

## Design of the Refueling Card Information Transmission System Based On DTMF

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### Abstract

Electronic payment has become the most preferred payment method, it is used by merchants and users increasingly because it has many advantages. It is very convenient for people to use electronic payment. The refueling card is generally applied to the gas station and every user of the motor vehicle. With the enlargement of the motor vehicle's action radius, gas station must be set in the remoter areas. Because of the poor communication networks in remote areas, it has affected information of the refueling card transmit with the server. The use of the refueling card has been restricted. This article designed a kind of system of the refueling card audio information transmission based on the mobile phone network and telephone network cable. The communication data is encoded and decoded by the way of DTMF. The refueling card information is transmitted in the form of wireless remote information exchange. Test results show the system has high transmission efficiency and low bit error rate. It can realized the refueling card remote transmit information under the only condition of mobile voice services.

### Keywords

refueling card; audio communication; DTMF; electronic payment.

### 1. Introduction

In recent years, with the improvement of people's living standard, the ownership of the motor vehicle increases year by year. With the enlargement of the motor vehicle's action radius, gas station must be set in the remoter areas. Electronic payment due to easy recharge, give change easily, fast payment and save carry the cash, it is increasingly used by businesses and users. The refueling card as one of the electronic payment means is widely used in oil sales company. The refueling card is authorized through the Internet in use process. The refueling card insert in the card reader of tanker, the card reader sent the card number information of the refueling card to the management computer of gas station, the management computer of gas station communicates with the remote server. Then, the remote server gets the refueling card information and the management computer waits for the server authorization. In remote areas of the gas station using gas card, due to the limitation of communication network, such as no cable communication mode (no cable line, no accessing the Internet), the wireless network cannot be covered, it can lead to the refueling card cannot communicate with the server, limiting the use of refueling card in remote areas, it can only use cash.

### 2. Overall Design Scheme

The design of the refueling card information transmission system based on DTMF is divided into the gas station client-side and server-side. It is mainly composed of the GSM module SIM900, CMX867A modulation/demodulation chip, embedded system, upper computers. These as hardware architecture to realize remote communication operations.

The gas station initiates the request of establish communication links by the wirelessly mode. After the server receives the request, it can response and agreed to establish a communication request. After establishing a communication link, the client of sending data encode the digital data. The data is sent to the receiver via voice channel, the receiver decodes the speech signal, the receiver sends digital signal to the PC. The system of communication mode is a full-duplex communication way. In order to realize the information remote transmission based on audio signal.[1]

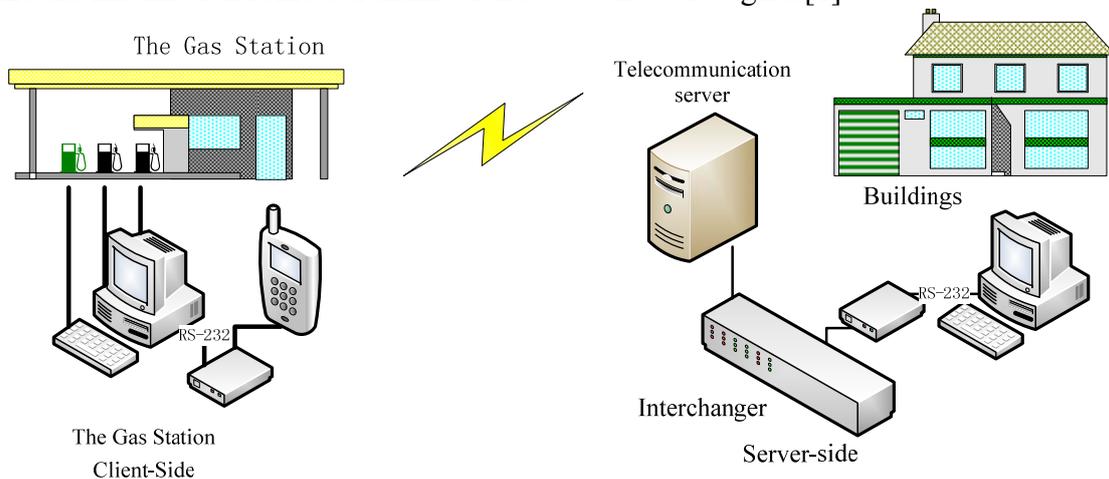


Figure 1 The Diagram of System Composition

### 3. Concrete Implement Scheme

#### 3.1 The Gas Station Client-Side

The gas station client-side is responsible for the information of each refueling card sending and receiving data in the gas station. The embedded system controls the GSM module to the phone. [2] According to the requirement of the upper computer the embedded system controls CMX867A to encode digital signal generating audio data and sends to the receiver via to the GSM module by C-BUS. At the same time, the GSM wireless communication module can receive audio signal by the other client sending quickly, safely and reliably. It need not to create a connection handshake signal it directly sends the received audio signal to the CMX867A modulation/demodulation chips by the 1200 BPS FSK/DTMF communication system of transmitting.[3] The speech signal is demodulated into digital signal through the CMX867A. Then, the embedded system analyses and processes the digital data.

