# MICRO-CONTROLLER BASED FREQUENCY DEVIATION OF POWER LINE METER+

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## Abstract

**This paper describes a new technique in calculating the frequency deviation in power systems. In order to get a high accuracy in measurements the micro-controller is used instead of the conventional electronic components. Hence a high reliability is attained in measurements according to any deviation in the frequency of the power line because it is very easy to change the data given to the micro-controller.**

## المستخلص

**يصف هذا البحث تقنية جديدة في حساب انحراف التردد في منظومات القدرة. ولغرض الحصول علـــى دقة عالية في القياس فقد تم إستخدام الضابط الدقيق (Micro-controller) بدلاً من إستخدام المكونـــات الالكترونية التقليدية. لذلك فأن مرونة عالية تم الحصول عليها في القياس، ولأي تغيير يمكن أن يحدث في إنحراف التردد في خط القدرة وذلك بسبب السهولة في تغيير معلومات البرنامج المعطاة الى الضابط الدقيق.**

## Introduction

Many researches have been achieved for measuring the frequency deviation in electrical power systems. Industrial power system applications require close monitoring of the deviations in supply frequency, because the frequency is very much dependent on the real power balance in power system network. Normally the rate of generation of energy must equal the rate of energy consumption plus losses. But small or large changes in load always take place in the system and the random nature of the load fluctuations renders it difficult to achieve a perfect match between input and load demand at every instant. This mismatch leads to system frequency fluctuations.

An accurate information of supply frequency variation is essential for satisfactory operation of interconnected power systems.

[1] has suggested the use of electrical resonance, as the basis for the development of a frequency deviation transducer. Such of transducers are unsuitable for continuous recording of frequency and do not have long term accuracy. [2] employed digital

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techniques for frequency measurements, but in spite of the high accuracy possible by such methods, their cost and complexity presented serious disadvantage.

[3] had developed a frequency meter using a digital-analogue technique. This instrument also suffered from one disadvantage or other in the form of complexity or low long-term accuray. [4] reputed the development of a solid state frequency deviation tranducer for continuous monitoring of power system frequencies. This system using discrete solid state circuitry works on the principle of modulation of supply frequency on a standard high frequency from a crystal oscillator.

The main disadvantages of all these methods are the complexity and limited accuracy. [5], suggested an electronic frequency deviation transducer using linear and digital ICs to measure the deviation in power system frequency with a high order of accuracy. [6] has suggested a frequency deviation meter based on P.L.L. frequency multiplication with a ±0.01Hz resolution. This method uses the micro-controller in order to get a high accuracy and reliability.

**Principle of Operation**

The method employs micro-controller for measuring the frequency deviation of the power systems, it receives the square pulses from the zero crossing detector (ZCD) and then converts it to a data depending on the program stored in the memory.

The operation of the instrument is illustrated with respect to the block diagram in Fig (1 – a) and the explanatory of waveforms in Fig (1 – b).

