

## Design and application of new kind of electronic and mechanical antitheft lock using DSP

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**Abstract**-A new kind of electronic and mechanical antitheft lock using digital code based on the technologies of DSP, serial communication and wireless data transmission is introduced .This lock has several functions with good security, identification and alarm-giving. It is simple and has wide application and high reliability. Hardware frame and software flowchart of the system are presented as its function,constitution,principle and the development of mechanism have been specified.

**Keywords**-electronic and mechanical lock; DSP; DS2401; identification code

### I. INTRODUCTION

The current popular household's door locks have two categories. A lock is through his traditions mechanical key to open and close the door, another lock is through electromagnetic force to open and close the door.

The principle and structure of machine locks is simple and machine locks have the habit of daily use. Electronic lock is the crystallization of modern technology, using simple and fast, but the need for auxiliary power support.. Mechanical locks reliability, all conditions can open, non-absolute lock to happen.

Electronic lock function is complex, relatively low reliability. In order to avoid an absolute lock, once the power-down, electronic locks are usually designed as a " open" status, that have poor security. But the fatal weakness of mechanical lock is anti-poor open technology, no matter how expensive mechanical lock, using technical means are able to easily open.

This article describes a new type of digital anti-theft electronic and mechanical lock,which combine the digital science technology and traditional techniques. Base on the structure and all the functions of mechanical lock , the new digital locks to increase a controlled electronic marbles. The marble was controlled by electronic digital key, only the legal recognition key of new digital lock can open it, the other key can not be opened. When the new type electronic lock fails to open, alarm system will be promptly reported this information to the management center monitoring system.

### II. THE OVERALL DESIGN OF DIGITAL ANTI-THEFT LOCK

Digital anti-theft lock design block diagram shown in Figure 1.

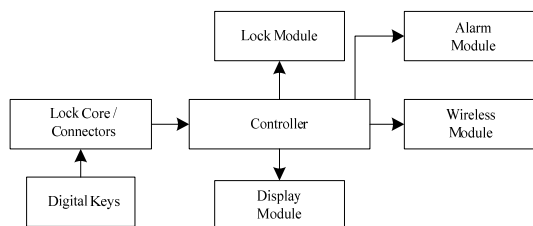


Figure 1. Design diagram of the digital anti-theft lock

Digital anti-theft lock constituted by the digital keys, lock core/connectors, control modules, memory modules, wireless communication module, power module and alarm module. When the digital key insert the lock turn the key moment, the controller through the lock core/connector to read digital in set chips, then compared this digital with digital in set memory module, if there is the same code group the electronic marble back to open the door, if there is not the same code group the electronic marble pop lock the door and through the wireless communication module to send alarm signals, telephone alarm module can immediately sent information to the management center monitoring system.

### III. HARDWARE DESIGN OF DIGITAL LOCK

#### A. Data transmission and control

Digital key based on structure and shape of the original mechanical key embedded a digital chip (DS2401) with 64-bit binary code, this 64-bit digital-chip data have unique code in global. The digital keys do not repeat even if the amounts exceed several trillions, ensuring unique identification code. DS2401 enhanced Silicon Serial Number is a low-cost electronic registration key, with minimal power interface (usually only a microprocessor port) to provide recognition. Includes a factory carved 64-bit ROM, which includes: 48-bit unique serial number, 8-bit CRC checksum and the 8-bit family code (01h). Data were 1Wire agreement, only through a signal wire and a ground wire serial transmission. Power for read and write device can be generated from the data line itself, no external power

supply. DS2401 is an upgrade version of the DS2400. DS2401 is fully compatible with the DS2400, but with additional multi-point communication capability, allowing multiple devices mounted on the same data bus. Common TO92, SOT - 223 or TSOC package provides a compact structure, easy handling of the standard installation of equipment. DS2401 storage shown in Figure 2.

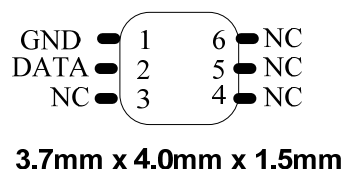


Figure 2. DS2401's TSOC package

Lock core / connector through 1-W and GND connected to the controller and the lock core, where 1-W is used to connect DS2401 chip in key ,DS2401 follows the single-bus protocol;GND connect the ground wire of power module.

#### B. Control circuit design

Controller used TMS320LF2407A; TMS320LF2407 is TI (Texas Instruments) company's 16bit DSP chips with perfect features and the best peripheral interfaces. TMS320LF2407A is the world's most integrated and highest performance motion control DSP chip in currently, which integrated 32K words flash, dual 10-bit A/D converter, conversion time 500ns, 41 multiplexed I/O pins which could be programmed independently, with a phase-locked loop PLL clock modules, watchdog timer module, 16 PWM channels, a CAN module, and five external interrupt.

Alarm module uses PM5020 chip, which structured by the dedicated voice microcontroller and a FLASHRAM memory,it has both 20S multi-segment audio playback,but also smart features programmable microcontroller. Alarm module and the DSP interface circuit shown in Figure 3. DSP and PM5020 with the serial communication program, in the serial mode, k1 is the data signal, k2 is the clock signal, O1 is busy signal. DSP directly sent the segment number to PM5020, at the end of play the

busy signal down, a voice in determining the end, then DSP sent the next paragraph number. Alarm module stored alarm sound, after three failed when unlocking, alarm module will send a loud siren. Alarm module is also stored the voice prompt to replace the battery when the battery voltage is insufficient, the user will be prompted to replace the battery.

