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Wavelet Signal Generation for Nonlinear Device Testing Applications

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Abstract- Testing using standard function generators for frequency response, pulse response is common. Oftentimes, certain nonlinear systems such as testing of saturable reactors, semiconductors of the p-n-p-n type as well as testing of avalanche conditions in power transistors need sharp rise and slow fall signals To this end, a PC based function generator where any kind of signal pattern such as the above, including wavelets could be realized with a very simple circuit, combined with a power OPAMP. Circuits of the above type could be tested using this set-up. The software is developed in Visual Basic.

Index Terms- Wavelet Signal Generation, Morlet, DB and Haar wavelets, Nonlinear Device testing,

I. Introduction

Function generators are able to test and characterize any circuit or system which is linear. Tests of signals with high voltages are often used for evaluation in insulation testing, semi-conductor avalanche or breakdown assessment.

Wavelet operators are useful in many practical applications. Wavelet based signals could be used for nonlinear systems and circuits.. Implementation of wavelets on DSP hardware has become popular.

To generate a wavelet signal is simple enough thorough a DAC from a PC. Since the waveform coordinates are known by a prior calculation, the same can easily be output via a port on the PC, such as the standard printer port itself. A DAC would convert the digitally output sample numbers into an analog signal, with some filtering provided externally. Though signals of high frequency (low scales, in Wavelet parlance) cannot thus be generated due to the software instruction time and DAC's own settling time limitations, it is easily possible to generate frequencies over the audio frequency range (< 4KHz) A single wavelet signal, for example, as in fig. 1 below, due to Morlet wavelet, would be requiring, at iteration level.

By making using of the PC's parallel printer port, the DACO8 interfacing circuit was developed and tested with suitable programs for generating various kinds of wavelets and tested separately . .

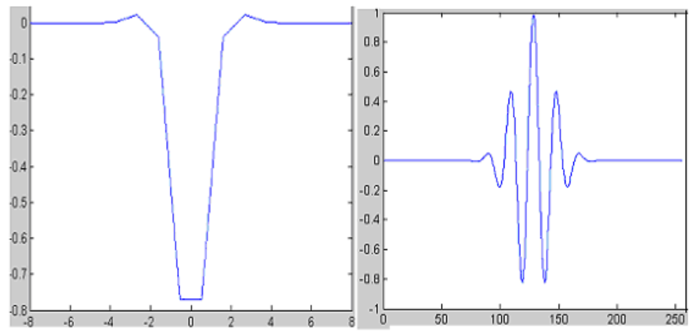

Figure.1. Typical Morlet Wavelet

II. A SHORT SURVEY OF WAVELET TECHNIQUES AND APPLICATIONS IN LITERATURE

Transient signals of known and unknown origin are fit subjects for wavelet analysis. Some signals of ergodic nature as arising from chemical analytical instruments and which presently use the Fourier spectral techniques have been considered in Chapter-2 for wavelet based interpretations.

In power systems, there occur several types of disturbance signals not periodically which are of short duration and rich in harmonic content. To cite an example, work by Fransisco Juardo and Jose R.Saenz (2002) relating to electronic six phase pulse converter drive has been performed in this direction using wavelets.

Signal processing in bio-medical Engineering has long since been under the purview of wavelets. Bentley P.M. and McDonnell J.T.E. describe the simple analysis of ECG (electrocardiograph) using wavelets to bring out the time course of the QRS complex better. But, since the ECG is a synchronised activity, this is not a signal arising out of multiple entities. Hence there is not much that could be gleaned further to the plain ECG signal itself for diagnosis. Unser and Aldroubi (1996) have attempted a review of wavelets in some biomedical applications. . Neuro images could be denoised using wavelets in lieu of Gaussian filtering As another different application, is using the wavelet for AGC (auto gain compensator) for hearing aids, which is more than an analysis of a signal using wavelets and is of practical applicability. Likewise, signal generation based on wavelets is itself offering scope for some new methods of testing of systems. Swarup Bhunia and Kaushik Roy [2000] using Mexican hat wavelet using wavelet transform have reported dynamic supply current testing for analog circuits.

