# Frequency Trend Meter

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***Abstract*— FTM is an advanced instrument, which is designed to measure the line frequency (F) and rate of change of line frequency (dF/dT) cycle by cycle. This helps the utility to take remedial action and to know the exact rate of change of frequency during tripping, and also during islanding condition on line and thereby protecting the whole network system from damage. This instrument is designed on the digital bases. This present instrument is designed by using an Intel microcontroller. The Frequency Trend Meter is provided with the software package designed in Visual Basics. Frequency tend meter (FTM) can be interfaced to any PC (dedicated to FTM) for continuous uploading of data. No such Frequency Trend Meter is available in India or abroad for measurement of frequency and rate of change of frequency. The device has further features such as higher sensitivity, resolution and is reliable and economical.**

**Keywords: -** ***Frequency meter, Frequency and df/dt meter***

## I. INTRODUCTION

Frequency Variation: A frequency variation involves a change in frequency of more than 3Hz from the normally stable utility frequency of 50Hz. This may be caused by erratic operation of emergency generators or unstable frequency power sources. The other reason for the frequency variation is the change in the load connected with the power system. For sensitive electronic equipment, the result can be data corruption, hard drive crash, keyboard lockup and program failure. Also it will affect the performance of the synchronous motor and also the induction motor if slip is taken into account. The variation in the frequency can be controlled if the proper step is taken and for that continuous monitoring of frequency is required.

### *A. Frequency Trend Meter*

Frequency Trend Meter is an instrument, which is designed to measure the line frequency (F) and rate of change of line frequency (dF/dT). This helps the utility to take remedial action. This instrument is designed by using state of art technology i.e. digital technology. This instrument is designed on the digital bases. With the ongoing development in the digital field, the digital equipments are replacing the analog one in each and every field. With more and more sophistication in the technology, the analog ones are becoming obsolete.

This is because the analog instruments have their own limitations. This present instrument is designed by using an Intel microcontroller.

The FTM also gives buzzer signal and a special tag is given to the file when the frequency (F) or rate of change of frequency (dF/dT) has exceeded the set limit along with the LED indication.

### *B. PC Interfacing Software*

The Frequency Trend Meter is provided with the software package designed in Visual Basics. Frequency tend meter (FTM) can be interfaced to any PC (dedicated to FTM) for continuous uploading of data. This powerful software displays two windows one at a time. The frequency (F), the rate of change of frequency (dF/dT), Maximum Frequency and Minimum Frequency are displayed on "Display Window". Variation of Frequehncy and df/dt with time can be observed by switching to "Graph Window". The software also generates the Access Database named according to the current date and time. Two different databases are generated foe "normal frequency" and "abnormal frequency". Normal frequency means frequency lying within the range of 45Hz to 55Hz, frequency exceeding the range is counted as "Abnormal Frequency". Both the frequency (F) and rate of change of frequency (dF/dT) along with time is continuously stored in these files. Files can be opened in Microsoft Access or Excel format for graph plotting and analysis of data.

## II. PRINCIPLE INVOLVED IN THE INVENTION

The basic principle of the frequency trend meter is based on the zero crossing detectors. The zero crossing detectors convert a sine wave into a square wave. The rising and falling edge of this square wave. represents the zero crossing of input sine waveform. Either of these edges can be used to measure the time interval for one cycle. Here we are using falling edge of the square wave to measure the time interval between two zero crossing (that is equivalent to time period of one cycle). At one falling edge an internal timer of microcontroller (µc) is started whose resolution is 1 microsecond and at the next rising edge timer is stopped. Now this timer is having the time period of one cycle. This time is used to calculate the line frequency and rate of change of frequency. At the same time, the serial port of the Microcontroller is configured in such a manner that it sends the data to the remote PC cycle by cycle. The software at the remote PC stores the data in the file and if the data exceeds the limit then a separate file is automatically created by the PC and audio alarm is given to the user.

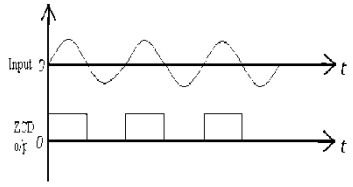



Fig1: Basic Principle of FTM.

## III. SYSTEM BLOCK DIAGRAM

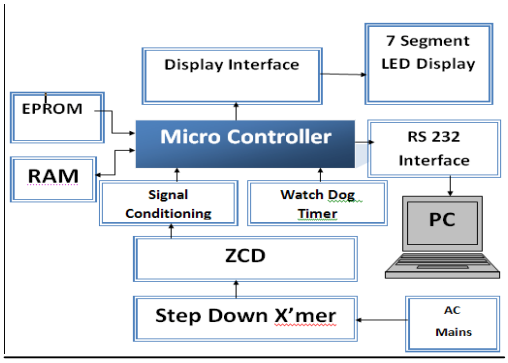



Fig. 2: System Block Diagram.

