# USER COST CONTROL SOLUTIONS BASED ON DIALING MANAGEMENT FOR PHONE SYSTEMS

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***Abstract.*** *To control some phone services at the subscriber end, especially the money consumer ones, is a permanent challenge. The principles described in the article offer some solutions to deny or to selective lock some types of phone calls. The basic idea is to count the number of dialed digits or to detect first (or second) dialed digit. Digital frequency and period filters are use for that. In this manner the phone call could be stopped if the call number contains a greater number of digits than settled up or if the number contains a certain prefix. Both, pulse and tone dialing technologies were taken into consideration. The solutions could be implemented as microcontroller based systems too.*
***Keywords:*** *phone lines, tone/pulse systems, selectively calls lock, period filters*

## The Principle

The information from the present article is part from a larger design oriented on phone line management at the subscriber end [1].
In usual phone systems sometimes are necessary to limit or to stop some specific phones calls like long distance ones. The idea here developed is supposing that the stated limitations have to be implemented at the user line end by means of counting the number of dialed digits (A) or by detecting if the first dialed digit is zero (B).
(A) If only a defined number of digits could be dialed at the time, because the outgoing long distance calls needs more digits, it is possible to set up such a digit limit so that when an extra dialed digit arrive on the line the equipment will shortly induce a "on hook state", cancelling the initiated dialed process and going to a new "waiting for dial" state.
(B) An alternative solution is to detect the first dialed number. If needs are to stop phone calls starting with zero (usually long distance calls), identifying the first digit could help by disconnecting for a short period of time the phone line, phenomena being equivalent with "on hook" situation as before. This second solution needs attention on dialed zero inside the dialing stream to avoid confusions with first digit being zero. Supplementary sequential logical circuitry is needed for that.
Whatever the solution is the principle is described in figure 1 and basically consist in counting the number of dialed digits or detecting the first (or second) digit value. When stop condition is detected a short pulse is send to a relay whose contacts induce a line interruption

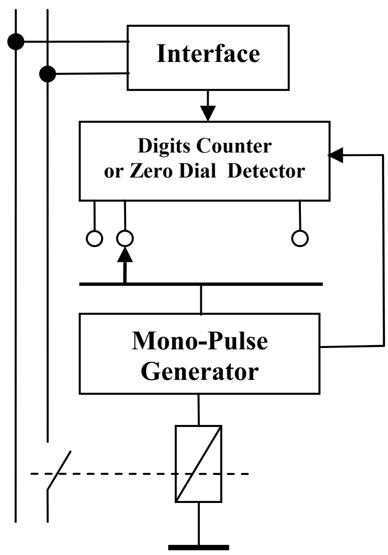


**Figure 1. The Principle**

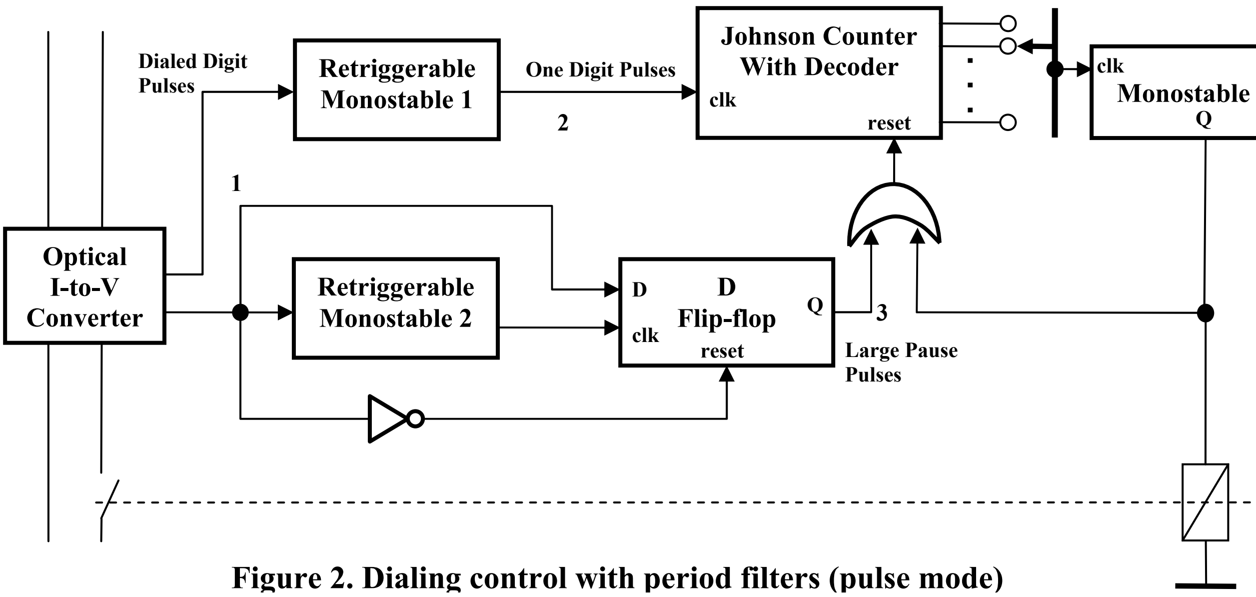


**Figure 2. Dialing control with period filters (pulse mode)**

detected as a short "off-hook" situation.