In the field of EEG for neuropathology and disorders, there are quite many references. Some aim at EEG noise reduction for a better visual observational diagnostics. A fast wavelet transform for EEG, with a view to real time instrument observation, has been reported by Strichartz, R.D., (1993). Multi-resolution decomposition of EEG with a view to analyze local pathological patterns is very useful. Apart from denoising, another area has been in (automatic) identification of onset of spikes to aid in continuous patient monitoring. For a certain patient, from his past e.e.g. records, if a set pattern of spike and wave has been noted, a wavelet could be constituted and used for automatic matching with data from continuous monitoring. This is combined with an ANN in some work described by Tugla Kalayci et al (1995). Spike and seizure localization could also be possible using wavelets according to Steven J.Schiff et al (1994).

III. PC BASED WAVELET SIGNAL GENERATION:

An 8-BIT HIGH-SPEED MULTIPLYING D/A CONVERTER DAC08 SERIES

The DAC-08 series of 8-bit monolithic multiplying Digital-to-Analog Converters provide very high-speed performance coupled with low cost and outstanding applications flexibility. The compact size and low power consumption make the DAC08 attractive for portable and military aerospace applications

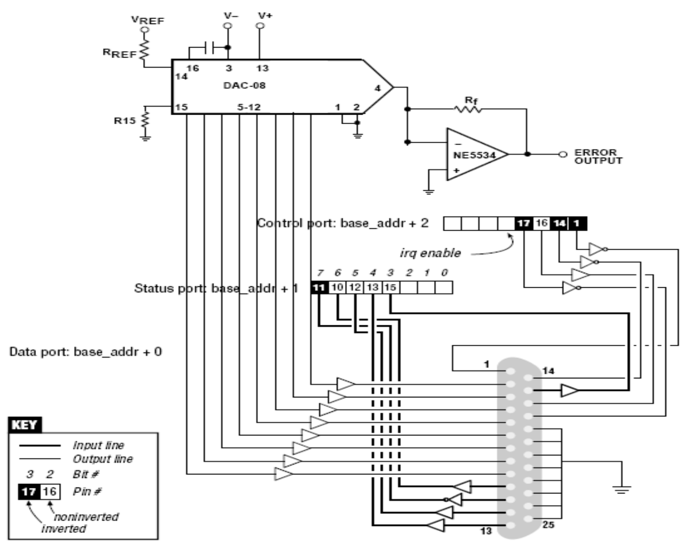

Figure. 2-Bit High-Speed Multiplying D/A Converter DAC Interface with Printer port

A typical program for generating a signal (basic) for testing the DAC Port with a 50 Hz sinusoidal waveform. Was written in basic.

IV PROGRAM TO GENERATE *DB* WAVELET

By making the use of the coefficients stored with the above Matlab program in .XLS format, the program to develop the continuous DB wave was generated and checked on the output of the DAC port. By making use of the same program, the other DB 7,db8,DB15 were generated and tested

By using printer port, the DACO8 interfacing circuit was developed and tested with suitable programs for generating various kinds of wavelets and tested separately. A DSP based wavelet signal generation is also suggested for generating the analog wavelet signal for use with non linear device testing purpose .

V TESTING FOR NON LINEARITY IN CIRCUITS USING MORLET WAVELET

With a suitable Power OPAMP, the wavelet signal generated can be amplified to any voltage or power level. The principles of testing simple semiconductor devices are outlined below.