Microcontroller (8051): The micro-controller 8051 is the heart of the whole system. This is responsible for carrying out most of the activities in the system.

EPROM (M27c512): -EPROM which stands for Erasable Programmable Read Only Memory is used to store the system program.

RAM: - RAM, which stands for Random Access Memory, is used for data storage during the execution of the program.

Potential Transformer: This is used for step down the input voltage which can be 230/110-volt ac, so that it can be fed to zero crossing detector.

Zero-Crossing Detector(LM325): This is used to convert a sine wave into square wave so that it can be used by micro-controller for zero crossing detection of input sine wave. In Figure 6 we see a typical comparator used for zero crossing detection application. The output is a square wave, which is then sent to a circuit which makes the output unipolar. This will create a single pulse for each cycle. Again It is fed to band pass filter for signal conditioning.

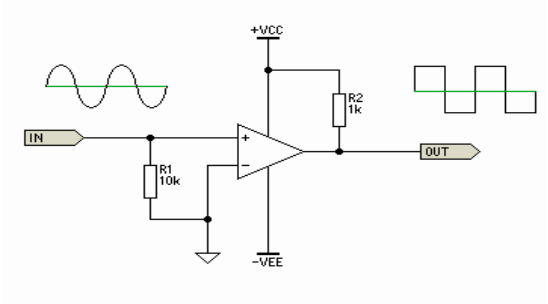



Fig. 3: Zero Crossing Detector

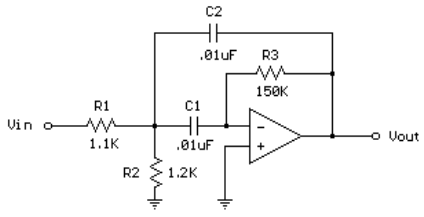



Fig. 4: Band Pass Filter

Signal Conditioning: - This block is used to make the output of zero-crossing detector compatible to micro- controller.A bandpass filter passes a range of frequencies while rejecting frequencies outside the upper and lower limits of the passband.

The range of frequencies to be passed is called the passband and extends from a point below the center frequency to a point above the center frequency where the output voltage falls about 70% of the output voltage at the center frequency. These two points are not equally spaced above and below the center frequency but will look equally spaced if plotted on a log graph. The percentage change from the lower point to the center will be the same as from the center to the upper, but not the absolute amount. This is similar to a musical keyboard where each key is separated from the next by the same percentage change in frequency, but not the absolute amount.

Watch Dog Timer: - Software stability is a major issue on any platform. Anyone who uses software has probably experienced problems that crash the computer or program in question. This is also true of embedded programs, and in most cases there is no user around to reset the computer when things go wrong. That job is occupied by the watchdog timer. The watchdog timer is a 16 bit counter that resets the processor when it rolls over to zero. The processor can reset the counter or turn it off, but, correctly used,

it will reset the processor in case of a code crash. To avoid getting reset, the program must reset the timer every so often. A program which has crashed will not do so, and the system will reset. To improve its efficacy, the watchdog timer register also requires a password. In order to change the lower part of the watchdog control register, the upper part of the register must be written with a specific value. This value is specified by the alias WDTPW in the MSP header files. This password reduces the likelihood that a random crashed instruction could prevent the reset.

Rs-232 Interface: - The RS-232 is a serial communication interface standard which is used to provide a reliable data transfer between two data communication equipments (here between FTM and PC). This is the link through which micro-controller send the data to PC.

Keyboard Display Interface (Tmp82c79): - This part of the system is used to interface the keyboard and display. This block is responsible displaying the frequency and rate of change of frequency on the seven-segment display.

Display(7 Seg): - For displaying frequency and rate of change of frequency we are using HP make 7- segment display.