The phone line dialing system, tone or pulse, involve different implementations. If the phone system is DTMF type (TONE), than using a DTMF decoder at the interface level and a BCD-to-decimal decoder following it, will be enough as described further below. On PULSE phone systems detecting the dialed digits mean to manage the pulses and pauses coming from the line and extracting the sequences associated with dialed digits. These could be done with period filters built with timing circuits. Both solutions can also be directly implemented especially if a microcontroller is managing the interface. The article is focused on the solutions based on integrated digital logic.

**Period filters applied in PULSE dialing filtering**

Because of the particularities of the PULSE dialing phone systems the most efficient dialed digits management is possible with period filters as shown in figure 2. The principle consists in counting the number of digits by means of counting the pauses or by counting the number of pulses stream associated with each digit.

Knowing that the pulses stream has a number of pulses equal with the value of the dialed digit, because they are send with a frequency of 8-14 periods per second, it is necessary to use a retriggerable monostable having a maximum timing period greater than 125 ms:

$$T_{max}=1/max[fm, fM]=1/8=125ms \quad (1)$$

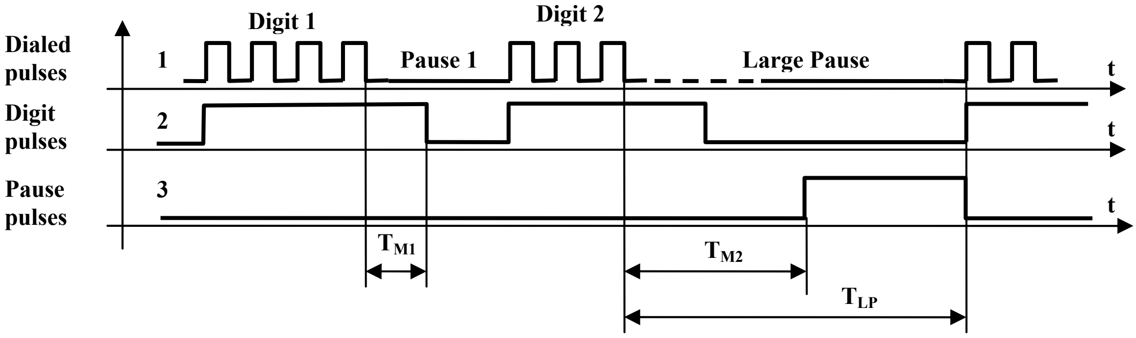


**Figure 3. Pulses diagram for period filters from figure 1**

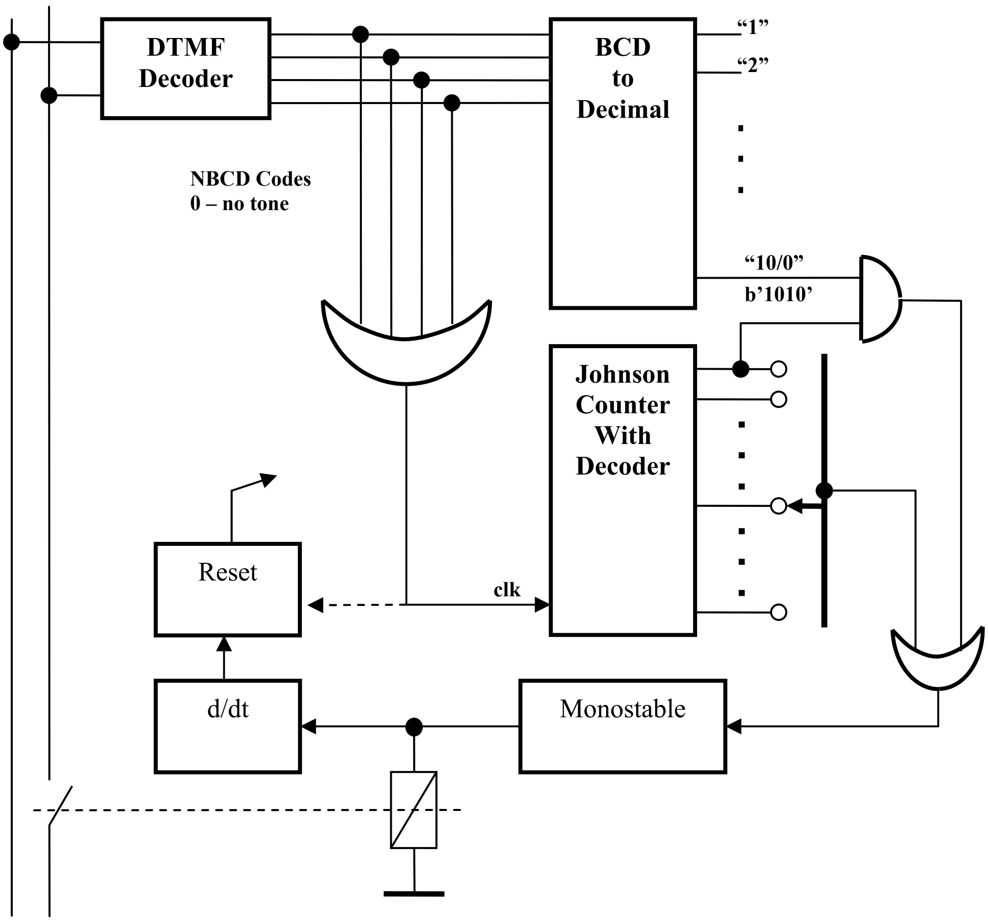


**Figure 4. Dialing control based on DTMF decoder**

A period filter with timing value of 150 ms will cover the filtering demands. The implementation means to use a monostable. The first input positive edge will trigger the monostable configured as a retriggerable one. It will go back to the initial state after the time delay, allowing the detection of a new pulse train. This way the monostable will generate one output pulse for each pulse train corresponding to one dialed number.

Having now one pulse for each dialed number a counter can be used to count how many digits are dialed. A Johnson counter with decoded outputs will activate one output from ten, one by one, synchronous with each active edge of the clock input. So, the "n"-th output will go on when the "n"-th digit will be dialed.

It is important to note that the timing period has to remain under 200ms to allow the pauses between pulses streams (figure 3 - pulse streams and timing values) to be detected and to assure this way the reset condition. Pause management is necessary in order to detect the situation when large pauses occur between dialed digits or the phone is off-hook. Also, pause management allow rejecting false pulses coming from ring signals (25Hz) by sending periodically reset pulses to the counter.

Practical solution means to use a modified "noise pulse discriminator" [4] which rejects any input pulses having a width less than the monostable timing period. As shown in figure 2, the number of allowed digits to be dialed can be selected by the corresponding output of the counter.

