Engineering Journal of Qatar University, Vol. 2, 1989.

"SIGNAL IDENTIFICATION USING A MICROPROCESSOR BASED PHASE LOCKED LOOP SYSTEM"

By

M.S. Metwally,
Qatar University,
Doha, Qatar.

Y.Z. Bahnas and R.A.A. Abouleinein,
Cairo University,
Giza, Egypt.

ABSTRACT

A scheme for waveform comparison and the measurement of periodic signal parameters through processing, controlling and measuring programs is realised. A microcomputer is used with a phase locked loop voltage controlled oscillator that operates as a synchronised sample generator. The comparison (matching) method is based on a sample-to-sample comparison, where the normalised sample is compared with a reference at specified instants. The reference samples are of normal sinusoidal, triangular or square waveforms.

INTRODUCTION

The use of microcomputers to control circuit operations and to stabilise performance combined with advanced studies of phase locked loop characteristics and performance have made it possible to realise a complete system for signal identification. Several studies have been carried out to realise measuring equipment using a microcomputer with a phase locked loop to determine the parameters of a known signal. The rms value of a signal and its distortion measurement are described in references [1,2].

In this paper, another use for the combination of the microcomputer and phase locked loop is discussed, in which an unknown waveform is sampled, at specified instants of time. The samples are then compared with samples of different known waveforms. The output of the microcomputer can be a complete signal identification, defining the shape of the signal, and giving parameters such as values of its amplitude, frequency, and harmonic content.

CONDITIONS FOR PROPER OPERATION

Several conditions must be fulfilled for proper operation of the suggested scheme. The sample frequency fo should be related to the unknown waveform frequency f, such that fo = Nf., where N is the number of samples (greater or equal to 2), as required by Shannon's sampling theorem [3].

The reference waveforms can be either:

a sinusoidal waveform with	$y=\sin(t)$	
or, a triangular waveform with	$y=(2/\pi)t$	$0 \le t \le \pi/2$
	$=2-(2/\pi)t$	$\pi/2 \le t \le 3\pi/2$
	$=(2/\pi)t-4$	$3\pi/2 \le t \le 2\pi$
or, a square waveform with	$y=1$	$0 \le t \le \pi$
	$=0$	$\pi \le t \le 2\pi$

NUMBER OF SAMPLES

In order to realise the proper number of samples a linear phase locked loop is used.

The sampling can start at any instant of time on the waveform. These samples are converted to digital signals, and then stored in the microcomputer memory by an interrupted program of data transfer. A search for maximum and minimum samples is carried among these samples, and the maximum sample is used as a starting point for comparison.

The complete program will block the d.c. value calculated from the maximum and minimum stored samples, and then normalisation is carried out to facilitate the matching process.

In this technique an aided frequency acquisition method is used such that the phase locked loop acquires the input signal very rapidly compared with the self acquisition pull-in-time usually needed for the VCO to operate at f, [4]. The phase difference between the two signals is adjusted to be from "0" to "$\pi/2$", as the the lock is achieved. Fig(1) shows the aided frequency acquisition scheme.

Before acquisition the VCO frequency fo is adjusted by the external resistors and capacitors connected to the phase locked loop.

A reference value M taken from a "frequency measuring loop" is fed to the microcomputer, which searches between the stored set of numbers ($N_1 = N_o$, N_1 , N_2, ... , N_n) that covers the operating range of the input frequency, to find a number equal to the reference one through a half way half point search. The frequency acquisition method is achieved by dividing fo output, controls the PLL operation; port B, an input, reads the digitised samples of the A/D converter.

SYSTEM FLOW CHARTS

The complete system comprises of the following modules: search for lock, data input, maximum and minimum sample determination, sample selection, data code conversion, normallisation and pattern matching. Reference data stored for comparison are samples of sinusoidal, triangular and square waveforms. The search for lock, sample selection and pattern matching flow charts are shown in Figs (3,4,5). They can be easily followed.

RESULTS

The complete scheme is used for comparison of different waveforms. Table (1) summarises the result of matching of a sine waveform to a reference. The maximum error allowed for signal identification was a difference of ± 2 bits. The error was defined as numerically equal to "the reading − the dc − the reference".

