

# **A Novel Approach to High Impedance Faults Detection Using Wavelet Transform; Design and Implementation**

H. Khorashadi-Zadeh

Department of Electrical Eng., University of Birjand

## **Abstract**

This paper presents a new approach for detection of high impedance faults in the Electric power distribution systems using wavelet transform. The proposed method has been implemented on a digital protective relay and its behavior is investigated using appropriate simulation software. Details of the design procedure, implementation and the results of performance studies of the proposed relay are given in this paper. The experiment show that the proposed algorithm performs very well in detecting a high impedance fault with nonlinear arcing resistance. It is clearly shown that the proposed relay is able to accurately distinguish between high impedance faults and other cases such as load and/or capacitance switching.

**Key words: Wavelet transform, Distribution network and high impedance faults.**

$$W T(a, b)=\frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} x(t) \cdot g\left(\frac{t-b}{a}\right) d t \quad (1)$$

$g(t)$   
 $b \quad a$

$x(t)$

[ - ]

[ ]

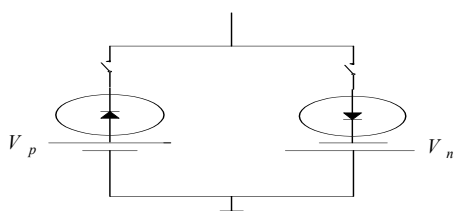
$$D W T(m, k)=\frac{1}{\sqrt{a_0^m}} \sum_n x[n] \cdot g\left[\frac{k-n a_0^m}{a_0^m}\right] \quad (2)$$

(FIR)

$g(n)$   
 $a_0^m \quad n a_0^m$

EMTDC

/



( )

[ ]

EMTDC

kV

( )

MVA

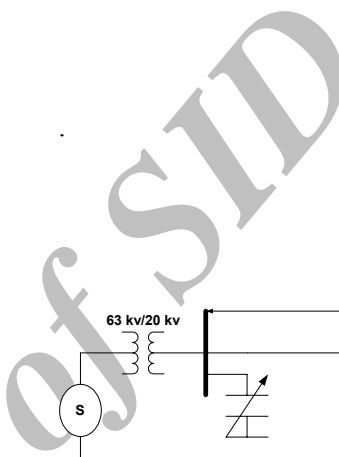
/

Hz

[ ]

( )

( )



Archive of SID

Coiflet Biorthogonal

(db5)

d1

(db5)

d1

( )

ag

d1

d1

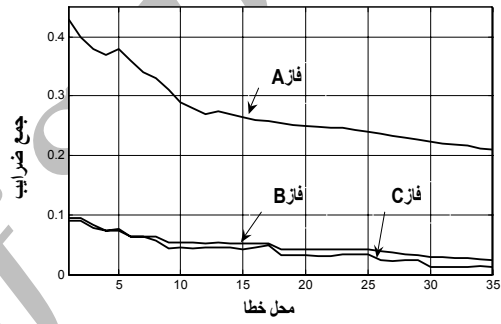
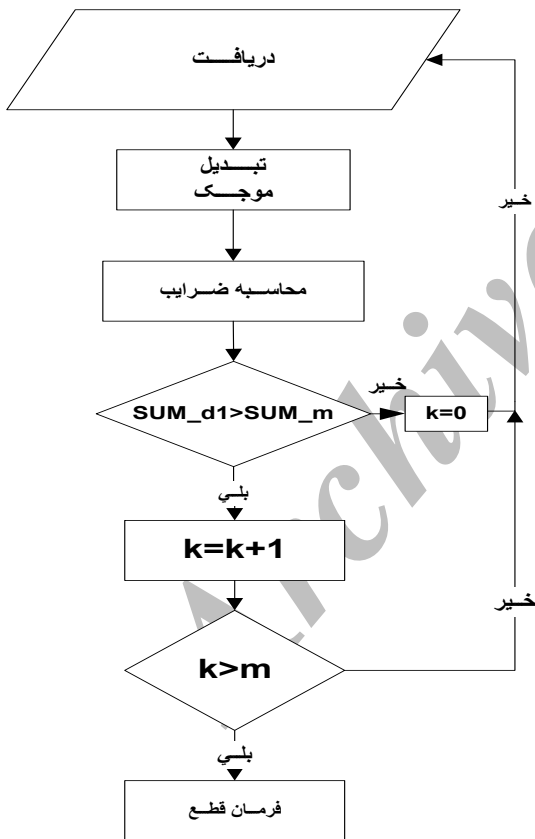
a

