Analog Displaying of Digital Quantities

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***Abstract*—Everyone looked at his traditional, dial face, watch and then asked what time it was, and then had to check his watch again to get a numeric value. The phenomenon is scaled with a simple, learned reflex, and instead of 13 hours 16 minutes our brains sense a quarter-two. What's more is how much time we have so far or how much time has passed.**
For some engineering applications and in everyday life, it is better to use an analog display. The advantage of this display is that with less effort, simple, learned reflexes allow one to determine value.
Not to mention that in such focused jobs - pilots, high-complexity industrial systems - analog display is also more appropriate based on the above considerations.

I. Introduction

We came to this article with some emotional consideration and respect for the old electronic instruments [3] [2]. There are many electronic devices in our environment that routinely display in digital-mode, LCD, LED, or any other seven-segment or decimal mode.
As a starting point, we have set the goal that these devices, as one hand they are usually manufactured in large series, are very cheap or other hand already work well as part of a system, so that we can achieve an analog display without modifying the device itself [10]. In this case, the analog display is performed with a conventional Deprez instrument [8] [9].
In order to accomplish the stated purpose, conventional digital instrument is equipped with special digital-to-analog (DAC) converters that can perform analog display without changing the original equipment (Fig. 1). Of course, it is necessary to make the right scale of instruments [16] [15].

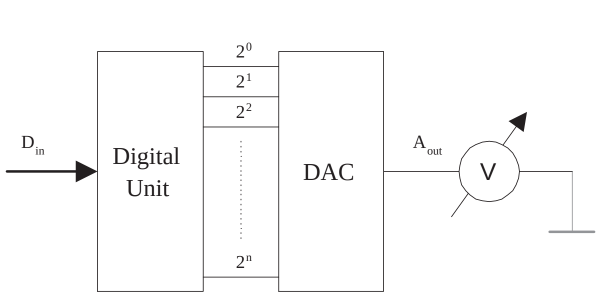

Fig. 1. Adapt Digital-Analog Converter to replace existing digital display, and connection of a Deprez instrument.

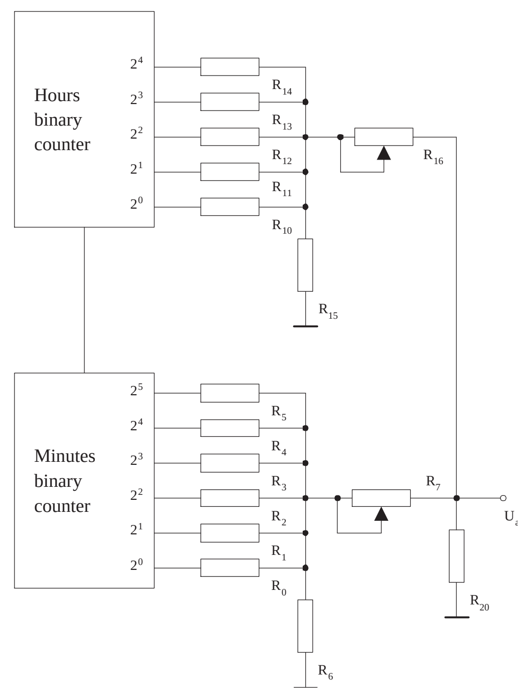

Fig. 2. Special application of the proposed procedure for one instrumented hour-minute display.

II. Theoretical Possibility of Conversion

In the conventional sense, the simplest solution is to use a summing-type analog-to-digital converter that matches the output of the existing equipment to a binary coded decimal

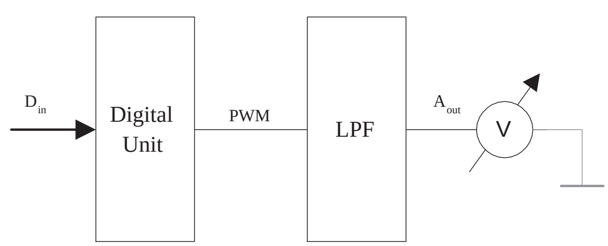

Fig. 3. Pulse width modulation (PWM) method as a digital-analog converter, and a low pass filter for fitting a Deprez instrument.