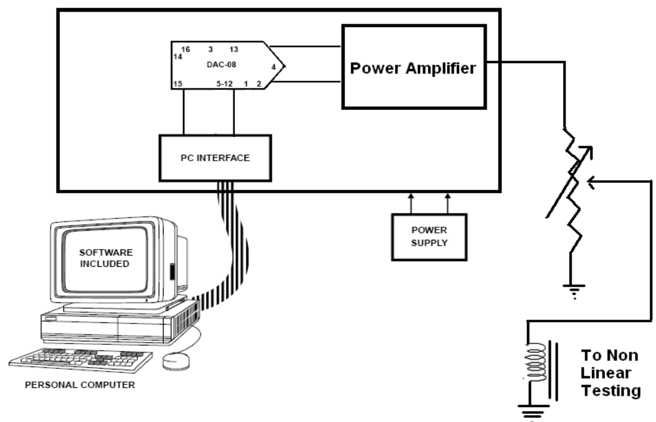

Figure 3a A basic test circuit

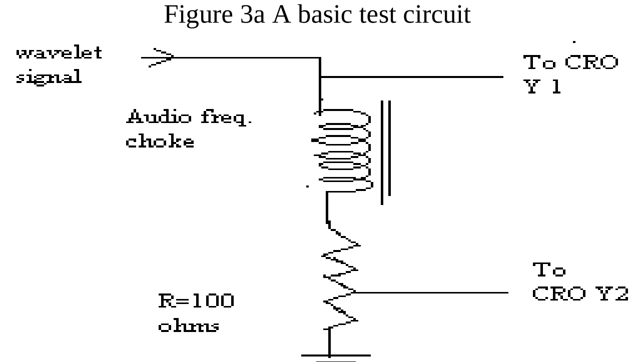

Figure.3b shows the Non-linear device testing unit and resistor

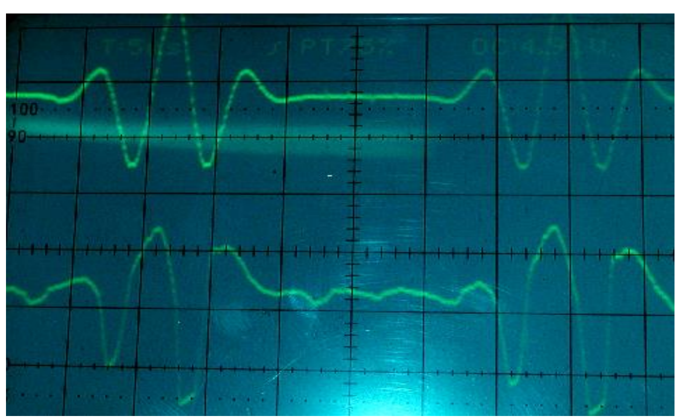

Fig.4a

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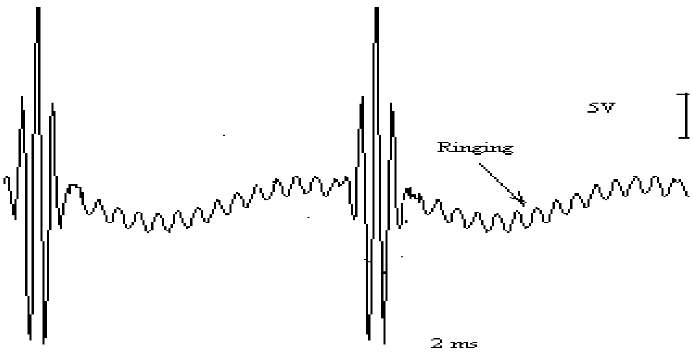


Figure.4b

Figure 4.a shows the oscillogram of the Morlet wavelet signal repeatedly applied to a circuit of nonlinear nature. Here, an inductor of iron core using an audio frequency transformer's winding is in series with a wire- wound resistor. The current in the circuit is measured by the oscillogram (Fig.4.b).

It shows that at the peak central wave, there is an effect of saturation. Additionally some low level oscillations are also present in the inter-wavelet gap period.

During the first oscillation (sinusoidal) of the Morlet wavelet, the waveform for current is not distorted. Thus, the level at which the saturation effect occurs is detected while slowly increasing the amplitude of signal. In one cycle of the wave, this detection is possible. Any possible damage to the device is thus reduced. If a continuous sine wave signal were applied, the saturation on the several cycles – since we cannot apply a single sine wave will cause worse effects if the device is not able to withstand that voltage level.

The low level oscillation midway between the two wavelets in the above figure indicates how the wavelet signal resonates with the inductor for this frequency input. This is not any resonation, but still the effect is noted. In another test, when the frequency of the wavelet was increased (through the program) slowly, these oscillations rose up at a certain point. Then, it is easy noted that the choke has ringing as shown in Fig 4.4 at this frequency due to its winding stray capacitances. If this frequency is further increased, it was found that the OPAMP output is not able to sustain the signal because of the coupling capacitor from the same to the circuit.