**Detecting the dialing digits number and specific prefixes in TONE phone systems**

The solution presented in figure 4 was designed for DTMF systems (tone mode) allowing two operating modes: detecting the "n"-th digit or detecting a specific digit. The core of the system is a DTMF decoder, usually a small and cheap specialized IC. Alternative solutions for DTMF decoder involve large calculus based on Fourier transform to detect the basic frequencies and can be implemented if a corresponding powerful microcontroller or DSP device is available.
The DTMF decoder is delivering the binary four bits code of the dialed number, except "0'" which get the binary code for "10" (b'1010). By observing that any dialing situation means at least on bit in "high" at the decoder output, a OR gate can be used to send one pulse each time when a DTMF coded digit is on the line. Because each DTMF pulse is followed by a pause, we'll get by this means a number of pulses equal with the number of the dialed digits and the algorithm described before (Johnson counter based) can be further used. Meantime, by means of a BCD-to-decimal decoder, the dialed number can be identified as a certain "high" output. This output can be further used by the procedure of rejecting a call starting with a certain digit ("0" for example, for long calls). A AND gate allow to detect the situation when the digit is the first one "and" it has also a certain value ("0"). The solution can be used also to detect if the second digit has a certain value ("0" like the second digit in a dialing stream, as "00" in international calls) by selecting the corresponding counter output.
The only device who needs initialization is the counter. It can be drive to initial state by reset signal generated via the derivative block (when a stop call action occurs) or via a time base (when a large pause occurs).

## Consideration on Microcontroller based solutions

A complete implementation could be easily done at low costs using microcontrollers. More, both PULSE and TONE modes can be used in the same system. It is recommended that DTMF decoder to be a dedicated external one since DTMF decoding is a complex process asking for large calculus resources. An important aspect concerns the galvanic insulation face to the phone line [2]. For this reason the optical interface converting currents to voltages used in pulse modes (see figure 2) has to be further kept. On DTMF implementation logical outputs of the decoder can be read via opto-couplers. To avoid different power supply sources, the DTMF decoder can be powered from the phone line. If no other interfaces are required, since the implementation is low consumption CMOS technology based, the entire system could be powered from the phone line with respect to standards regulations.
Using a microcontroller in the system, than further processing is possible. The authors tested, as separate experiments, the possibilities of using the phone line information (state of the line, dialed digits etc.) to develop a local counter measuring call times/costs directly.

## Conclusions

The principles here described were successfully tested in various applications. Both available dialing systems, pulse and tone, were treated. The main goal is to offer a technical approach to control a phone line, at the subscriber end, with minimum interferences with the services provider. Based on functional solutions above, further developments are possible, including complex cost control procedures.

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