ULTRASOUND LEVEL MEASUREMENT SYSTEM

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ABSTRACT:
The automatic method for controlling the segregation level of two environments with the help of the ultrasounds is based on the spreading of the sound impulses inside any liquid that could be measured. The level measurement device it actually refers to some acoustic items that establish the distance from one side of the device to the levels' limit of segregation.

KEYWORDS: level, ultrasound, measurement, device

1. INTRODUCTION

The automatic process of the technological processes, especially of the elaborating processes, could not be accomplished without continuously measuring the main parameters: temperature, pressure, and level, at least one of them – in order to fulfill a correct production.

This simple method is very secure, but it has one flaw: the levelling instrument could be used only in case of a particular density of the liquid. The electrical methods used for measuring the level is based on different features – conductivity, capacitive features, electric-magnetic etc. - of all substances contained by the bunkers or tanks. In order to choose a method and a type of device one should refer to the characteristics of the material and to the production environment, the shape of the reservoir and the type of the measurement we use.

In case of technical use of ultrasounds, a number of devices use the same features for measuring the level of the liquid inside the reservoirs and bunkers.

2. PHYSICAL SCHEME AND SYSTEM OPERATION

The circuit IC3 is a decade numerator (MMC40192), who works according to the next process: we use logic "1" from the switch S1 (when the device is turned on) to the Reset entry (pin 14), which forces QA, QB, QC and QD outputs to switch to logic "0" (for the device we have used only QA output). From the QA output - to the LOAD input (pin 11) who uses information from the numerator J0J1J2J3 inputs (in our case, their weight is logic "0000"; and those impulses produced by the oscillator made up by the gates P2P3P4 are accepted at the CARRY input (forward only). Step 0 of the S2 numerator is open and S1 is closed, (S1, S2 are switches, and due to a MMC4066 circuit we have used only two switches out of four; four is the number of the switches inside a circuit). Step 1 - S2 is closed and S1 is open and so is (QA=1) - LOAD input is set to logic "1" and it blocks off the inputs so that it should not receive any time impulses form the P2P3P4 oscillator. Step 0 – the ultrasound sequence of impulses produced by the IC1 oscillator go through S1 (closed) and reach the piezo-electric translator that emits an ultra-resounding sound of 48kHz. Step 1 - S2 is closed and it allows the S signal – received by the translator - to go thorough to the operation amplifier IC6. When we amplify the signal we can also regulate it from the P1 potentiometer, so that the A node reaches 5V. The S impulse at the output of the IC3 operational amplifier is segregated as such: it is replaced by P5 in order to change the value of the output of the gate P8 from logic "0" to logic "1", in order to stop the numbering process made up by the IC4, IC5 and IC6 circuits, who are connected in a "cascade" sequence; on the other side, the impulse is made up at the setting of the circuits IC7 and IC8 in order to receive the information from the input, made up by the numerators (IC4, IC5 and IC6), and to take it to the output in order to be decoded (with BCD: IC9, IC10 and IC11). The IC7 and IC8 circuits are also registers – they record the informationat from the output, until another setting impulse is produced (logic "1"). Step 0 - the state of the logic "0" at the QA output of the IC2 is also reaching the gates (P3 P4) and it also changes the value of the P9 output from logic "1" (initial) to logic "0" – thus, the counting process is started; when the translator starts sending an ultrasonic sign, the counting process starts, too; it stops when it receives the S impulse, sent by the translator. When we count the impulses produced by the P6P7P8 oscillator, who proceed the S impulse and establish the distance between the translator and the surface of the liquid.
Specialists have proposed the speed of the ultrasonor sound should be 340 m/s and they have calculated that the sound travels through 1 m in 2.9 ms.

$$t = \frac{d}{v} = \frac{1}{340} = 2.9\text{ms}$$

We have supposed that the surface of the liquid is 1 m away from the translator. We should multiply 2.9 ms by 2, because the time that the sound needs to travel through is double – from the translator to the surface of the liquid and back to the translator. Throughout the 5.8 ms - when the emission started and when we have received the first impulses - the oscillator should have transmitted 100 impulses to the numerators (IC₄, IC₅ IC₆). If we count them, they reach exactly 100 cm. The time we need for the impulse to be produced by the oscillator (P₆, P₇ și P₈) is the following:

$$T = \frac{5.8}{100} = 0.058\text{ms}$$

$$f_{osc.} = \frac{1}{0.058} \approx 17.2\text{kHz}$$

The oscillator is equipped with a potentiometer in order to regulate the frequency, so that it should send 100 impulses from the beginning of the emission to the moment the oscillator begins to receive the signals.

3. THE COMPONENTS OF THE SISTEM

The BCD decoder has 7 segments. The 7 segment-board is provided with lights or LSD.

Each light lights up if the input of the positive electrode receives a logic „1“ (5V). There is also a common positive electrode and each light is connected to Vcc, and the control is set up to logic „0“.

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  a
 /  \
f|g|b
 /  \
|e|d|c|
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D
C
B
A

BCD

E

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The decoders for the LCD boards are similar. The synchronous numerators CDB74190 and CDB74191. Features:
- there are 4-bits synchronous memory;
- active inputs – positive; active ENABLE to logic “0”;
- data inputs I₀…I₃ – controlled by LOAD;
- control input of the counting module CVD \( \frac{CV}{\text{UP}} \) = 1 \( \Rightarrow \) UP
  \( \frac{CV}{\text{DOWN}} \) = 0 \( \Rightarrow \) DOWN.
- output MAX/MIN=1

The cascade” sequence has another output - RIPPLE COUNT ENABLE (RCE), who reaches „0” when MAX/MIN=1  și \( \overline{E} = 0 \). RCE is produced in case of a positive value, when it goes from 9 to 0, in case of the the decade numerator, or 15 to 0 in case of the binary numerator. The I₀…I₃ inputs allow us to introduce the binary combinations where the counting starts.

The parallel register:
No matter when the information reaches the I₀…I₃ inputs, it is sent to the output in the same time, in case of a negative value CLK at Q₀…Q₃ outputs.

\( \overline{ID₁} \) and \( \overline{ID₀} \) allow us to switch according to the inputs. If we consider the data we receive from „IN” in order to send them to „OUT”, when \( \overline{ID₁} = \overline{ID₀} = 0 \). \( \overline{OD₁} \) and \( \overline{OD₀} \) could establish the exchange of information of the outputs when they reach High Z and one of them reaches „1”.

4. CONCLUSIONS
We have calculated the period of small emission reaches 5,8 ms – similar to 1 ms. The mounting does not measure the level of the liquid, but the empty space inside the tank: \( 0,2 \div 9,99 \) m. In order to measure the level of the liquid, the numerators mounted in a “cascade” sequence are connected so that they should count backwards – the impulses send by the oscillator (P₆P₇P₈) should reach the 4 IC₄ pin (DOWN) from the output BORROW, the 12 pine to 4 IC₅ pin, and the output of the 12 pin to 4 IC₆ pin.

REFERENCES