(Ω/km)	$l + i l$
(%)	$l$
X/R	
(Ω)	

( )

	( - )
	( - )
C(kVar)	( - )
Tap_Trans	( - / / )

m d1 Sum\_m  
 db5 /  
 d1 Coiflet  
 d1 Sum\_d1 Biorthogonal  
 Sum\_d1  
 Sum\_m Sum\_d1 Sum\_m  
 k  
 m  
 m k  
 / m Sum\_m  
 Hz



d1 -

db5

kHz

( )

		/	

( )

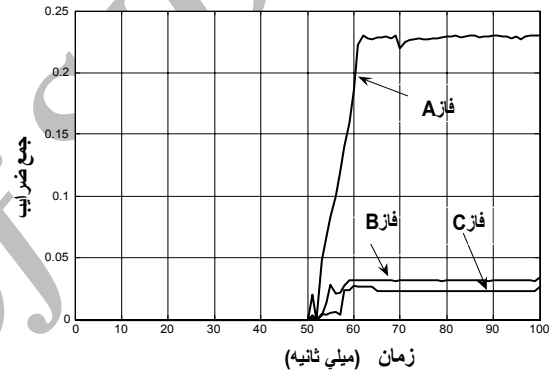
k

d1 Sum\_d1

( )  
 ( )  
 ag d1 ( )  
 km

AG / a d1

/ A



ag d1 -

				d1		
				a	b	c
AG				/	/	/
AG				/	/	/
BG				/	/	/
CG				/	/	/
AG				/	/	/
CG				/	/	/
AG				/	/	/
BG				/	/	/
CG				/	/	/
BG				/	/	/

-

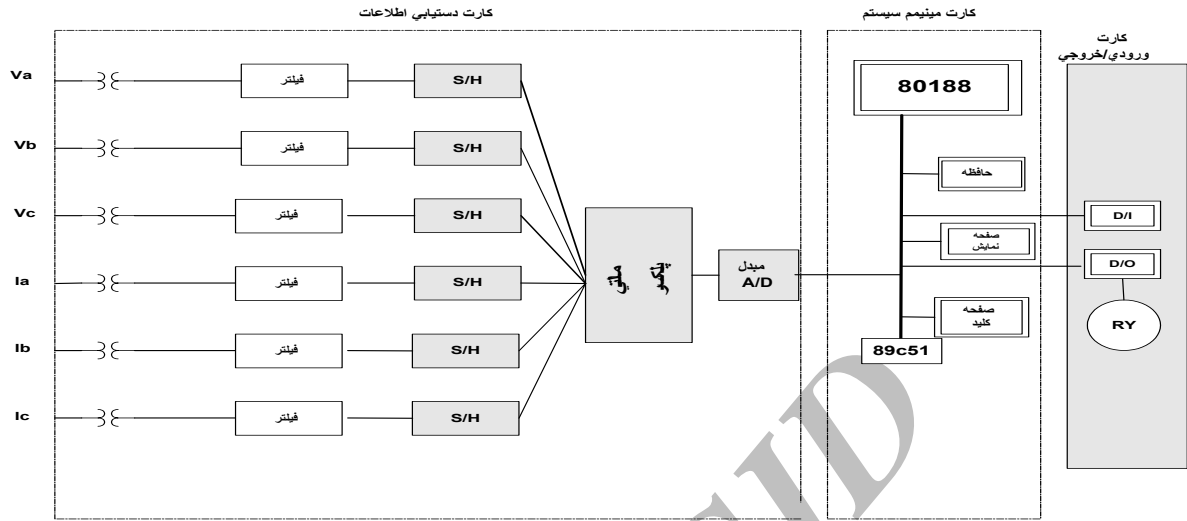
		d1		
		a	b	c
	kVar → kVar			
	→	/	/	/
	→	/	/	/
	→	/	/	/
	→	/	/	/
	→	/	/	/
	MW → MW			
	→ /	/	/	/
	/ →	/	/	/
	→	/	/	/
	→ /	/	/	/
	→ /	/	/	/
	% → %			
	- / →	/	//	/
	→ /	/	/	/
	/ →	/	/	/
	→ - /	/	/	/

