

NUMERIC FREQUENCY METER WITH PLC

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Abstract In this paper is presented a numeric frequency meter that is realized with faze fittings circuit (βE 565). The realized frequency meter is destined to control the network frequency around the frequency of 50Hz.

To display the value of the frequency two display devices with a common cathode VQE23F are used. Each display device contains two seven segments display cells. Frequency's from 40 to 60 Hz can be measured which can then be displayed with two decimals.

Keywords: oscillator ,PLC

1. THEORETICAL CONSIDERATIONS

1.1. Frequency measurement methods

After the principle they work with, frequency measurement methods and apparatus are analogical or numerical. After the followed precision, the methods used to measure frequencies can be grouped in three large categories. Analogical methods are part of the first category, in which a 2% precision order is obtained. Digital methods are part of the second category, in which a much better precision, up to 10^{-12} , can be realized. Finally, the third category consists of great precision methods with a precision order of up to 10^{-14} . These precision orders are currently used in laboratories specialized in generating and precise frequency measurement, as is the National Institute of Metrology.

Digital methods are based on measuring the number of N cycles of the studied phenomenon, in a time interval T_e : the frequency is

$$f = \frac{N}{T_e} \quad (1)$$

Analogical methods are based on the comparison of the unknown frequency with known elements: impedances or frequencies.

1.2. Numeric Frequency meters

Numeric frequency meters are of several types: after the measured value: medium, instantaneous or nominal frequency. Their scheme consists of a number of specific elements interconnected which would allow frequencies as well as periods to be measured. These elements are: pilot oscillator – also named reference oscillator; time base – a circuit which is similar to the cathodic oscillator: it is made out of a series of frequency dividers, which can create a series of frequency guide marks with a known value starting from the known value of the pilot oscillator; forming circuit: circuits which generate normalized impulses, which are easier to count, starting fro arbitrary shaped signals; gate – SI circuit; bring back to zero circuit for counting initialization; display.

The pilot oscillator is generally a quartz oscillator with a small drift and a small instantaneous frequency fluctuation. Work frequencies are generally of 1 or 5 MHz. From these, guide mark frequencies with a period of 10 or 100 MHz are obtained.

The normalization circuit generally consists of an attenuator, followed by an element for tuning a limit value and an amplifier followed by a trigger. Once the trigger is set off by signals that exceed the limit, it produces a normalized impulse at the output.

1.2.1 Medium value frequency meters

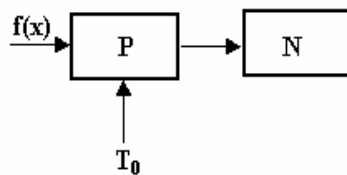


Fig. 1 The medium values frequency meter scheme

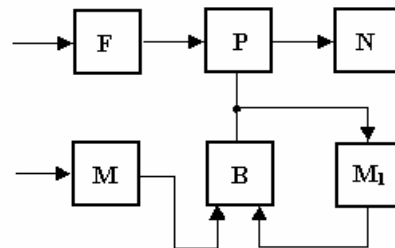


Fig. 2. Second scheme of medium values frequency meter

This apparatus category is based on the following principle: determining the number of N cycles in a given time interval T_0 . Because each cycle of unknown frequency signal lasts for

$$T_x = \frac{1}{f_x} \quad (2)$$

we have the equation:

$$N = \frac{T_0}{T_x} = T_0 f_x \quad (3)$$

The main scheme of such an apparatus is presented in fig. 1, where P is a gate, and N a counter. If we consider

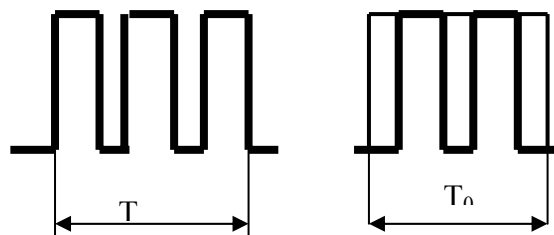


Fig. 3. Positioning of impulse T_0

$T_0 = 1s$, then N is exactly f_x ; for other values of T_0 the indication remains proportional with f_x .