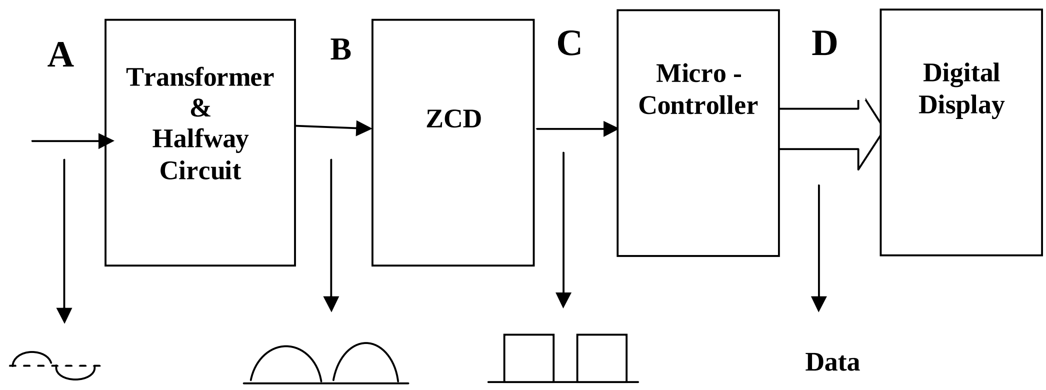


**Fig. (1-a)** Block diagram of the circuit

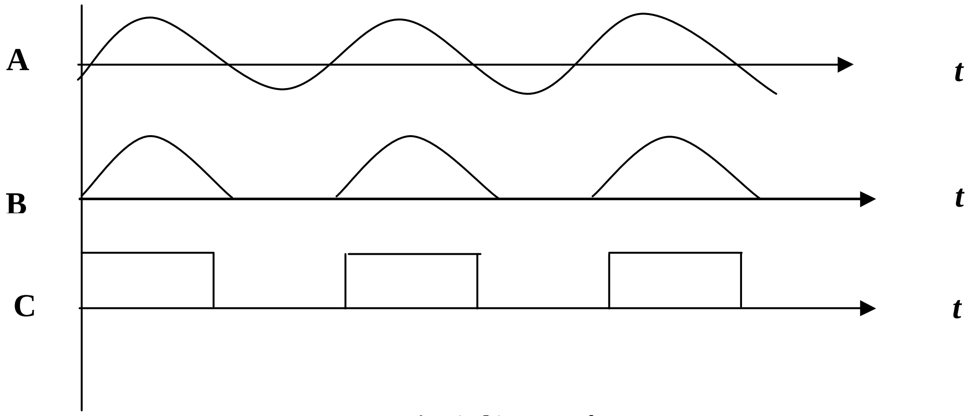


**Fig. (1-b):** Waveforms

Supply voltage is applied to a (220/15V) transformer and half-wave circuit, the output at point (B) will be as shown, the output B applied to a (ZCD) which is converted to a square pulses (C).

These square pulses are applied to the micro-controller unit which converts then to data and injects the digital display which appears the ± deviation in a line and the frequency measured in another line.

Principle of operation is described in the practical circuit diagram, and the flowcharts describe how the micro-controller converts the square pulses to a data and then injects these data to the digital display (LCD).

**Practical Circuit Diagram**

The schematic diagram in Fig (2) illustrates how the frequency deviation is achieved, first the supply frequency voltage stepped down by the transformer (220/15V).

The transformer has two 15V outputs, one of them is used as a line voltage to be fed to the circuit and the other is fed to the DC circuits to provide the required voltage for all the circuit

The line voltage decreases again using resistance voltage divider to 5V to be suitable for the operational amplifier (op-amp).

Through the two way switch, the line voltage is applied to the half wave rectifier circuit. The output of the half wave rectifier is fed to the single source operational amplifier.

Different waveforms are illustrated in Fig (1-b), the output of the op-amp is fed to the microcontroller (8051 type), which contains the necessary components required to convert the square wave received from the op-amp to data and then sent to the LCD display.

Different processes are done by the microcontroller described in the program structure.

