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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 fulfil 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 IC_3 is a decade numerator (MMC40192), who works according to the next process: we use logic „1" from the switch S_1 (when the device is turned on) to the Reset entry (pin 14), which forces Q_A, Q_B, Q_C and Q_D outputs to switch to logic „0" (for the device we have used only Q_A output). From the Q_A output - to the LOAD input (pin 11) who uses information from the numerator $J_0J_1J_2J_3$ inputs (in our case, their weight is logic „0000"; and those impulses produced by the oscillator made up by the gates $P_2P_3P_4$ are accepted at the CARRY input (forward only).Step 0 of the S_2 numerator is open and S_1 is closed, (S_1, S_2 are swith, and due to a MMC4066 circuit we have used only two swith out of four; four is the number of the swith inside a circuit). Step 1 - S_2 is closed and S_1 is open and so is (Q_A=1) - LOAD input is set to logic „1" and it blocks off the inputs so that it should not receive any time impuses form the $P_2P_3P_4$ oscillator. Step 0 – the ultrasound sequence of impuses produced by the IC_1 oscillator go through S_1 (closed) and reach the piezo-electric translator that emits an ultra-resounding sound of 48kHz. Step 1 - S_2 is closed and it allows the S signal – received by the translator - to go thorugh to the operation amplyfier IC_2. When we amplify the signal we can also regulate it from the P_1 potentiometer, so that the A node reaches 5V. The S impulse at the output of the IC_3 operational amplyfier is segregated as such: it is replaced by P_5 in order to change the value of the output of the gate P_{10} from logic „0" to logic „1", in order to stop the numbering process made up by the IC_4, IC_5 and IC_6 circuits, who are connected in a „cascade" sequence; on the other side, the impulse is made up at the setting of the circuits IC_7 and IC_8 in order to receive the information from the input, made up by the numerators (IC_4, IC_5 and IC_6), and to take it to the output in order to be decoded (with BCD: IC_9, IC_{10} and IC_{11}). The IC_7 and IC_8 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 Q_A output of the IC_3 is also reaching the gates (P_3 P_4) and it also changes the value of the P_{10} output from logic „1" (innitial) 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 $P_6P_7P_8$ 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 340 m/s and they have calculated that the sound travels through 1 m in 2,9 ms.

$$t = \frac{d}{v} = \frac{1}{340} = 2{,}9ms$$

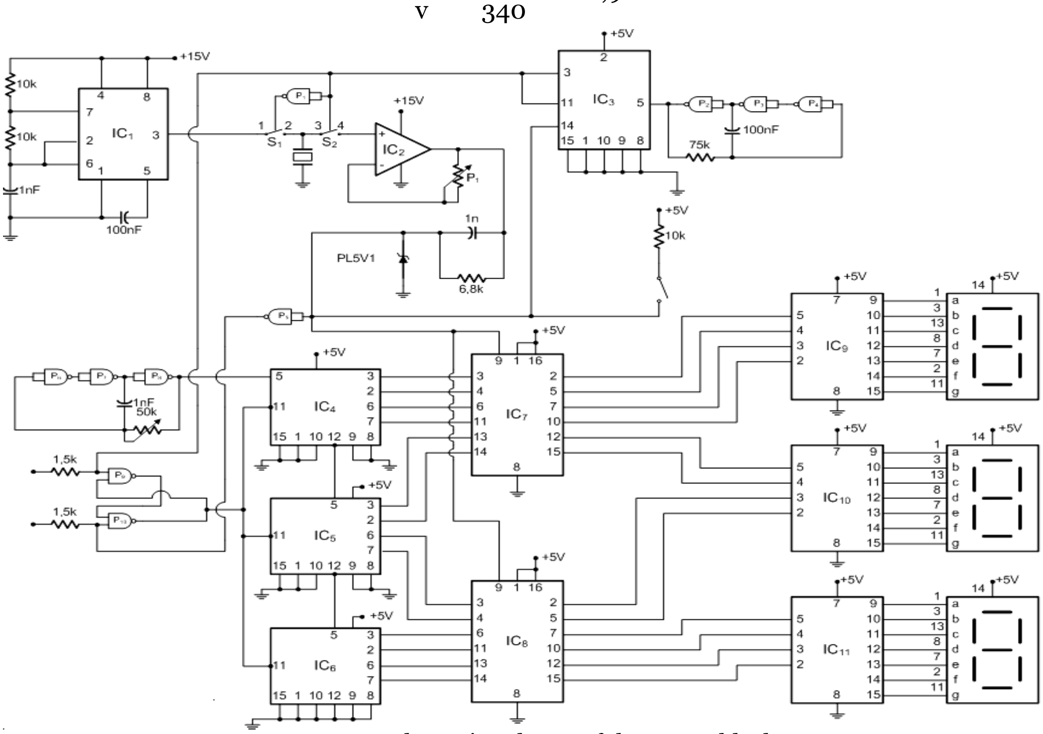


FIGURE 1. The main scheme of the report block

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 (IC_4, IC_5 IC_6). If we count them, they reach exactly 100 cm.The time we need for the impulse to be produced by the oscillator (P_6, P_7 şi P_8) is the following:

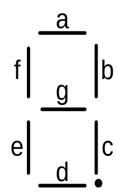
$$T = \frac{5{,}8}{100} = 0{,}058ms \text{ ;}$$

$$f_{osc.} = \frac{1}{0{,}58} \approx 17{,}2kHz$$

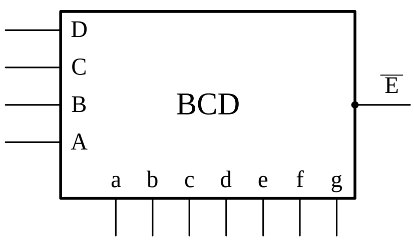
The oscillator is equiped with a potentiometre in order to regulate the frequency, so that it should send 100 impulses from the beginning of the emission to the moment the oscillator begins to receive the signals.

3. THE COMPONENTS OF THE SISTEM

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



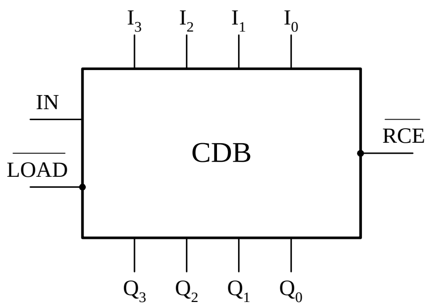
Each light lights up if the input of the positive electrode receives a logic „1“ (5V). There is also a common positive electrode and each light is connected to Vcc, and the control is set up to logic „0“.



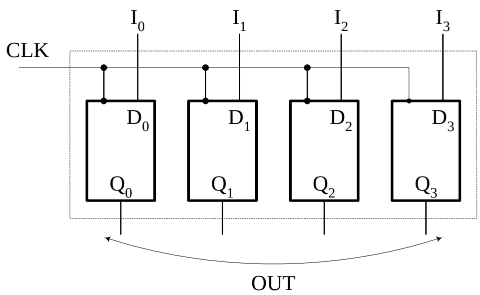
The decoders for the LCD boards are symilar.The synchrone numerators CDB74190 and CDB74191. Features:

D	C	B	A	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
:										
0	1	1	0	0	0	1	1	1	1	1
:										
1	0	0	1	1	1	1	0	0	1	1
1	0	1	0	0	0	0	0	0	0	0

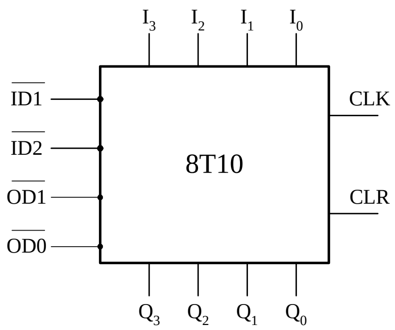
- there are 4-bits synchrone memory;
- active inputs – positive; active ENABLE to logic „0";
- data inputs $I_0 \ldots I_3$ – controlled by $\overline{LOAD}$;
- control input of the counting module $CV/\overline{CV}\begin{pmatrix} =1 \Rightarrow UP \\ =0 \Rightarrow DOWN \end{pmatrix}$.
- output MAX/MIN=1



The cascade" sequence has another output - RIPPLE COUNT ENABLE (RCE), who reaches „0" when MAX/MIN=1 şi $\overline{E}$=0. RCE is produced in case of a postive 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 $I_0 \ldots I_3$ inputs allow us to introduce the binary combinations where the counting starts.



The parallel register:
No matter when the information reaches the $I_0 \ldots I_3$ inputs, it is sent to the output
in the same time, in case of a negative value CLK at $Q_0 \ldots Q_3$ 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 – symillar to 1 ms. The mounting does not measure the level of the liquid, but the empty space inside the tank: 0,2÷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 ($P_6P_7P_8$) should reach the 4 IC_4 pin (DOWN) from the output BORROW, the 12 pine to 4 IC_5 pin, and the output of the 12 pin to 4 IC_6 pin.

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