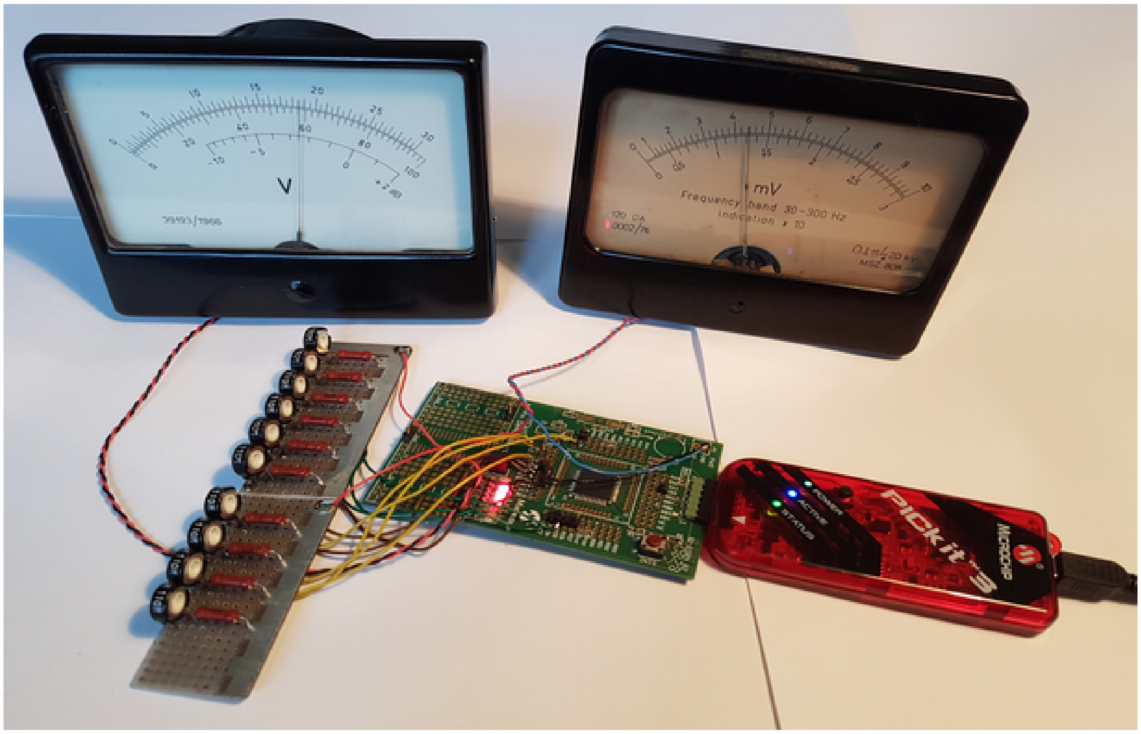

Fig. 4. Test environment for connection of microcontroller digital clock outputs with two analog instruments, by application of additive DAC. (6.27PM)

number (BCD) output (Fig. 1). The equation describing the digital to analog conversion is shown in each context. In this case, the resistances are halved from R_0 to R_n, respectively, according to the increasing binary weighting (1);

$$U_{out} = U_{oH}(2^0R_0 + 2^1R_1 + 2^2R_2 \ldots 2^nR_n); \qquad (1)$$

where U_{out} output voltage of DAC, U_{oH} is typical voltage binary digital output, and $R_0 = 2R_1$, $R_1 = 2R_2$, $R_2 = 2R_3$ $\ldots R_{n-1} = 2R_n$.

At the output of each converter, a device-matching resistor network is used, which fits the full scale of Deprez instrument. This method is the simplest, since it requires only the use of passive components, and as a result digital to analog conversion is possible.

Further considering the proposed procedure, a single instrument may be used for multiple-digit BCD displays. In this case, the numerical weighting is also solved by a resistor network (Fig. 2).

With the help of Pulse width modulation (PWM) we can also implement digital analog conversion using additional hardware. In this method, a microcontroller is connect to the output of an existing digital device (Fig. 3) and from binary information of this output, PWM signals carrying information in a duty cycle are generated [4] [6].

The average value of the PWM signals is performed with a low pass filter (LPF). Again, the filter output must be matched to the Deprez instrument input parameters (Fig. 5).

III. Practical Possibility of Conversion

Figure 4 shows a digital wristwatch with the output of hours and minutes in binary form, possibly with LEDs. The control electronics themselves are pennies, and this electronics requires only a three-volt power supply to operate. The Deprez instrument can be fitted to the output of this digital device using the additive resistive digital to analog converter described above [11].

Another example is shown in Fig. 4. Here we implemented a digital clock in a microcontroller environment (PIC 16F887), which displayed the hours and minutes on the parallel ports. The resistive digital to analog converter shown in Fig. 6 is attached to this port [1]. For example, potentiometers such as R_2, R_4, etc. were used. to adjust the weighted resistance values.