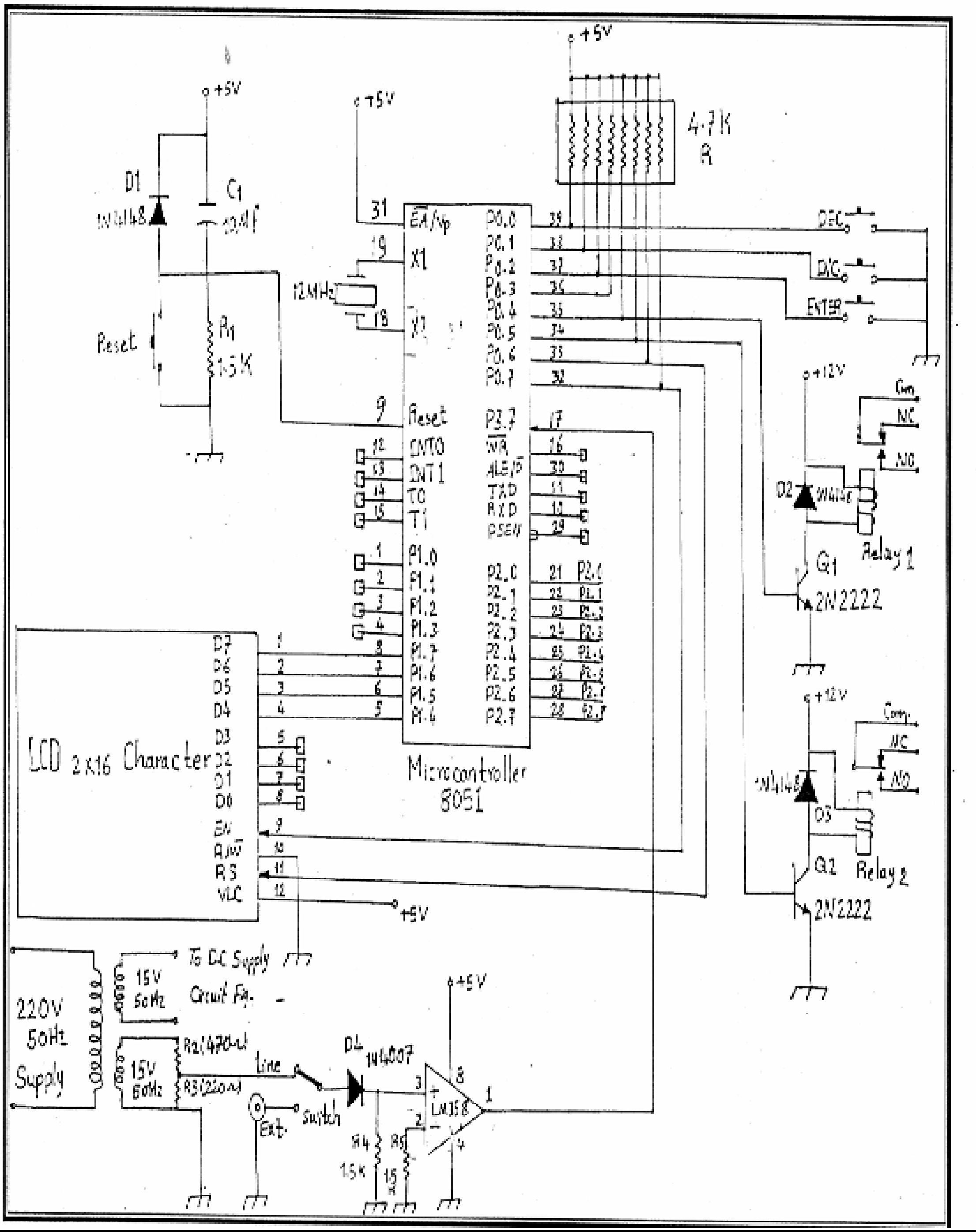


**Fig. (2):** Circuit Diagram

## Program Structure

The following flow charts explain the program structure on which the microcontroller depends to achieve its different accesses, main flowchart Fig (3).