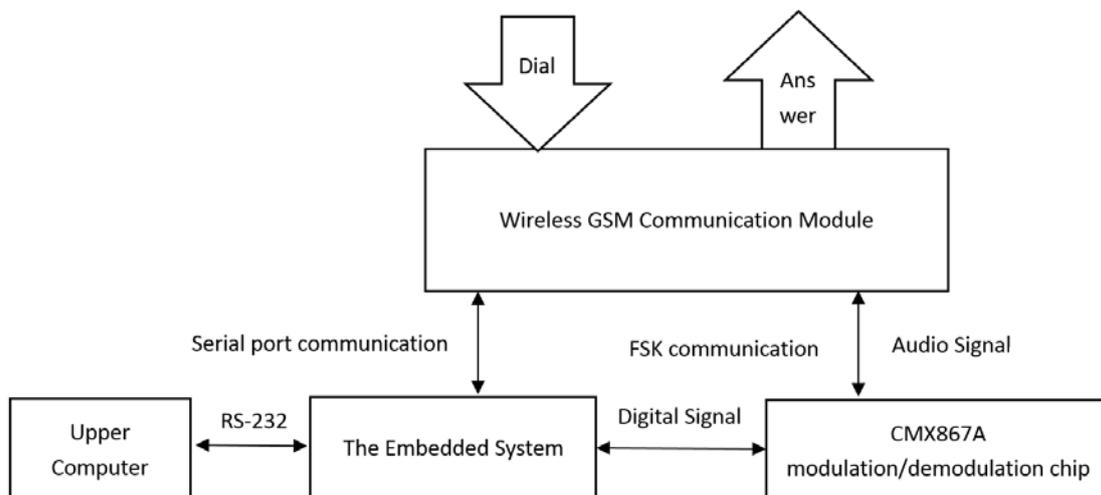


Figure 2. The System Operation Diagram Of The Gas Station Client-side

### 3.2 Server-side

The server-side is responsible for communicate with each gas station, due to the gas station is multiple, it needs many channels to be used for communication at the same time, the interchanger is responsible for the allocation exterior link to an extension. The extension has a CMX867A chip and some functions, such as a ringing detection, automatic picking and hanging up, DTMF coding and decoding.[4] The ringing detection technology of CMX867A detects and judges signal that GSM phone receive, the embedded system communication via a serial port to send data to control whether GSM phone and be responsible for the control extension work and communicate with PC. System is responsible for control and management of each of the communication link.