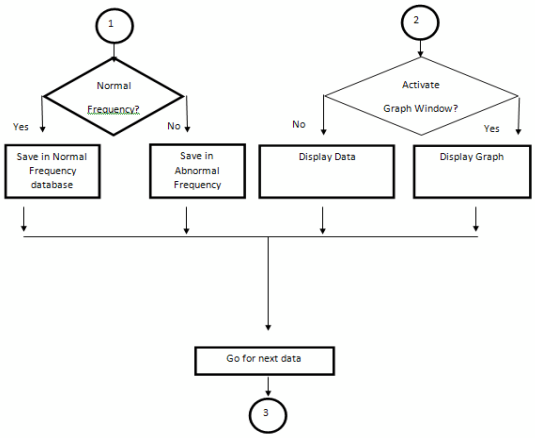
## IV. SOFTWARE

***A.*** 1. ***How exactly it counts***
Crystal Frequency = 11.0592 M hz
2. 1 Machine Cycles contains 12 t states
3. Time taken for timer to get incremented by 1 = 1.08507 µsec
4. For the frequency of 50Hz timer count = 4801 Hex

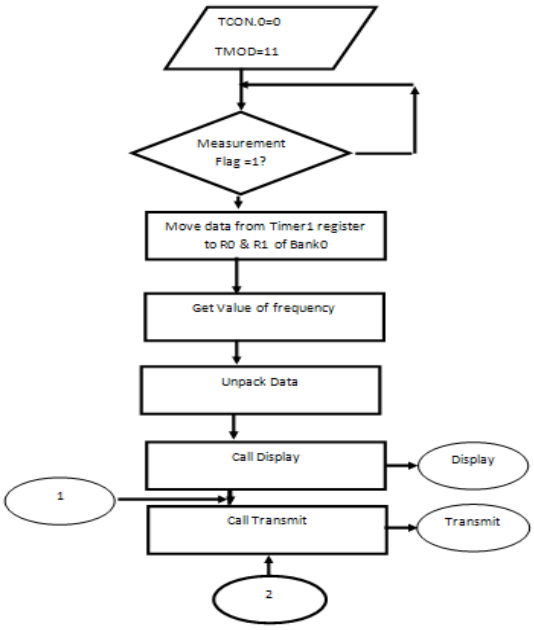
From above data it easy to understand how does microcontroller counts frequency.

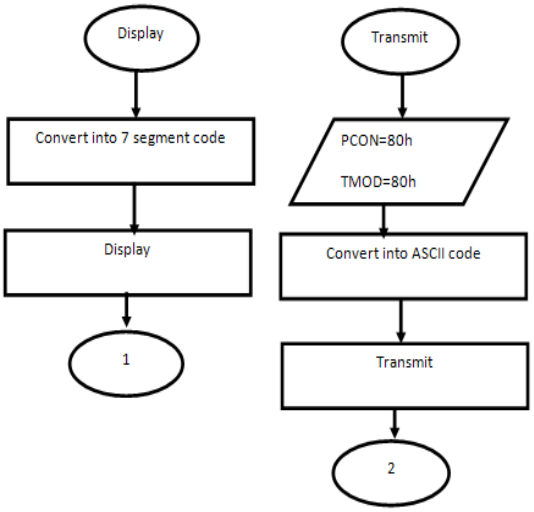
| Frequency | Timer Count Decimal | Hex | Frequency Displayed | |
|---|---|---|---|---|
| 55 | 16757.436112 | 4172 | 55 | 0.00 |
| 54.999 | 16757.740798 | 4172 | 55 | 0.00 |
| 54.998 | 16757.603687 | 4172 | 55 | 0.00 |
| 54.997 | 16758.525346 | 4173 | 55 | 0.00 |
| 54.996 | 16758.525346 | 4173 | 55 | 0.00 |
| 54.995 | 16758.525346 | 4173 | 55 | 0.00 |
| 54.994 | 16759.447005 | 4174 | 54 | 0.99 |
| 54.993 | 16759.447005 | 4174 | 54 | 0.99 |
| 54.992 | 16759.447005 | 4174 | 54 | 0.99 |
| 54.991 | 16760.368664 | 4175 | 54 | 0.99 |
| 54.99 | 16760.368664 | 4175 | 54 | 0.99 |
| 54.989 | 16760.368664 | 4175 | 54 | 0.99 |
| 54.988 | 16761.290323 | 4176 | 54 | 0.99 |