Another scheme is presented in fig. 2. The signal arrives first at the F formatter circuit which transforms sinusoidal in impulses.

The gate P does not open unless a B bistable circuit passes in position 1, as a consequence of the command signal given at M_1 entrance; here a signal can be applied to a tact generator or it can be a manual command. The B bistable circuit output signal is applied at the input at of the M monostable, which stays in its new position a T_0 interval. After T_0 time the bistable switches to 0. As a consequence the gate closes so the number N records only the impulses that are in the T_0 interval.

Like any other system of this kind, errors may appear due to several causes. One easy to determine comes from the imprecision of witch T_0 is known.

Another cause for errors comes from the random character of placing impulses to be measured in comparison to the “window” of T_0 length. As shown in fig. 3 N or $N+1$ impulses may be recorded according to the position of the first impulse.

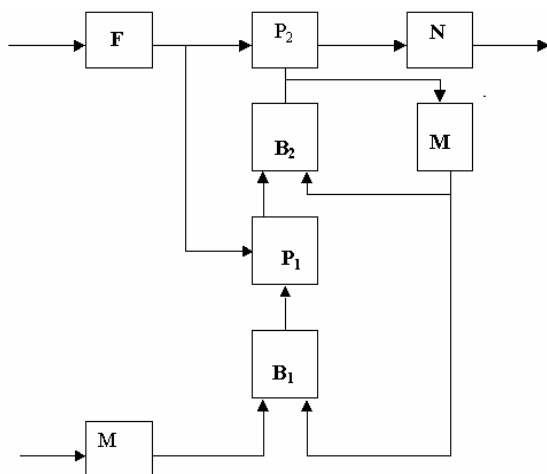


Fig. 4 The scheme that allow the eliminating of the errors determined by framing of T_0 impulse

To eliminate this cause of errors or to reduce it, a scheme in which the T_0 interval has a fix position regarding the first impulse can be used. Fig. 4.