-

( ) ( )

RAM

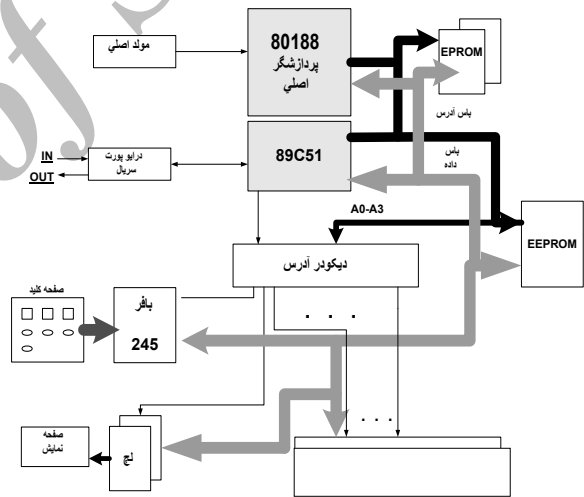
LCD



( ) E<sup>2</sup>PROM  
E<sup>2</sup>PROM . RAM

WR  
E<sup>2</sup>PROM

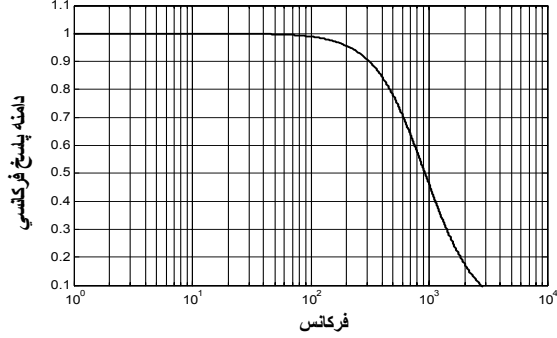
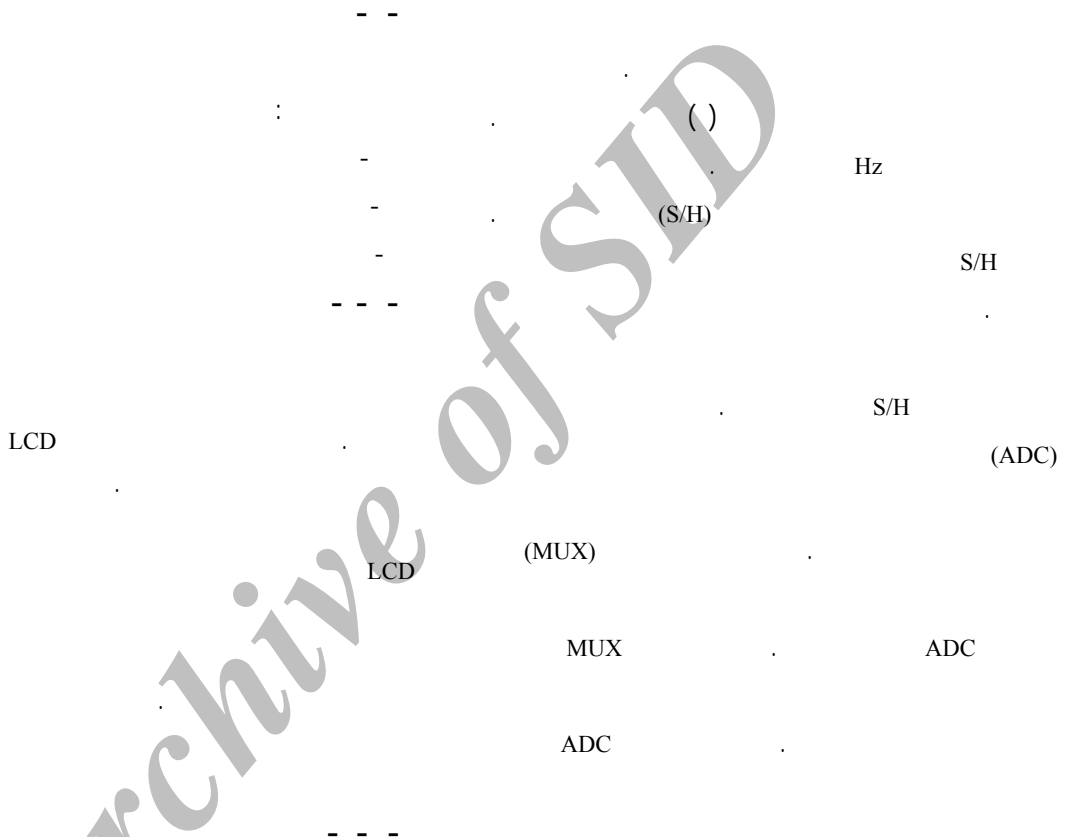
RAM  