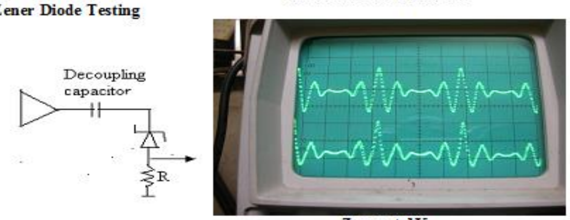
VI. DEVICE TESTING MAKE EASY BY WAVELETS AND RESULTS

It is easy to identify defects in semi-conductor devices in this method, rather than by sinusoidal or pulse excitation, even if there is mild leakage. Non linearity is immediately noticeable from the current waveform. The following pictures illustrate the principle typically for forward biasing zener with .different resister values, testing both silicon and germanium junctions of transistors with a good and a defective components. in the results.

Green LED forward Bias:

Green LED forward Bias

Zener Diode Testing



Zener + 1K

Transistor Testing (Silicon)

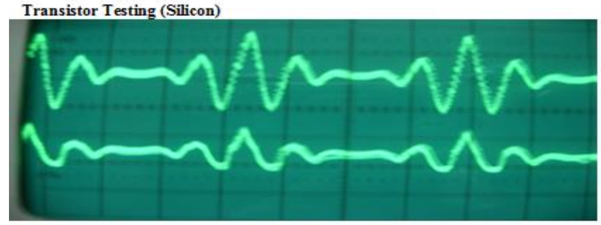


Fig. Base -Collector junction of silicon (2N5172) transistor + 150 ohms

Figure 5. shows the Oscillogram of the typical Non-linear components under test

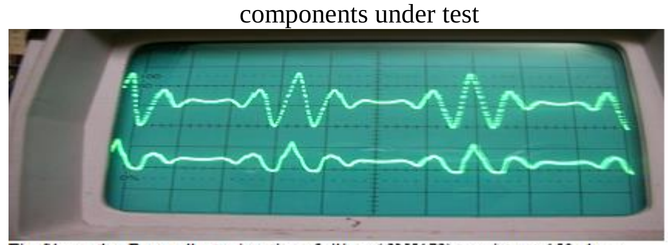


Fig. Shows the Base collector junction of silicon (2N5172) transistor + 150 ohms

Emitter – Base junction silicon Transistor

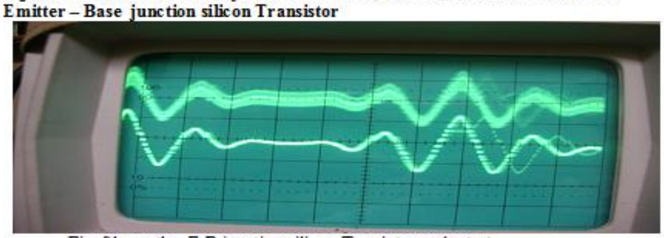
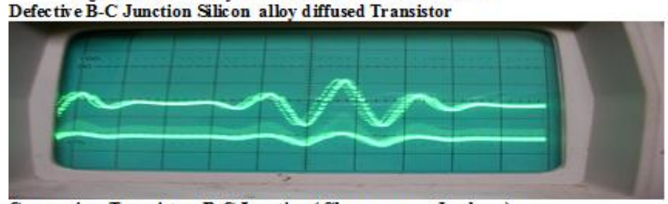


Fig. Shows the E-B junction silicon Transistor under test

Defective B-C Junction Silicon alloy diffused Transistor



Germanium Transistor B-C Junction (Shows reverse Leakage)

Fig. Germanium Transistor B-C Junction (Shows reverse Leakage)

Figure.6 Shows the defective transistors tested with the given wavelet signal along with the oscillograms

Thus, the wavelets generated by any one of the methods suggested in chapter 3, and chapter 4 of this dissertation work, is an useful method for testing the non linear device so that any defective components and devices can easily be identified in pre determined way by looking at the waveforms. The photpgraphs gives the clear idea of the components used in a circuit under test with various conditions are given here.