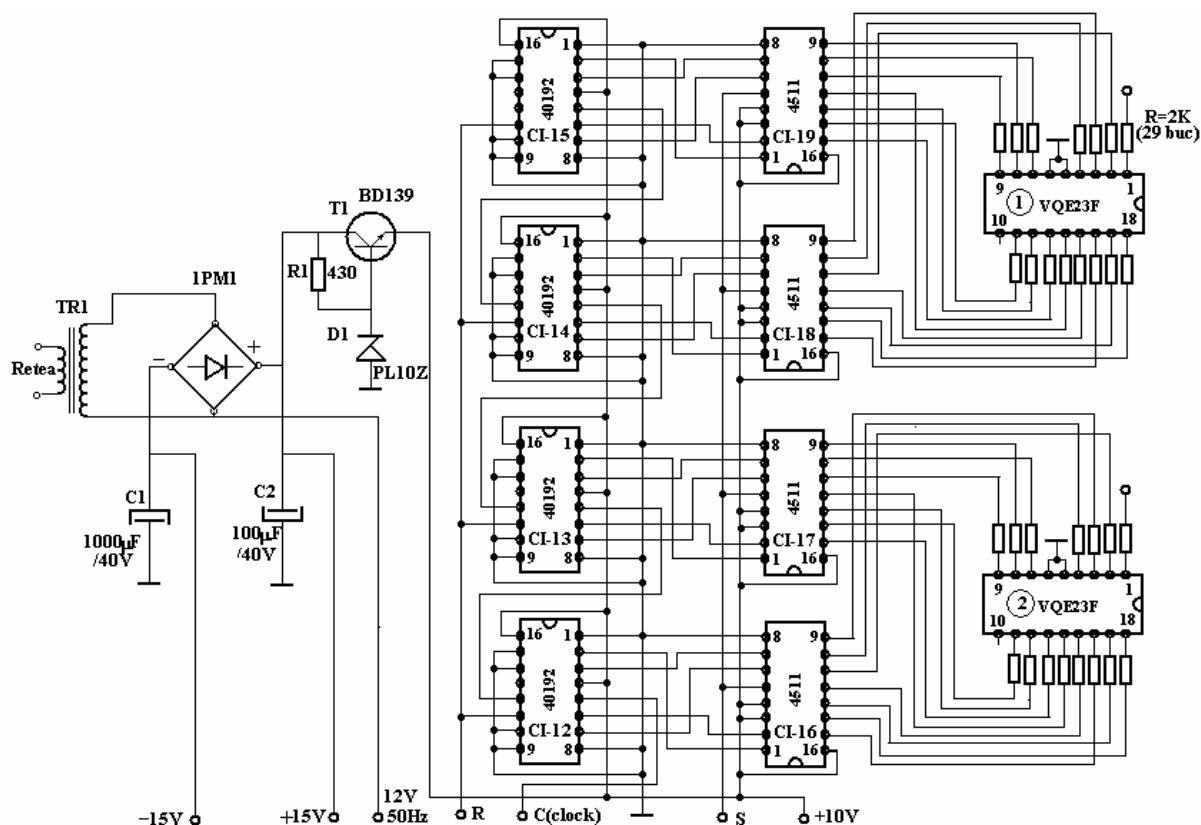


Fig.5. The displaying scheme

The given command makes the bistable B_1 to switch, which can potentially open gate P_1 . This is effectively open in the moment in which the first impulse arrives; as a result B_2 switches which opens gate P_2 and in the same time starts the time interval generator M .

This way the position of the first recorded impulse in comparison to the start of the T_0 interval is well recorded.

2. The description of a realized numeric frequency meter

Starting from the principle presented earlier a numeric frequency meter has been designed and built whose scheme is presented in figure 5 and 6.

The way it works is presented in the following.

The realized frequency meter is destined to control the network frequency around the frequency of 50MHz

To display the value of the frequency two display devices with a common cathode VQE23F are used. Each display device contains two seven segments display cells.

The first two numbers are used to display the integer part of the frequency value, and the other two numbers are used to display the fractions of Hz (tens and hundreds). The coma is obtained by charging the number one pin of the first display device. The frequency meter is charged at 220V, 50 Hz through a transformer noted TR1. Secondary to this a double 2x12v alternative current is obtained

With the help of a rectifier deck 1PM1 a double voltage $\pm 15\text{Vc.c.}$ is obtained which is filtered through the capacitor C2 of 1000mF/25V and C1 of 100mF/40V.

The double voltage is used to connect the circuit with fittings of $\beta\text{E } 565$ faze. To connect logic circuits and

