# Design and Experiment of Remote Communication System Base on GPS/GPRS Technology

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*Keywords:* GPS/GPRS technology; RS232 serial communication; Communication protocol; remote control.

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DESIGNANDEXPERIMENTOFREMOTECOMMUNICATIONSYSTEMBASEONGPSGPRSTECHNOLOGY

*Strictly as per the compliance and regulations of:*

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## I. Current Application of GPS/GPRS Technology

Currently there are some questions of GPS/GPRS (Global Position System/General Pocket Radio Service) Technology application in construction machinery; one is less function, another is simple circuit for this system. So it can't provide the function of monitoring machine directly, and leads to the cases of machine stolen or lost often, it is a problem for suppliers to secure their machines safe with this tooling. Follow the developing situation of domestic construction machinery, it is one urgent requirement from supplier to apply GPS/GPRS technology on machine effectively.[1] This article mainly describes the technology of data transportation between machine ECU with GPS terminal and remote lock machine via RS232 serial communication circuit. Communication and shutdown circuit is shown as Figure 1.

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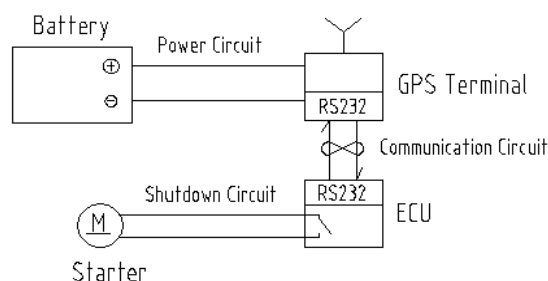
*Figure 1:* Communication and Shutdown Circuit

## II. System Theorem

The purpose of remote communication system is to realize the function of real-time monitoring and prevent GPS terminal from removed in machine. This system is primarily composite of ECU (Electric Control Unit), GPS terminal and RS232 serial communication circuit. And its working theorem is shown as below. At first it is to collect running parameters by ECU, such as engine cooling temperature, engine oil pressure, engine speed, diesel level, hydraulic pump pressure, hydraulic oil temperature and hydraulic oil level, etc. Then ECU is to forward these parameters to GPS terminal via RS232 serial communication circuit. Later on they are sent to base station of mobile telecom in a fixed interval by GPS terminal through SMS or GPRS. Next the monitoring website receives and translates them into the original value obey the rule of communication protocol base on mutual agreement. In the end supplier can read the real machine running information online. Meanwhile, supplier can shutdown machine remotely online also, the processing is shown as below. Firstly supplier sets shutdown order on monitoring interface, then website forwards it to GPS terminal through GSM network, after receives it GPS terminal sends this order to ECU, and ECU demands engine to stop when engine speed is idling, so as to shutdown machine remotely successfully. And its anti-demolition function is working with below way. When ECU can't detect shake-hand code for a while communicating with GPS terminal base on mutual agreement protocol, it will demand engine to stop immediately due to fail to communicating. That is the way to prevent GPS terminal from removed in machine. [2] Communication system diagram is shown as Figure 2.
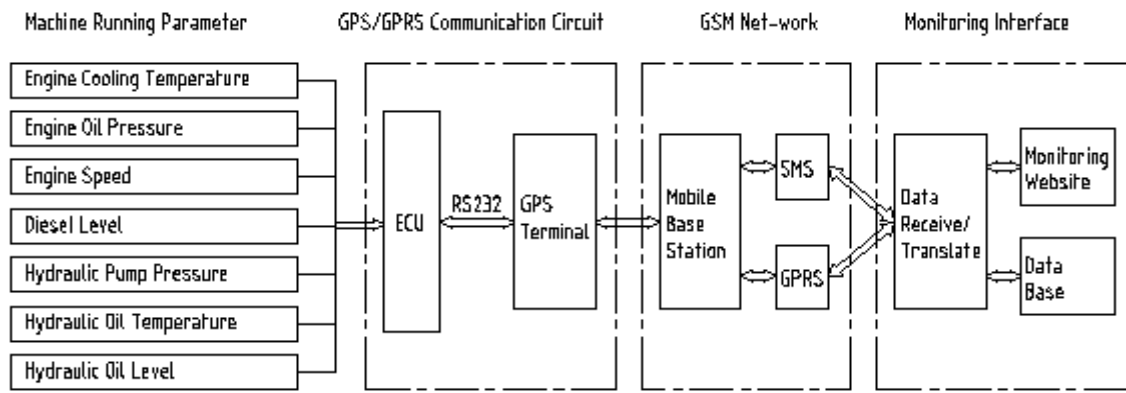
*Figure 2:* Communication System Diagram