### *B. PC Interfacing Programme Flowchart*




### *C. Controller Programme Flowchart*




## V. EXPERIMENTAL

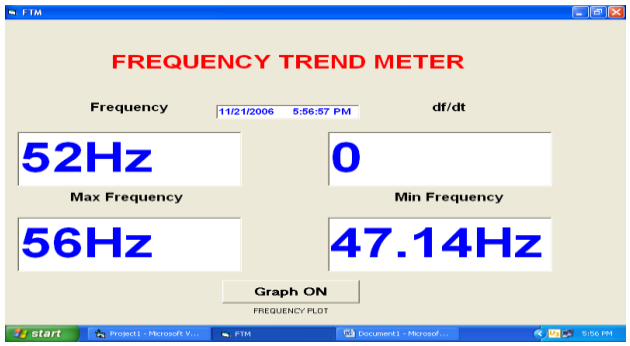
The input signal whose frequency is to be measured is first stepped down through a potential transformer (PT). The input to the PT can be system voltage of 230/110-volt. The output of the potential transformer is fed to a zero crossing detector. The output of the zero crossing detector is conditioned so that it can be fed to the micro-controller's interrupt pin. Micro- controller measures the time interval between two falling edge of input at the interrupt pin. After finding this time interval micro-controller do the necessary calculation for finding frequency and rate of change of frequency. After calculating the Frequency and dF/dT micro-controller display the F and dF/dT on the seven-segment display. The unit can be operated in either of two mode remote or local. In local mode micro-controller will save the data into system RAM. In local mode when dF/dT exceed the set limit system will stop sampling the input signal and wait for the user to upload the data into PC. At this point either user can upload the logged data from the circular buffer to PC or restart the system for subsequent reading. In the remote mode FTM will calculate and display the F and dF/dT and also send to PC through serial communication interface. Now PC will store this data into its own memory from where it can be used for analysis purpose. The detail operation of the system will be clear from the operating instruction given in the following section of the report.

## VI. RESULT

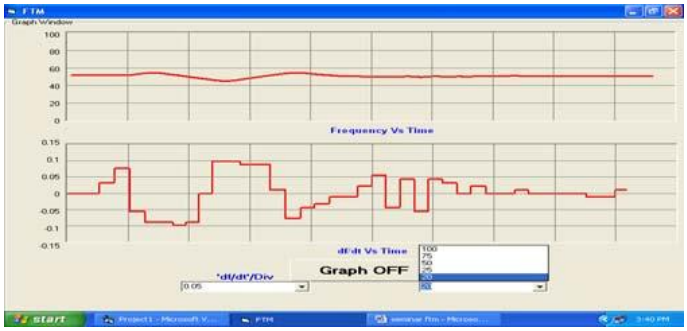
### *A. Display on FTM*


### *B. On Computer*

*Main Display Window*

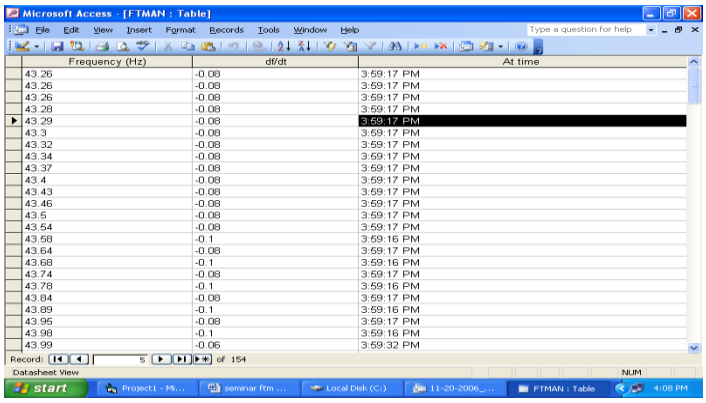



### *C. Graph Window*




### *D. Generated File*






## VII. CONCLUSION

Now a days the quality of the available energy is the major factor in case of power system. Power quality covers quality of energy without any interrupion. As we have already seen that the frequency is the major parameter of the power quality. It decides the loading condition of the grid as well as it affects the performance of various equipment. It is always desirable to maintain the frequency of normal value rated value that is 50Hz. To take the corrective action against the frequency variation or rate of change of frequency variation s they need to be measured very correctly and fastly. Frequency trend meter is only the instrument to measure the frequency and the rate of change of frequency in the whole world. It measurs the data cycle by cycle with the resolution of three digits after decimal points

Advantages over other alternatives:

- This is the only instrument available all over world for measuring dF/dT.
- Measurement is cycle by cycle
- Resolution up to 3 digits after point
- Eight 7-segment displays for displaying Frequency (F) and rate of change of frequency (dF/dT)
- Multi-level LED indication for dF/dT. In case dF/dT exceeds the set(s) value it will provide a LED indication
- A RS-232 port, which can be used to upload data from FTM to PC
- Software displays frequency, rate of change of frequency, minimum frequency and maximum frequency as well as graph of frequency and rate of change of frequency with time
- Software generates two different access databases for normal and abnormal frequency

## REFERENCES

[1] Muhammad ali mazidi, Janice gillispie Mazidi, "The 8051 Microcontroller and Embedded Systems", second edition.

## BIO-DATA OF AUTHOR(S)

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