)

This chain, which contains a combination of elements with different specifications, ensures the most efficient protection from electromagnetic IRDI. In addition two low-voltage, opposite connected Zener diodes should be installed on the opposite sides of both internal VT and CT. They will restrict the voltage level of electromagnetic interference, which enters the input of an electronic circuit, if it manages to get to the secondary winding though all layers of insulation and the shield.

Usually, internal impulse power supplies of DPRs have built-in filters at the input, which include VDR, chocks and capacitors and are efficient in suppression of electromagnetic interferences, including IRDI. It is very important to equip all power supplies of DPR with these high quality filters.

III. Protection of Auxiliaru Power Supply

The measures mentioned above are related to the design of DPR and this is the responsibility of manufacturers. Besides these measures it is necessary to consider the measures of group protection of DPR, which include special relay cabinets [2] and other known measures of passive protection. Among these measures special filters need to be highlighted. They are connected at the entry ports of the voltage and current circuits into the relay room running from the external CT and VT located outside and into the AC supply circuits of the battery chargers. It should be taken into consideration that these are not just simple ordinary filters, which weaken natural electromagnetic interference, but filters that are specially designed to suppress electromagnetic impulse of a HEMP and powerful electromagnetic radiation of IRDI. Technical requirements to these filters are stipulated by military standards and reference books, such as MIL-STD-188-125 and MIL-HDBK-423.

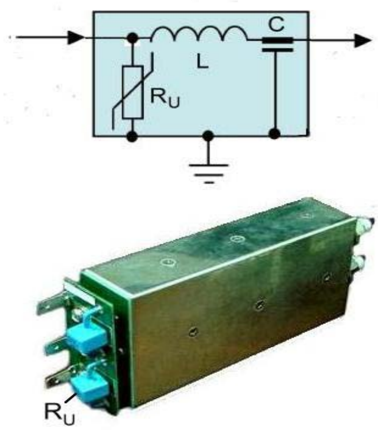

Fig. 5 : Layout of the filter and simplified circuit of one section of the filter designed to protect from IRDI. In practice the circuit contains several sections connected in series per each line. There is also a powerful varistor, $R_{U,}$ at the input of the device

These filters include kits of elements designed to suppress impulse overloads (as a rule, these are powerful VDR - varistors) and weaken high frequency signals (induced chocks connected in series and capacitors connected parallel), see Fig. 5.

The best respresentatives of such filters ensure damping of 80-100 dB of interference in a broad spectrum of frequencies: from tens of kilohertz to tens of gigahertz at full load with current ratings from tens to hundreds of Amps, see Fig. 6

Such filters are manufactured by various specialized companies, such as: ETS-Lindgren, Captor Corp., LCR Electronics, MPE, Transtector, Eurofarad, Holland Shielding System, European EMC Products Ltd., EMS Development Corp., Meteolabor, Fil-Coil, RFI Corp., Genisco Filter Corp. and others

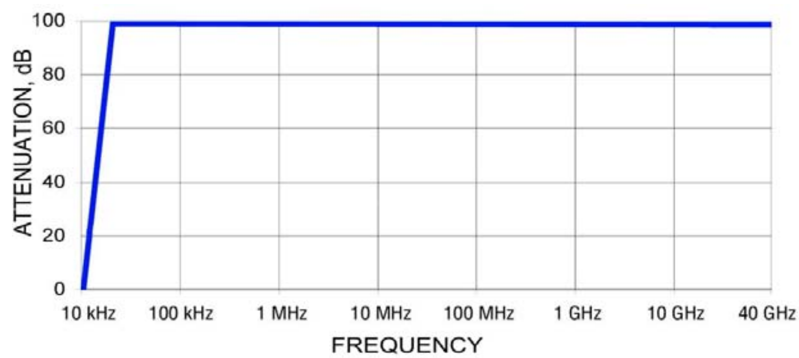

Fig. 6 : Typical frequency specification of filters designed to protect from IRDI

The filters designed for installation in the supply circuits of AC and DC current in single-phase and 3-phase consumers for current ratings from several tens of Amps to several thousands of Amps are available in the market, see Fig. 7.

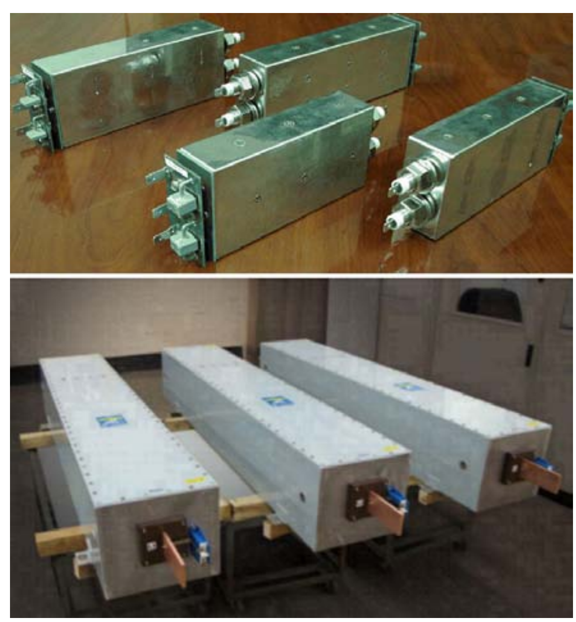

Fig. 7 : Powerful filters for supply circuits: Above - for current rating of several tens of Amps; below - for current rating above 1000 A

There are also less powerful filters for control circuits rated 1-3 A (which can be used to protect the secondary voltage circuits of external VT), see Fig. 8, as well as for communication and data transfer systems, see Fig. 9.