E<sup>2</sup>PROM



E<sup>2</sup>PROM EPROM  
EPROM ( )

E<sup>2</sup>PROM  
reset  
RAM E<sup>2</sup>PROM

(DAS)  
RAM E<sup>2</sup>PROM



LCD



kHz

S/H

MUX

#

A/D

A/D

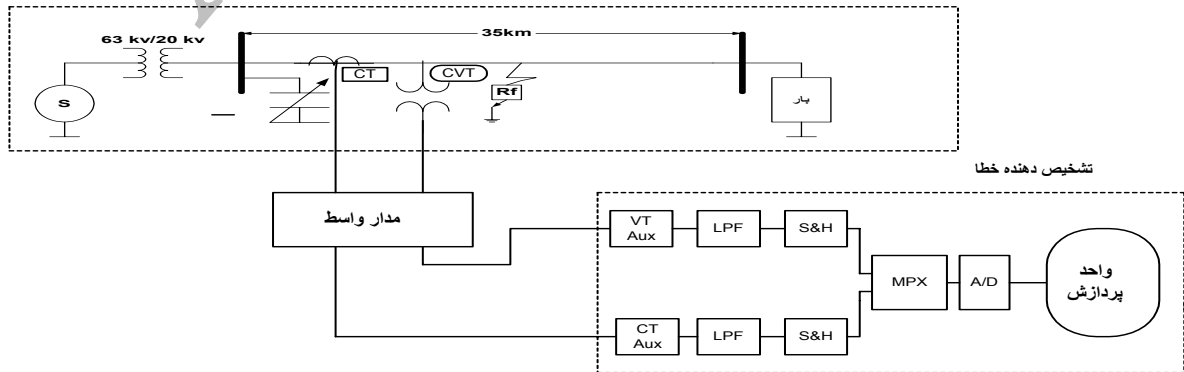
/ - - -

( - )