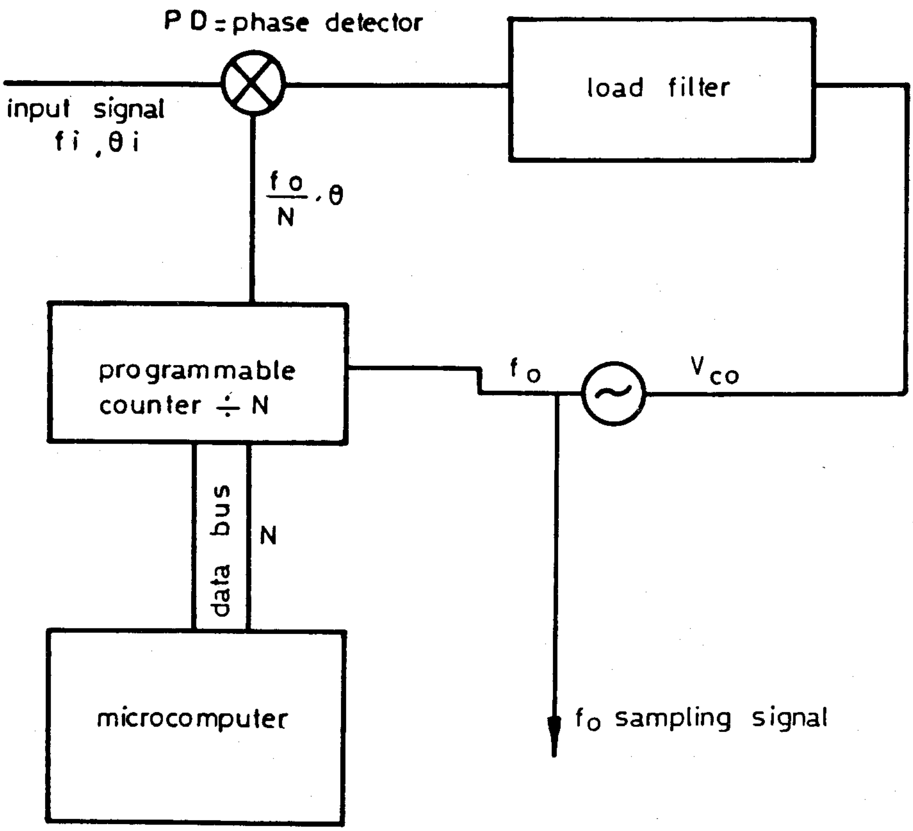

Fig. 1 : Aided Frequency Acquisition Method.