Fig. 8 : Filter for control circuit rated up to 1 A

Fig. 9 : Filter for communication and data transfer systems

Special devices can be used for additional protection of the system of the secondary DC power supply. They include powerful varistors and thermocouples, which disconnect the varistor and generate a signal in case the varistor damaged, see Fig. 10.

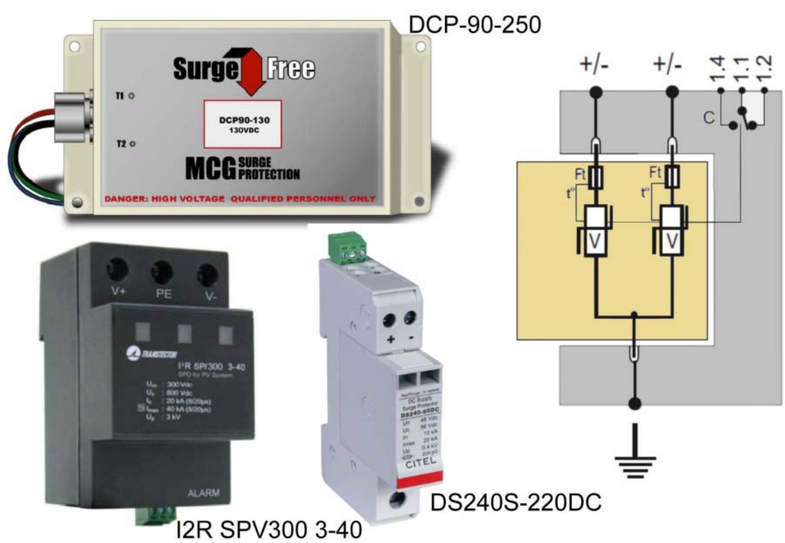

Fig. 10 : Protection devices for the system of secondary DC power supply

These devices are intended to protect the system of secondary DC power supply from impulse overloads.

IV. Conclusion

Thus, a conclusion can be made that today there are reliable methods of protection of DPR from all types of IRDI. The choice of one or another method of protection fully depends on a specific situation. The most comprehensive and efficient protection from all types of IRDI is provided by a complex protection, which includes both active and passive means of protection. It is clear that use of additional technical means will result in some degree of increase of relay protection system. However, taking into consideration that special protection from IRDI is not necessary for all the DPRs, the total cost increase of an electric power facility will not be significant. Besides, it should be taken into consideration that the use of protection from IRDI significantly increases DPR resistance to common electromagnetic interference, i.e., improves reliability of its operation not only under possible extreme conditions, but also under normal operation mode conditions.

References Références Referencias

1. Gurevich V. Cyber and Electromagnetic Threats in Modern Relay Protection. CRC Press, 2014, 224 p.
2. Gurevich V. I. Electromechanical and Digital Protective Relays. Whether the Symbiosis is

Possible? – Relay Protection and Automation, 2013, No. 2, pp. 75-77.

3. Gurevich V. I. About of terminology in relay protection - PRO Elecktrichestvo. - 2013. - No. 3-4. - pp. 51 - 52.
4. Gurevich V. Reducing the Vulnerability of Digital Protective Relays to Intentional Remote Destructive Impacts. - Global Journal of Researches in Engineering (F): Electrical and Electronics Engineering, 2013, vol. 13, issue 15, pp. 30 - 40.
5. Gurevich V. Reducing the Vulnerability of Digital Protective Relays to Intentional Remote Destructive Impacts: Technical-and-Economic Aspects. Global Journal of Researches in Engineering (F): Electrical and Electronic Engineering, 2014, vol. 14, issue 1, pp. 26 – 34.

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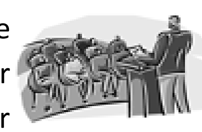

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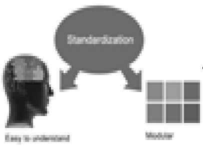

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The Institute will be entitled to following benefits:

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The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.
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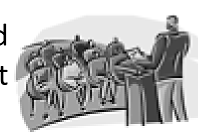

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

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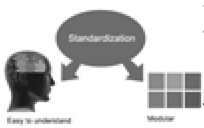

After nomination of your institution as “Institutional Fellow” and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.

The board can also take up the additional allied activities for betterment after our consultation.

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Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
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2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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- Do not give permission to anyone else to "PROOFREAD" your manuscript.
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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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