LCD

Archive of SID

شبیه سازی خطاهای امپدانس بالا



(km)	(deg)			
		(kV)	/ (kV)	(kV)
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip
		Trip	Trip	Trip

c

- [1] H. Calhoun, M. T. Bishop, C. H. Eichler, T. E. Lee, "Development and Testing of and Electromechanical Relay to Detect Fallen Distribution Conductors", IEEE Transactions on Power Apparatus and system, PAS-101, no. 6, June 1982, pp. 1643-1650.
- [2] A.M. Sharaf, Guosheng Wang, "High impedance fault detection using feature-pattern based relaying", Transmission and Distribution Conference and Exposition, 2003 IEEE PES, vol. 1, 7-12 Sep. 2003 pp. 222-226.
- [3] Z.Q. Bo, X. Z. Dong, S. X. Shi, Z. Gan, B. R. J. Caunce, "Detection of High Impedance Fault Using Adaptive Non-Communication Protection Technique", Power Engineering Society Summer Meeting, 2002 IEEE, vol. 1, 21-25 July 2002 pp. 376-381.
- [4] Zeng Xiangjun, K. K. Li, W. L. Chan, "Wavelet analysis based protection for high impedance ground fault in supply systems", Proceedings. International Conference on

- [10] L. A. Snider, "High Impedance Fault Detection Using Third Harmonic Current", EPRI Report EI, 2430, Prepared by Hughes Aircraft Co., June 1982.
- [11] L. Angrisani, P. Daponte, M. D. Apuzzo, A. Testa, "A New Wavelet Transform Based Procedure For Electrical Power Quality Analysis", Proceeding of ICHQP'96, Oct. 1996.
- [12] A. Lazkano, J. Ruiz, E. Aramendi, L. A. Leturiondo, "A New Approach to High Impedance Fault Detection Using Wavelet Packet Analysis", Proceeding of ICHQP 2000, Oct. 2000, pp. 1005-1010.
- [13] D. J. Jeerings, "Ground Resistance Revisited", IEEE Transactions on Power Delivery, vol. 4, no. 2, April 1989, pp. 949-956.
- [14] I. Daubechies, "The Wavelet transform, Time-Frequency Localization and Signal Analysis", IEEE Transactions on Information Theory 36, vol. 5, 1990.
- [15] PSCAD/EMTDC User's Manual, Manitoba HVDC Research Center, Winnipeg, Manitoba, Canada.
- [16] M.B. Djuric and V. V. Terzija, "A New Approach to the Arcing Faults Detection For Fast Autoreclosure In Transmission Systems", IEEE Transactions on Power Delivery, vol. 10, no. 4, Oct. 1995, pp. 1793-1798.
- [5] R. Das, S. A. Kunsman, "A novel approach for ground fault detection", 2004 57th Annual Conference for Protective Relay Engineers, 30 Mar-1 Apr. 2004, pp. 97-109.
- [6] Z. Gan, X. Z. Dong, Z. Q. Bo, B. R. J. Counce, D. Montjean, "A New Protection Scheme for High Impedance Fault Using Adaptive Trip and Reclosure Technique", Proceedings. International Conference on Power System Technology, Power Con 2002, vol. 1, 13-17 Oct. 2002 pp. 295-299.
- [7] C. H. Kim, R. K. Aggarwal, A. T. Johns, "Wavelet Transform in The Accurate Detection of High Impedance Arcing Faults in High Voltage Transmission Lines", Seventh International Conference on Developments in Power System Protection, (IEE), 9-12 April 2001 pp. 422-425.
- [8] H. Khorashadi Zadeh, "A Novel Approach to Detection High Impedance Faults Using Artificial Neural Network", Proc. of the 39<sup>nd</sup> International Universities Power Engineering Conference, UPEC2004, Sep. 2004, pp. 373-377.
- [9] B. M. Aucoin, "Detection of Distribution High Impedance Faults Using Burst Noise Signals Near 60 Hz", IEEE Transactions on Power Delivery, vol. PWRD-2, no. 2, April 1987, pp. 347-349.

Archive of SID