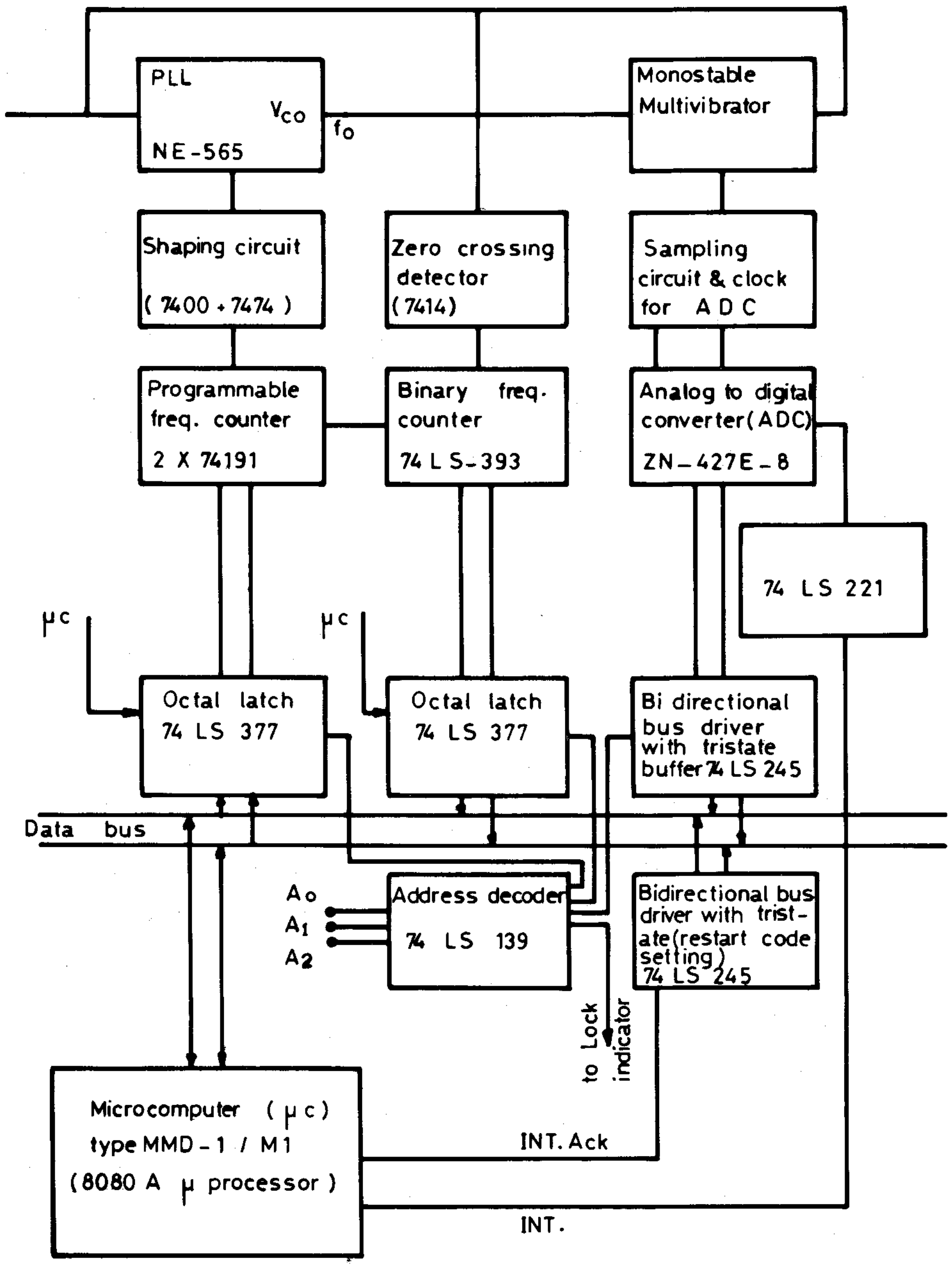

Fig. 2 : Hardware Realization.