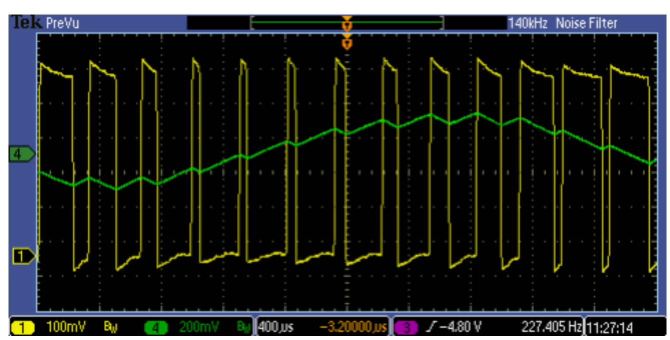

Fig. 5. Oscilloscope screen shot of Pulse width modulation (PWM) signal. (Yellow is PWM impulse and green is output of low-pass filter.) [5]

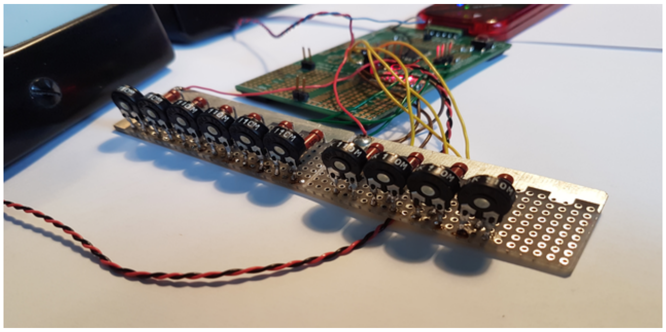

Fig. 6. Implementation of the breadboard model of additive ADC. The exact value of each resistor is adjusted using trimmer potentiometers.

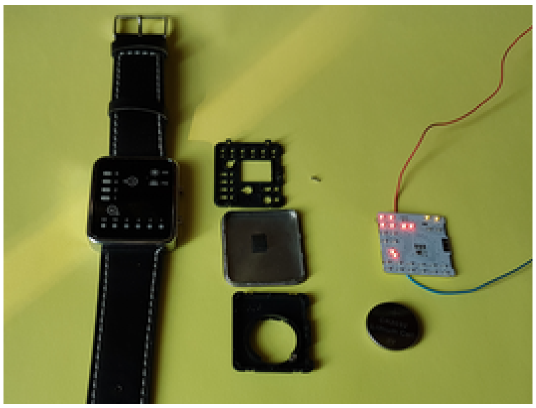

Fig. 7. Popular pillar watch with binary digital display.

A spectacular result can be achieved by converting a commercially available cheap binary digital watch (Fig. 7). To operate the control electronics, you only need one three-volt power supply. The hour and minute display LEDs are fitted as digital binary outputs to the additive digital to analog converter described above (Fig. 8). Of particular interest to the proposed solution is to continuously press one of the control buttons on the wristwatch for half a second to continuously see the time value [14]. To accomplish this, we use an astable multivibrator that performs the above operation in parallel with the switch by means of a tiny relay [1]. An additional result of this solution is that turning on the relay every second actually mimics the ticking of the clock.

IV. Conclusions

With regard to the proposed solution and the examples, we have seen that an analog instrument can simply be fitted to an existing digital display device that gives the observer some interpolation scaling result without the exact value. The stated objective thus avoids the risk of continuous calculations [13]. Another challenge is to find another low-cost, highly adaptable display that is easy to use in the context of existing, well-functioning devices.

It is important to find other options than Deprez instruments. The aim is also to investigate the applicability in the industrial environment [7] [12].

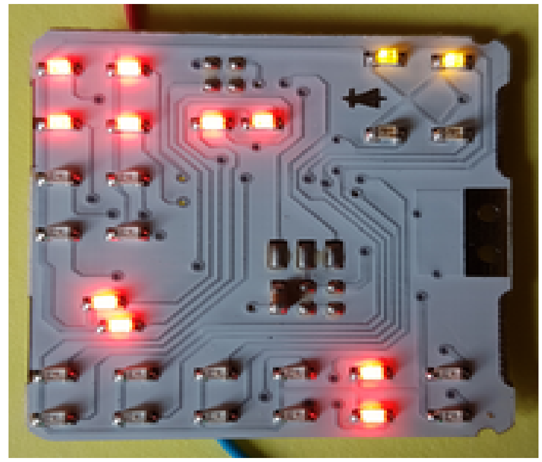

Fig. 8. Electronics of the watch. We make this display suitable for driving an analog instrument.

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