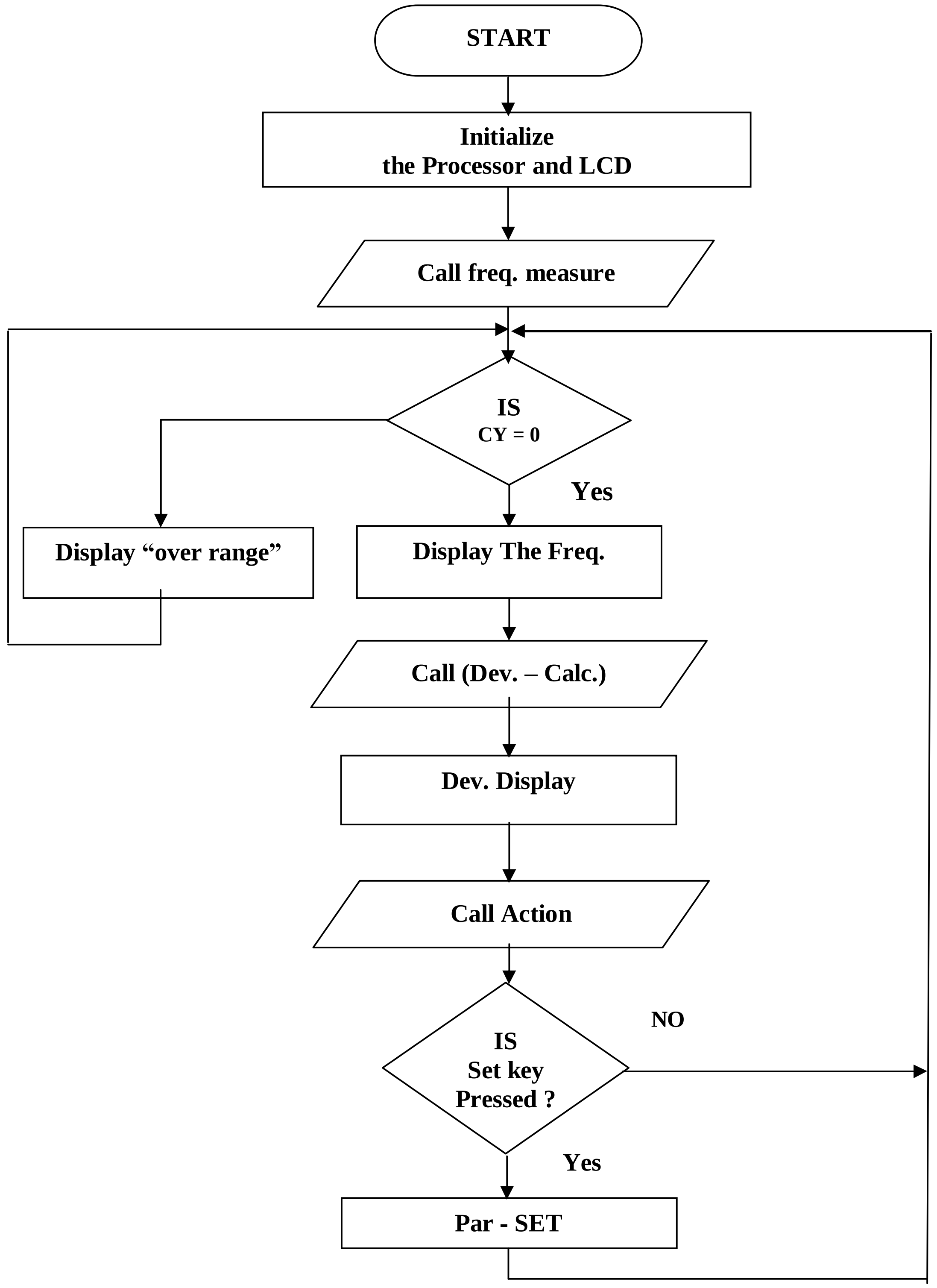


**Fig. (3):** Main Flow Chart of the Program

- Processor initializing.
- LCD initializing.
- Call frquency subroutine (see fig.4 , 5).