## III. System Component and Working Flow

The hardware of this system includes power circuit, CPU (Central Process Unit), I/O module, RS232 module, GPRS module and GPS module, etc. Hardware frame is shown as Figure 3. Later on introduce these modules one by one in detail.
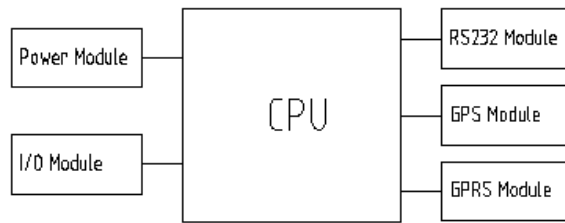


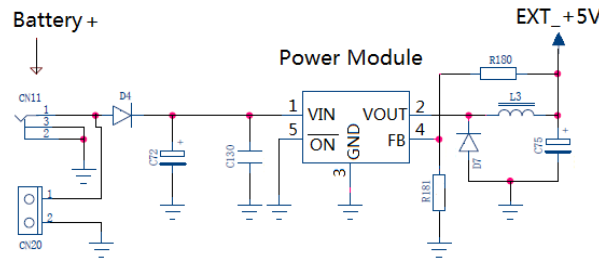*Figure 3:* Hardware frame Diagram



*Figure 4:* Power Module Circuit

### a) Power Module

This module is the power of CPU and other modules, and its key specification is to support reliable voltage. There are 5 pins in this module, pin 1 is battery+ input, pin 2 is voltage output, pin 3 is ground signal, pin 4 is feedback signal and pin 5 is enable signal input with low side. The circuit is shown as Figure 4. In order to secure the output steadily, there is feedback signal in pin 4 of power module to adjust the pulse ratio of output, when feedback signal is high, it will reduce the pulse ratio to drag voltage down; verse wise, and it will push voltage up.

### b) CPU

CPU is the core part of this system, and its function is to process data and control other parts working correspondingly. Working flow of CPU is shown as Figure 5.

### c) I/O Module

I/O module is to collect the running information in machine, including digital signal, analogue signal and pulse signal.

### d) Digital Signal Collection

The main question of digital signal collection is data fluctuation, in order to eliminate this disturbance we take the measure of delay sampling collection and times sampling collection in programming. For instance, we set to continue collecting signal in 30 seconds, the result is true if this signal is lasting with the same value, or it is false. And it is right this way to collect warning signal on real machine. Working flow is shown as Figure 6.
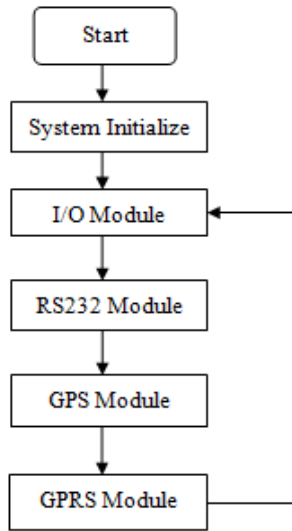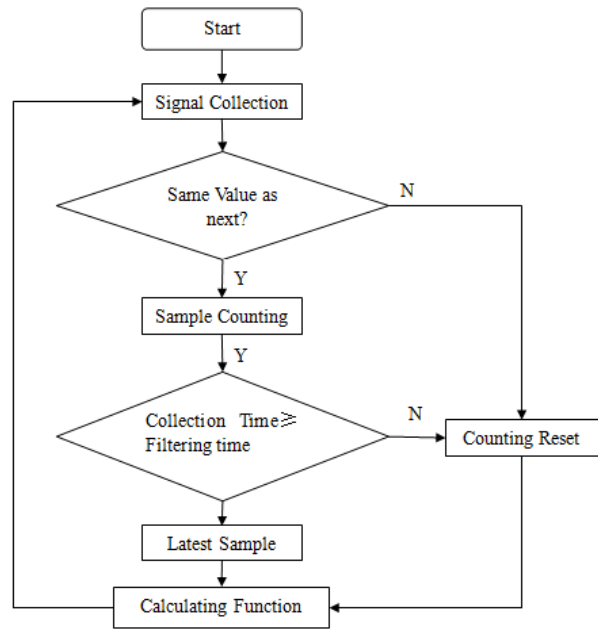
Figure 5: CPU Working Flow Chart