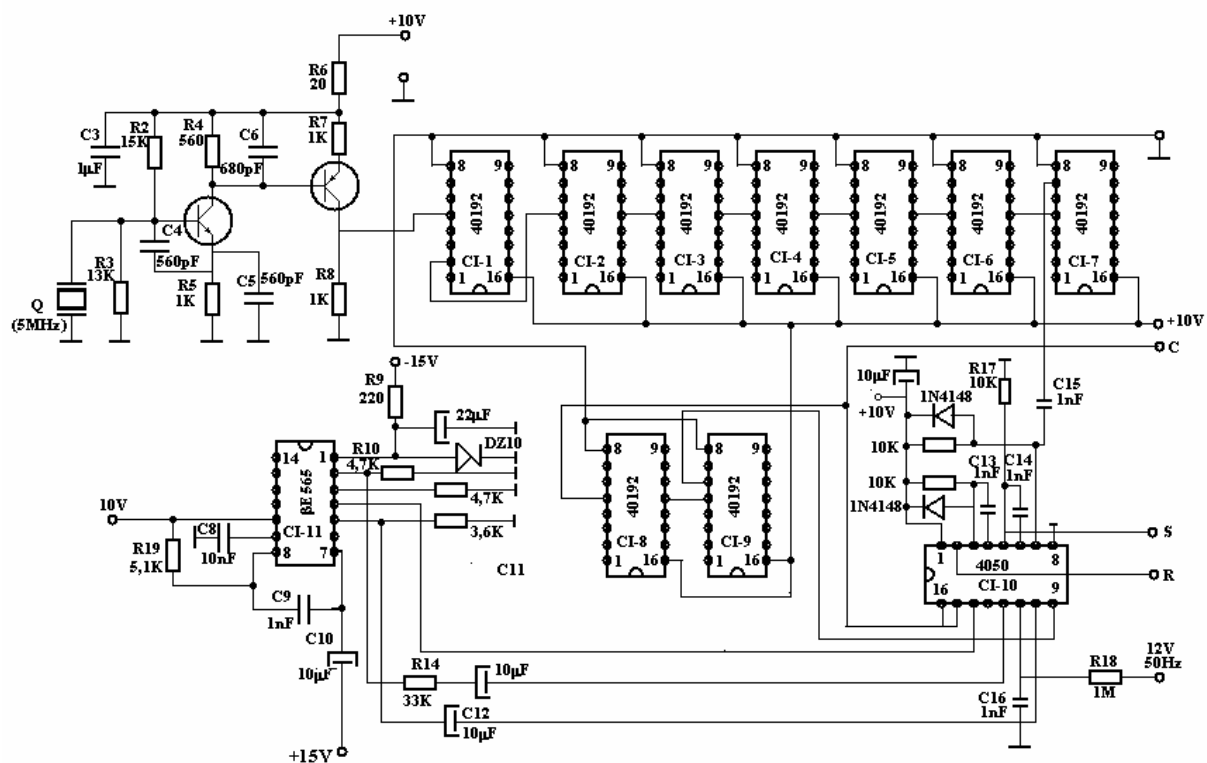


Fig. 6. The frequency meter scheme

display devices a $\pm 10\text{Vc.c.}$ is needed which is obtained from the $\pm 15\text{V c.c.}$ voltage with the help of the stabilizer made out of the T1(BD 139) transistor, Zenner PL 10z diode and R1 of 430ohm resistance.

The network frequency control signal is obtained from the second input transformer and has a value of 12 V c.a. with the network frequency (40-60Hz).

This signal is applied through the integrator R18 circuit, C16 at the buffers input CI-10 type MMC 4050.

Their output signal (pin12) is applied through the R14 network, C11 at input @ of the circuit with phase fittings ($\beta E 565$).

The voltage controlled oscillators (OCT) central frequency from the PLL circuit is stabilized with the help of the R19 resistance and the C8 and C9 capacitors to the $f_0=5$ KHz value.