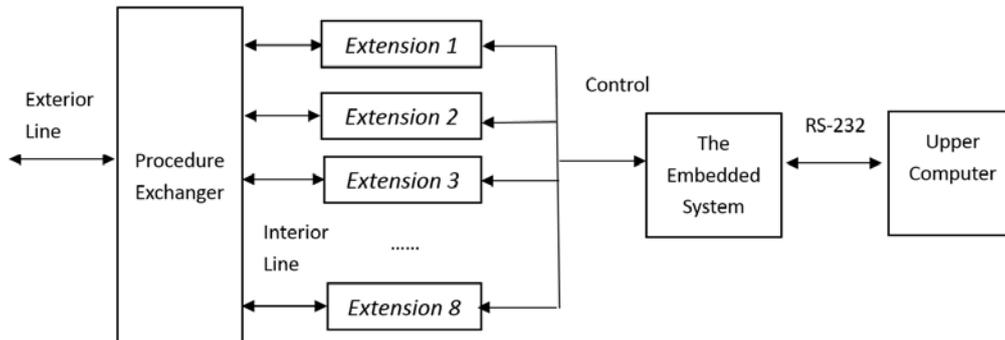


Figure 3 The System Operation Diagram of The Server-side

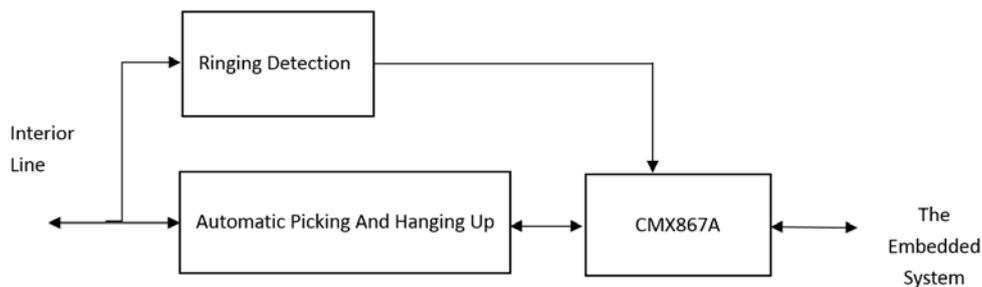


Figure 4 The Schematic Diagram of The Extension Composition

## 4. Hardware Design And Implementation

### 4.1 The Encoding and Decoding of The Audio Data

The communicate mode of system is audio communication. During the process of communication, when data is interfered by external sound, an appropriate communication mode and a protocol are needed to be designed, encoding the data that need to be transmitted, to improve the efficiency of communication and decrease the error rate.

The system adopts CMX867AD2 modem, The CMX868A is a multi-standard modem for use in telephone based information and telemetry systems. Control of the device is via a simple high speed serial bus, compatible with most types of  $\mu\text{C}$  serial interface. The data transmitted and received by the modem is also transferred over the same serial bus. On-chip programmable Tx and Rx USARTs meeting the requirements of V.14 are provided for use with asynchronous data and allow unformatted synchronous data to be received or transmitted as 8-bit words.

A high-quality DTMF decoder with excellent immunity to falsing on voice and a standard DTMF encoder are included. Alternatively, these blocks can be used to transmit and detect user-specific, programmed single and dual-tone signals, call progress signals or modem calling and answering tones. The device also features a hook switch relay drive output and a Ring Detector circuit which continues to function when the device is in the Power save mode, providing an interrupt which can be used to wake up the host  $\mu\text{Controller}$  when line voltage reversal or ringing is detected.

The CMX868A operates from a single 2.7 to 5.5V supply over a temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and is available in 24-pin TSSOP, SOIC and DIP packages.