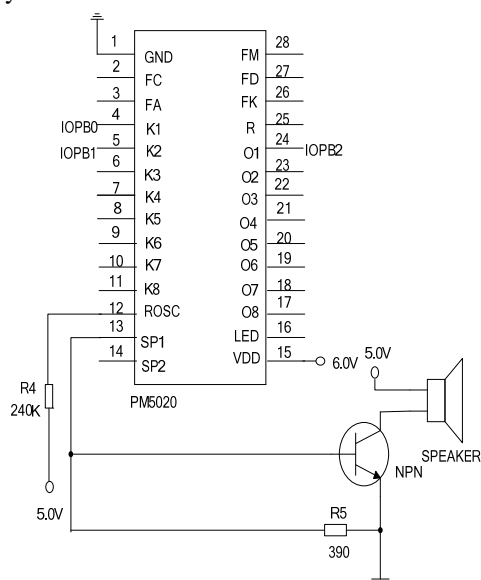


Figure 3. The interface circuit of voice module and DSP

In order to achieve the 500-meter wireless transmission distance, use the RFC-30F wireless module, the module works in 433Mhz open license-free ISM band used by Nordic companies nRF905 wireless communications, high-performance chips, high GSKK modulation, the receiver sensitivity up to -110dBm, the maximum transmit power 100Mw (+20 dBm), communication range up to 600-800 meters, can be widely used in long-distance wireless communications, industrial control, wireless data transmission and other fields. Wireless transmission module and the DSP interface circuit shown in Figure 4.

Key Settings button: If the key set button is pressed, the controller reads the digital key information and the information is stored to a storage module, complete the authorization key.

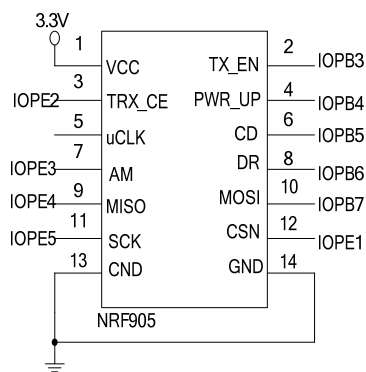


Figure 4. The interface circuit of wireless transmitter module and the DSP

Working indicator: When the Key Settings button is pressed, the working indicator lights.

The battery voltage detection circuit: battery voltage detection circuit for monitoring battery voltage, when the battery voltage falls below 5V, the controller will prompt the user to replace the battery.

Electromagnetic coil form lock module, as shown in Figure 5. When provide the electromagnetic coil 5V DC voltage, then the electronic billiard was inhaled lock body by magnetic field and allow unlocking. As there is spring between electronic marbles and electromagnetic coil, when electromagnetic coil power is lost, the electronic marbles under the action of the spring being bounced back between the lock and the lock core.

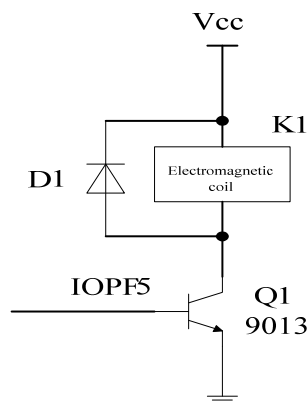


Figure 5. The driving circuit of lock module

### C. The software design of digital anti-theft lock

Software design using TMS320C2X/C2XX/C5X C compiler, using C language programming TMS320LF2407A. Modular software design is

conductive to modify and debug. Program is divided into three parts: the main program, open program and setting program. Main program initializes all data registers and peripheral circuits; use of light indicates the system working state. Programming block diagram shown in Figure 6.

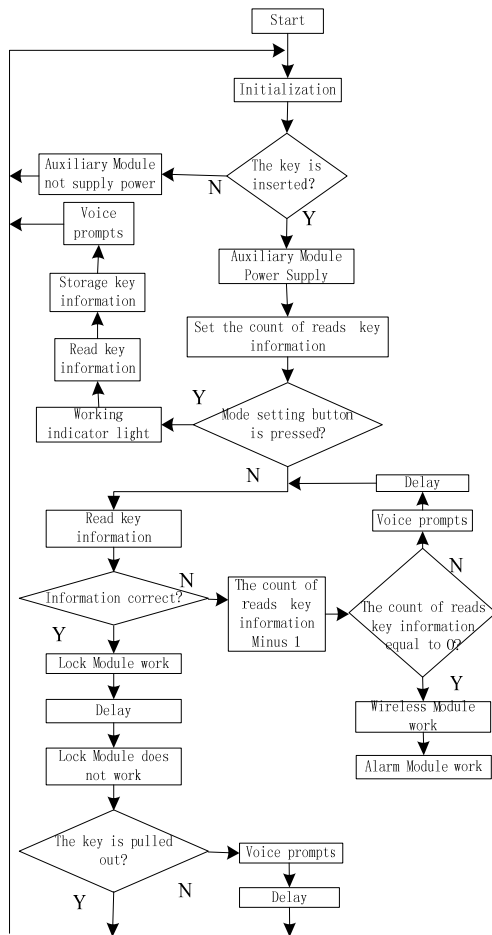


Figure 6. The main program flowchart

#### IV. CONCLUSION

Digital anti-theft lock used a special technique of digital identification and memory, allowing users to delete any key is being used. Users do not need to worry about lost keys. Digital anti-theft lock can be used in homes, offices and file cabinets and other need safe security places, which have a certain practicality.

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