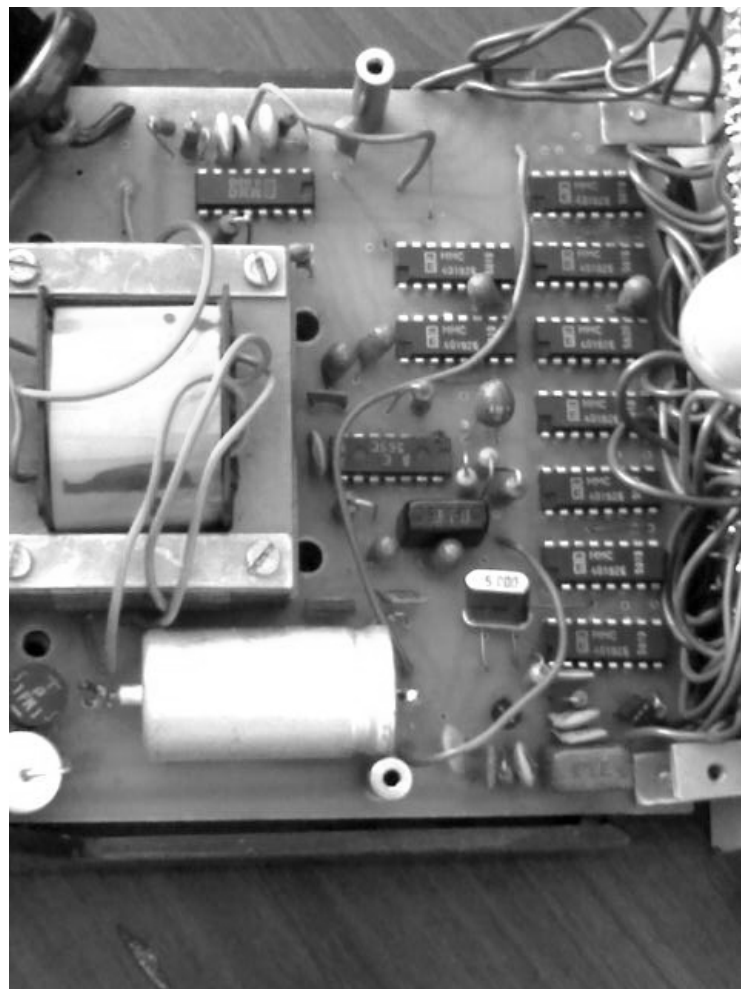
The oscillators output signal (pin 4 CI-11) will have a frequency in the 4-6 KHz domain, multiple of 100 of the network frequency (in the 40 and 60 Hz interval).

The measure signal is passed through the CI10 buffer (input 14, output 15) and is applied at the output of the CI8 decimal divider, where a signal of frequency between 400-600 Hz is obtained. To get a signal in the network frequency domain, the signal has to be divided again by 10 with the help of the CI-9 divider (input 5, output 6).

The signal we have obtained has a frequency in the 40-60 Hz domain. It is then passed through the CI10 buffer (input 9, output 10) and then applied through the C 12 capacitor at the reference input which detects the phase of the PLL circuit. This signal will be compared with the one from the network (secondary to the transformer) and will command the output in the 4-6 KHz domain until the two signals will be in phase (therefore they will have the same frequency).

Output 4 signal from the PLL circuit is passed through the CI-10 buffer (input 14, output 15) and becomes a clock signal to control the networks frequency. This signal is applied to the pre settable reversible BCD counter which is fitted with CI-12, CI-13, CI-14 and CI-15 circuits (MMC40192 type circuits).

With the help of the BCD decoding circuits – 7 segments(CI-16, CI-17, CI-18 and CI-19) the result is encrypted in the counter and then displayed with the VQE 21F display devices. Frequency will be displayed in the 4000-6000Hz but the position of lightened point at the first display will determine the display of a value in the 40,00-60,00Hz range.



In order to realize a stable display it is necessary to realize the set and reset signals, which assures that the measurement and display processes are replayed periodically. These signals are obtained from a signal generator which is realized with the help of the T2 transistor and 5 MHz Q quartz.

The oscillator output signal is transformed into a step signal with the help of a limit amplifier made with the T3 transistor, at whose output a 5 MHz frequency rectangle signal is obtained.

This signal is divided with the help of the CI-1...CI7 (MMC 40192) counters.

At output 7 of the CI-7 circuit, a 2Hz frequency signal is obtained, which is applied through C15, R15, D3 at output 7 of the CI-10 buffer. The output 6 of this circuit, a set signal (S) is obtain, which is necessary for the display circuits.

This signal is passed through the C14, R17 and C13, R16 and D4 derivation networks which creates a reset (R) signal at the buffers output number 2, which is necessary for the next CI-12...CI15 counters.

The positioning of electronic pieces is presented in figure 7.

Fig. 7. The positioning of electronic pieces

CONCLUSIONS

A apparatus for frequency measurement was realized that have a 4 digits display. This apparatus is destined to measure frequency from 40 to 60 Hz. The accuracy of frequency meter is better 0,5.

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