V. CONCLUSION

Testing using standard function generators for frequency response, pulse response is common. Oftentimes, certain nonlinear systems such as testing of saturable reactors, semiconductors of the p-n-p-n type as well as testing of avalanche conditions in power transistors need sharp rise and slow fall signals To this end, a PC based function generator where any kind of signal pattern such as the above, including wavelets could be realized with a very simple circuit, combined with a power OPAMP. Circuits of the above type using dedicated AVR microcontroller (atmega 8535) based unit was designed, fabricated and tested with suitable program for the above units is one of the contribution made in this work.. Secondly, a PC based DAC 08 port has been employed for the generation of the wavelet signals for testing the non-linear devices and components has also been done in this work. The software is developed in Visual Basic.

REFERENCES

[1] Aaron T.Deever and Sheila S. Hemami " Efficient Sign Coding and Estimation of Zero-Quantized Coefficients in Embedded Wavelet Image Codec", Jl. Of IEEE Transactions on Image Processing, Vol.12, No.4, April 2003.

[2] Alfred Mertins, "Boundary Filter Optimization for Segmentation-Based Subband Coding", Member, IEEE. Jn: IEEE Transactions on signal processing, Vol.49,No.8, August 2001.

[3] Arthur A. Peterson and F.G.Meyer, "Wavelets in Signal and Image Analysis", Kluwer Academic Publishers, Netherlands, 2001

[4] Burrus, C. S. and R. A. Gopinath, H. Guo, " *Introduction To Wavelets And Wavelet Transforms, A Primer", Prentice Hall,* Upper Saddle River, NJ (USA), 1998

[5] D.B.H.Tay, IEE, "Analytical design of 3-D wavelet filter banks using the multivariate Bernstein polynomial Proc. Online no.20000184, Nov.1999,pp122-130.

[6] Elena L. Glassman, "A Wavelet-Like Filter Based on Neuron Action Potentials for Analysis of Human Scalp Electroencephalographs", IEEE transactions on biomedical Engg, vol.52 (11) Nov.2005, pp1851-1862. (Student Member IEEE).

[7] Eric Jones, Paul Rumble, Nilanjan Das Gupta, Luise Couchman and Lawrence Carin, "Genetic Algorithm wavelet design for signal classification", IEEE Transactions on Pattern analysis and Machine Intelligence, Aug.2001.

[8] Fabrizio Argenti and Enrico Del Re, "Design of Biorthogonal M-Channel Cosine-Modulated FIR/IIR Filter Banks",. Jn: IEEE Transactions on signal processing, Vol.48, No.3, March 2000.

[9] Francisco Jurado, Jose R. Saenz, "Comparison between discrete STFT and wavelets for the analysis of power quality events", Elsevier publications, Electric power systems research, 2002, pp183-190.

[10] Gianpalolo Evangelista, Sergio Caratetire , "Discrete frequency warped wavelets, theory and applications", IEEE Trans. Sig. Proc., 4(4),1998,p.874.

[11] Gilbert G.Walter, Xiaoping Shen, "Wavelets and other Orthogonal Systems Series V.36, ISBN 158488271 , CRC Press, Florida, U.S.A.,Dec.2000.

[12] D.Gopikrishna, "Compression of EEG signals using novel wavelet based techniques with application to Telemedicine", Jour. Inst. Sci., Bangalore, 2004.

[13] Swarup Bhunia and Kaushik Roy, "Dynamic Supply Current Testing for Analogy Circuits Using Wavelet Transform", School of Electrical and Computer Engineering, Purdue University, W. Lafayete, IN 47907-1285, USA The Electrical Engineering Handbook Series.

[14] Strichartz, R.D., (1993), "How to make wavelets", Amer.Math.Monthly, 100(6):539-56.

[15] Tugla Kalayci and Ozcan Ozdamar, " Wavelet Preprocessing for Automated Neural Network Detection of EEG Spikes" , Jl. Of IEEE Engineering in Medicine and Biology March/April 1995.

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