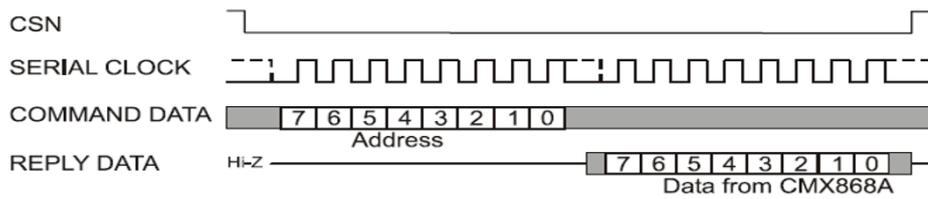


Figure 5 The Working Sequential Chart of CMX867AD2

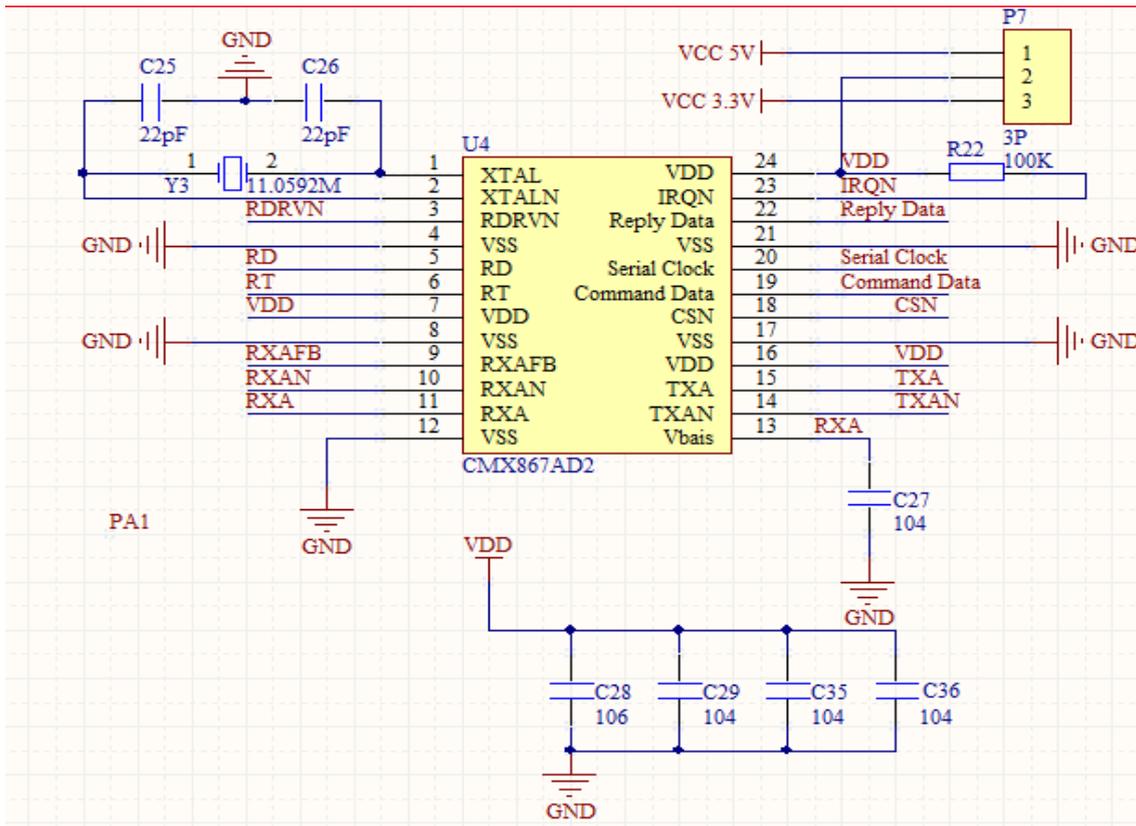


Figure 6 The CMX867AD Schematic

**4.2 Embedded System**

The modem module, USARTs module of this system, they are all needed to be controlled by MCU. Considering the cost, performance and many other factors, we choose the high performance Cortex™-M3 MCU STM32F103.

Main Clock of STM32 reaches up to 72MHz,80 high speed GPIO,49 5V- tolerant I/O. All the I/Os are mapping to the 16 external vectors, Nested interrupt controller with 43 maskable interrupt channels, 128K Flash,20K SRAM,2 x 12-bit, 1 μs A/D converters (16-channel),7-channel DMA controller,

Peripherals that DMA supported: timers, ADC, SPIs, I2Cs and USARTs.

**4.3 The System of Remote Audio data Exchange**

The system of communication mode is a full-duplex communication way. It means multiple stations communicate with a server. In the process of communication, the server publishes a perimeter number to the gas station, the gas station wants to communicate with an extension on the server needs to exchange the communication link on the server side.

The system adopts SIM900A send signal that is DTMF/FSK mode to the sever.SIM900A is a compact type product that produced by SIMCOM, it's a industrial dual frequency GSM/GPRS module, totally package in SMT, which has stable performance, exquisite appearance ,high price performance, and flexible application.SIM900A adopts standard industrial interface, dual working frequency

/900MHz/1800MHz, embedded TCP/IP protocol, Achieving voice function with low power cost, short message, data and fax transmission. SIM900A supports RS232 USART and LVTTTL USART with hardware flow control.

## 5. The Experiment and conclusion

The embedded communication equipment based on CMX867A has a good wireless communication performance, its instruction cycle is measured in microsecond, therefore it has higher computing speed. The data transmission time is measured in microsecond, so the hardware communication rate is higher, at the same time hardware has high reliability.

The design of the refueling card information transmission system based on GSM network need not spend a lot of manpower and material resource in setting up communication lines and laying the communication medium in remote areas. System is mainly composed of the GSM module SIM900, CMX867A modulation / demodulation chip, embedded system, upper computers. These as hardware architecture to realize remote communication operations.

In remote areas there are some influence factors. Such as no cable phone line, no accessing the Internet, causing erection line difficult, the wireless network cannot be covered, limited to the communication network, etc. These facture highlight contradiction that the refueling card unable to communication with the server, limiting the refueling card used in the remote areas. According to the actual situation can only dial the mobile phone, it has a design of remote data exchange system based on GSM network. The realization of the system is of great significance. It can realized to use the refueling card in remote areas and expand the company's business, improve the company's overall image. As a result, the refueling card information transmission system based on GSM network solves the gas company's demand and provides convenience for people at the same time.

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