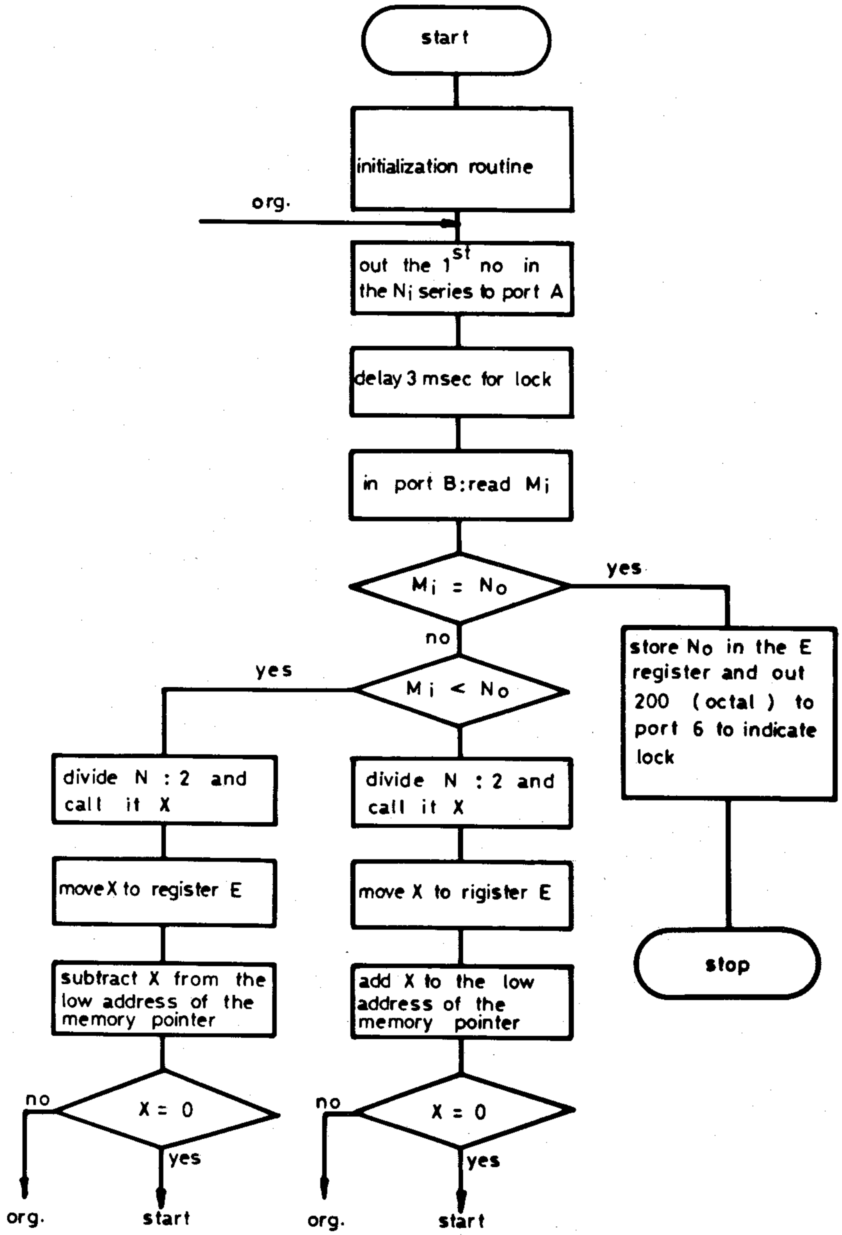

Fig. 3 : Flowchart of Search For Lock.

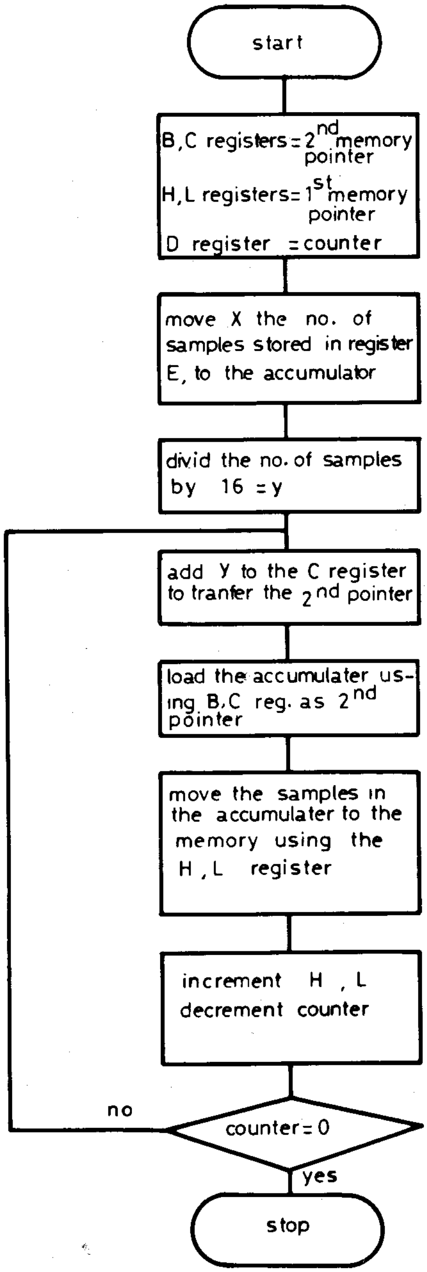

Fig. 4 : Flowchart of Sample Selection.

