Electronic Water Flow Meter for a Centralized Computer Control Station

Ph.D. Emil Altimirsky, Ph.D. Ratcho Ivanov, M.Sc. Alexander Kerezov
Technical University, Sofia, Bulgaria.
e-mail: rmi@cait-gate.vmei.acad.bg

Nowadays the regional water supply systems are monitored by a centralized computer control stations, that are connected in local networks through wireless radio communications. A specialized microcomputer electronic water flow meter was developed that sends the data for the instant consumption and total flow passed to that stations. The first kind of data are send in 8 bit asynchronous serial interface while the second kind uses 16 bit synchronous serial interface according to the specifications of the computer control station. Four different time bases can be selected for the instant consumption. Moreover the result can be sent to the main computer as a linear function or as a nonlinear function with a constant error of approximately 1,5%. The device has its own battery back-up and the total power consumption in that mode is 150 μA.

Every device has two channels and can measure two different flows. Every channel can be configured with its own time base and transfer function. A self test for correct operation on every single channel is also included.

The existing computer control stations for monitoring the regional water supply systems are sending to the control room via wireless communication information about the current consumption of the motor of water pumps, the integrity of the system, etc. Unfortunately they are not able to give information about the instant and the total water flaw of every single pump because of the old mechanical water flaw meters mounted in those systems.

So there was a need for a specialized device to satisfy all the requirements of the existing equipment. The front end was the rotation of the disk of a mechanical water flaw meter and the output had to meet the existing transmission standards of the computer stations. It had also to be a low cost with low consumption, battery back-up and automatic self-test piece of equipment. Because of the very wide range of the rotation speed of the different mechanical water flaw meters the device had to have also the possibility for changing the measurement time-base for the instant water flaw. Only an 8-bit transmission protocol was available for sending the last data so a linear and a constant error transfer function had to be implemented.

The devise was created on the base of PIC16F84 single chip microcontroller. It has a RISC-like architecture, low cost, low-power mode and all the necessary data and

program memory on chip. Further cost reduction is achieved by implementing a two water flaw meters inputs on a single devise. The transmission lines are open collector outputs so more outputs can be connected to the same computer station input and time multiplexed without a need for additional logic. Two different inputs are provided for the instant and total flaw measurement results. The principal circuit of the device is shown in figure 1.

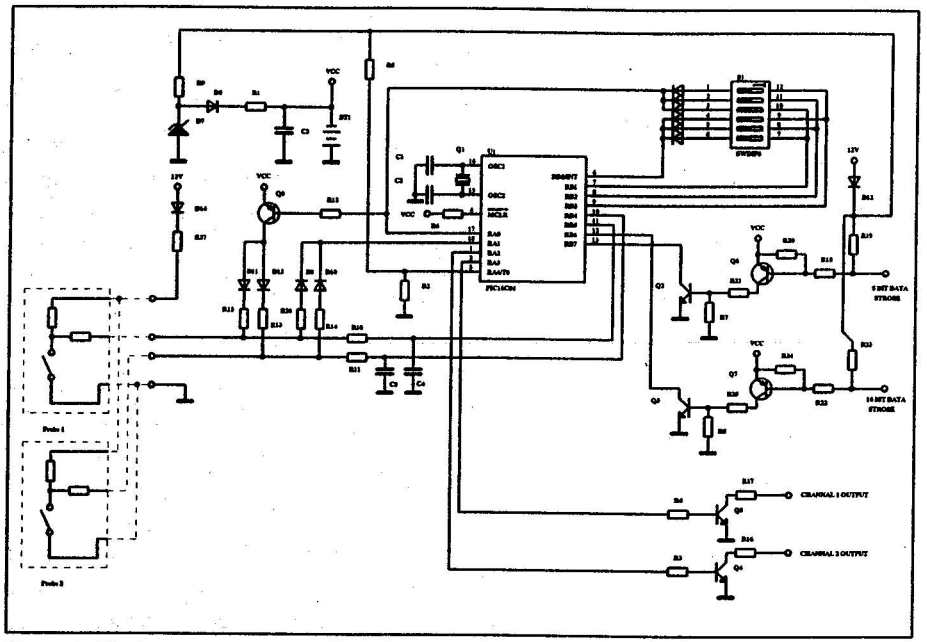

Figure 1. Electronic water flaw meter principal circuit

A special circuitry is included for automatic test of the probes. The both possibilities, short circuit or cable interruption, can be detected. A DIP-switch array gives the possibility to the operator to choose the instant flaw measuring timer base and transmission law according to the type of the mechanical measurement system mounted. Every channel has its own configuration switches completely independent of the other.

The program algorithm consists of a sequential part and interrupt-driven parts.