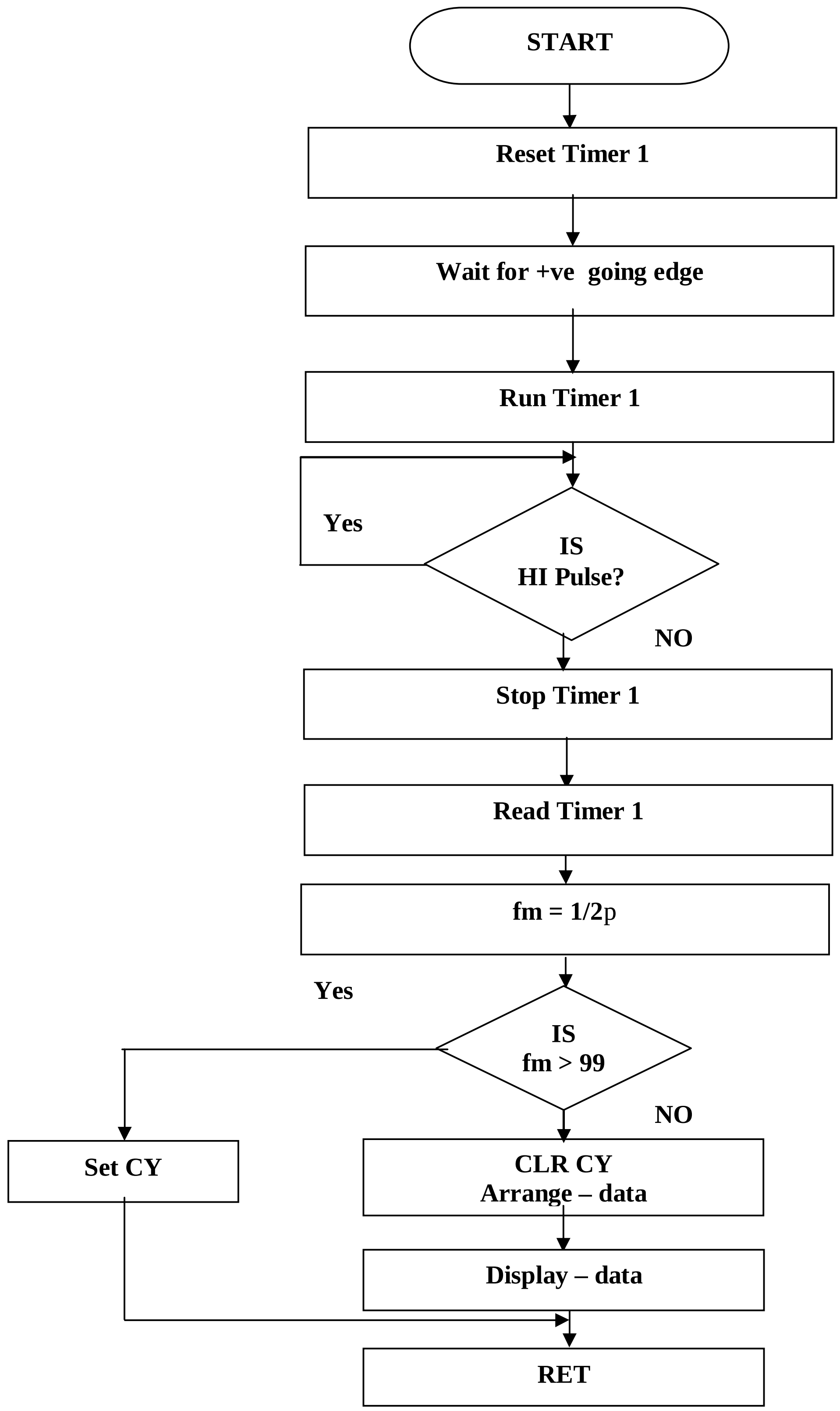


**Fig. (4):** Frequency Measure Flow Chart

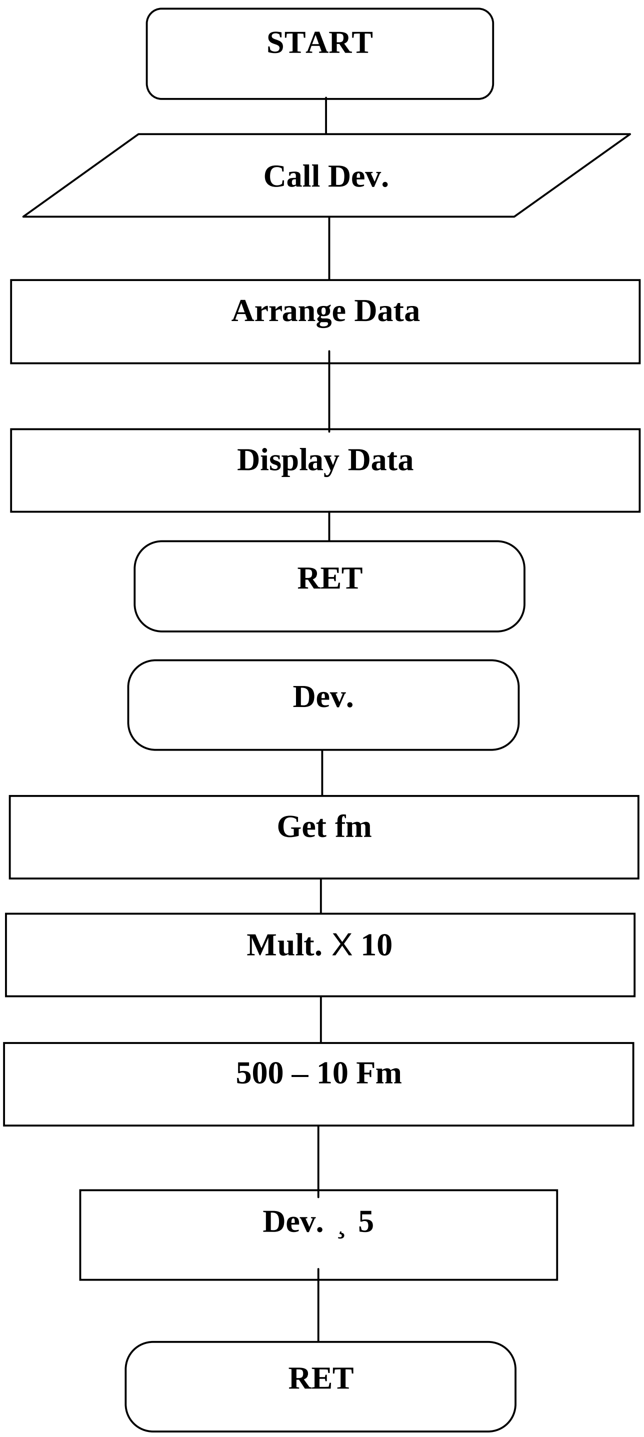


**Fig. (5):** Deviation Calculation Flow Chart

When a new positive edge comes, the timer begins to read one count for each 1μs, the measured frequency $f_m = \frac{1}{2T}$ , if the frequency measured is greater than 99, setting of (cy) will occur and return to its form state.

If no, the data will be arranged and then will be displayed. If (cy) equals zero the program continues to the next step displaying the frequency and then enters next subroutine [Call (Dev.- Calcu.)]. This routine compares the measured deviation DEV with desired value (Dev.-plus and/or Dev.-minus). If the measured deviation is positive, then the routine will enter the positive comparison subroutine. If the result of comparison is positive then turn on relay 1 and off relay 2, otherwise turn off both relays. If the measured deviation is negative, then the routine will enter negative coparison subroutine. If the result of the comparison is positive turn off both relays, otherwise turn on relay 2 and off relay 1.

## Conclusions

The scheme is simple, reliable and reasonably accurate, it is multipurpose instrument. It can be used as a frequency meter, deviation meter, and it is suitable to be operated at line voltage source and an external source (function generator).

The accuracy is higher than the previous type, because of that the previous types contain many hardware parts, each part has a percentage error and the summation of these errors will impair the accuracy of the instrument, when all of these parts are replaced by the one unit (Micro– Controller) the accuracy becomes higher.

Another very important advantage of using micro-controller is the possibility of changing the store program with not adding more parts to the instruments, which is impossible in the previous types. Also operating of auxiliary circuits is possible in case of occurring positive or negative deviation by means of the two relays (relay no.1 and relay no.2), by connecting an alarm or lighting circuit with the relays.

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