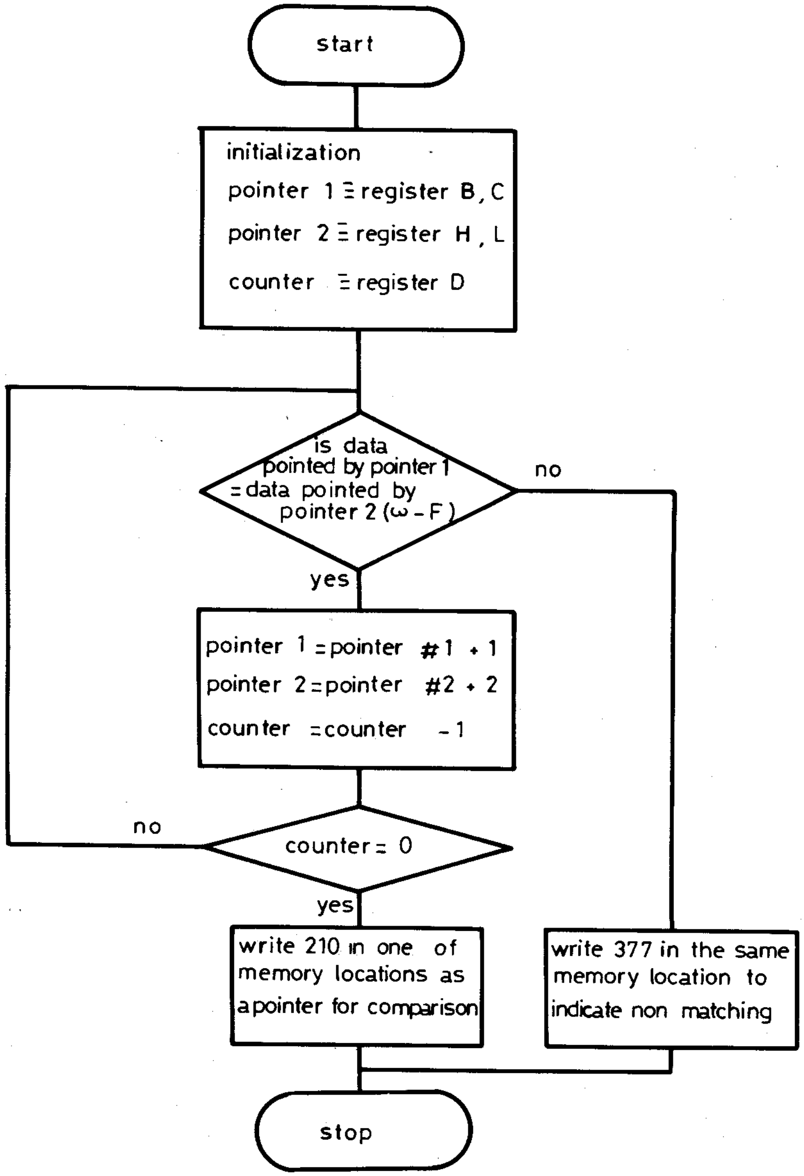

Fig. 5 : Flowchart of Pattern Match.

TABLE (1)

No.	Reading (bits)	D.C. (bits)	Reference (bits)	(Reading −DC) bits	Error bits	Error volt
1	42	6	35	36	1	0.04
2	36	6	28	30	2	0.08
3	16	6	10	10	0	0.00
4	− 4	6	− 10	− 10	0	0.00
5	− 24	6	− 28	− 30	− 2	0.08
6	− 29	6	− 35	− 35	0	0.00
7	− 24	6	− 28	− 30	− 2	− 0.08
8	− 6	6	− 10	− 12	− 2	− 0.08
9	16	6	10	10	0	0.00
10	34	6	34	28	0	0.00

CONCLUSION

A signal identification algorithm was developed using a microcomputer with the aid of a phase locked loop; the complete system was realised using INTEL 8080A. The system can be used for frequency measurement, Fourier coefficient determination and other parameters which will aid the signal identification. The system can be modified to analyse complex signals and to compare with simple reference waveforms stored into the microcomputer memory.

REFERENCES

[1] **M.M. Hanafy.** : "Microprocessor Based Multipurpose Measuring Instrument", M. Sc. thesis, Cairo University, 1979.

[2] **F.M.A. Fahmy.** : "Microprocessor Based Distortion Measurement", M. Sc. thesis, Cairo University, 1980.

[3] **O.I. Elgerd.** : "Control System Theory", McGraw-Hill, 1967.

[4] **F.M. Gardner.** : "Phaselock Techniques", Wiley, 1979.

[5] **J.L. Hilburn** and **P.M. Julich.** : "Microcomputer/Microprocessor Hardware, Software and Applications", Prentice-Hall, 1976.

[6] **L.A. Leventhal.** : "8080A−8085 Assembly Language Programming", Osborne, Berkeley, Ca., 1978.

[7] MMD−1/M1 Minicomputer/Memory and Interface Instruction Manual.