After the initial system configuration the program continues with a main loop, that includes calculation of the result for every channel according to the time base and the

low of transmission pre-selected. For a maximum instant flaw of 10 m^3/s the constant error transmission is done according to the formula:

1. For Q < 64 l/s - Q = 10 000 / T [l/s]
2. For Q > 64 l/s - $Q_i = 64 (65 / 64)^{\cdot 64}$ [l/s]

The real time implementation of the last expression is:

$$Q_i = Q_{i-1} + Q_{i-1} / 64$$

If the instant flaw timer is overflown the device is doing automatically a function test of the corresponding probe for short circuit or cable interruption. The both situations have different error codes, so the operator knows exactly the type of the problem. If the time elapsed from the last pulse of the probe goes above two times more then the last valid period the device sends another special code to the station so the operator is aware of every significant change in current water flaw.

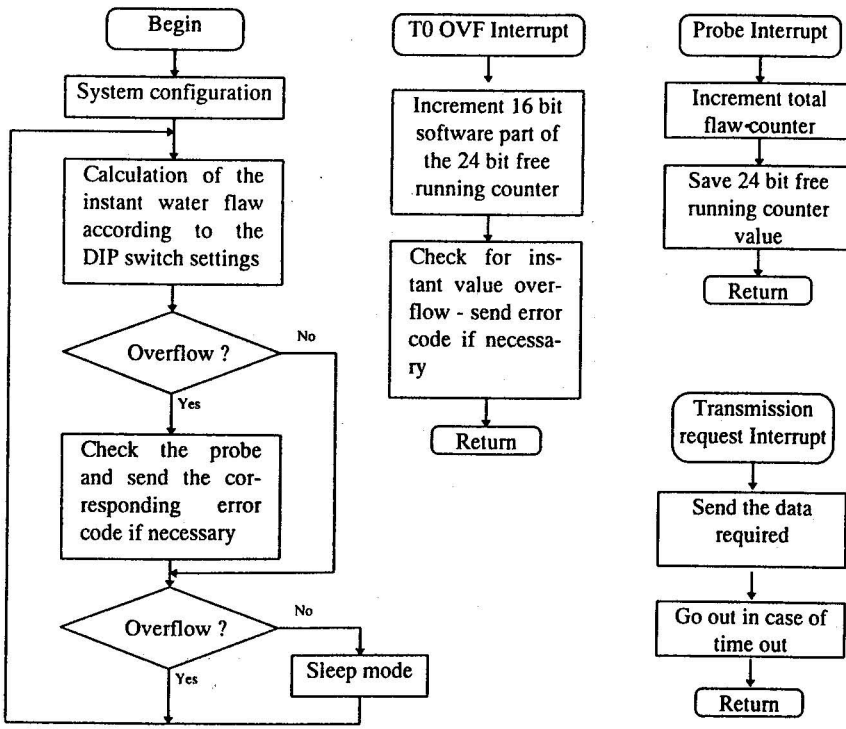

Figure 6. The program algorithm

In case the main station is switched off the device continues functioning on battery back up power supply. In that mode the microcontroller goes in sleep mode thus dramatically reducing its power consumption up to 150 μA. The instant water flaw measurement is not supported, only the total counters continue to increment on every probe pulse. After the normal power supply is returned a special error code "values still not valid after sleep" is send as a current flaw measurement result till two successive pulses are generated from the probe.

On every pulse from the probe an interrupt is generated that is able to "arouse" the microcontroller even in sleep mode. On that interrupt the total water flaw 16 bit counter is incremented and a value of the 24 bit free running counter is saved into the memory. The instant water flaw is calculated by subtracting from this value the value of the previous pulse free running counter value.

The 24 bit free running counter is created on the base of the 8 bit hardware timer T0 of the PIC16F84 and is extended in software with 16 more bits. On every timer overflow interrupt this additional 16 bit value is incremented and in case the current value matches the value memorized during the previous probe pulse interrupt an error code "instant flaw measurement timer overflow" is send to the calculation routine and therefore to the central computer.

The request for sending the result to the computer station generates another interrupt thus having also the possibility to "arouse" the microcontroller from sleep mode. The instant water flaw is transmitted in 8 bit asynchronous serial interface according to the specifications of the computer control station. The time delay is done in software because the only timer T0 in the system has another function. The total value transmission uses 16 bit synchronous serial interface according to the specifications of the computer control station. This protocol has also a "time out" feature that gives it the possibility to interrupt the transfer and return to normal operation in case of a problem in the synchronization clock line during the transmission. The flaw chart of the program is shown in figure 2.

The device designed has a very low price per channel and satisfies all the requirements of the centralized computer control station. The prototype pass successfully all the tests.