Figure 6: Digital Signal Collection Flow Chart

e)  *Analogue Signal Collection*

There is disturbance phenomenon in analogue signal collection also, so we always set several methods to remove the noise in programming, such as arithmetic average filter, limit range filter, sliding average filter, median value filter, weighted valve filter, average value filter, etc. And sliding average filter and arithmetic average filter are the common smoothing ways, when the actual time of sample collection is more than the defined time, we will choose sliding average filter, or we will adopt arithmetic average filter. And it is the same way to collect signals of engine cooling temperature, engine oil pressure, engine speed, diesel level, hydraulic pump pressure, hydraulic oil temperature and hydraulic oil level in real machine. Working flow of analogue signal is shown as Figure 7.

f)  *Pulse Signal Collection*

The way of pulse signal collection is to count the sample value in an interval through timer capture function, and engine speed is one of the examples of pulse signal collection. Working flow of pulse signal collection is shown as Figure 8.
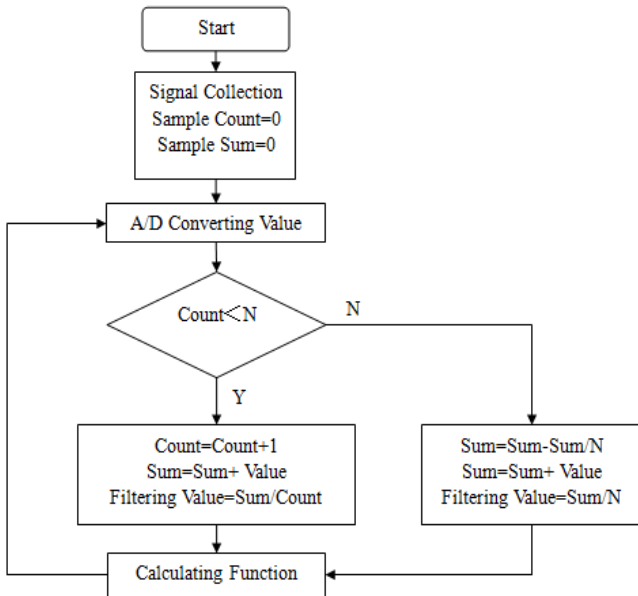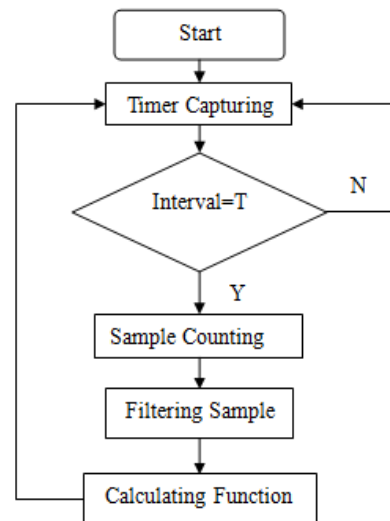


Figure 7: Analogue Signal Collection Flow Chart



Figure 8: Plus Signal Collection Flow Chart

*g) RS232 Module*

This module provides connecting port for ECU and GPS terminal. And data transportation with RS232 serial port is basic on communication protocol of mutual agreement, so it is our first step to define communication protocol.

Obey the rule of data frame in RS232 asynchronous communication definition; each frame is composite of these data with 1 bit of start bit, 8 bits of data bit, 1 bit of check sum bit and 1 bit of end bit including. Data frame is shown as Table 1. Moreover, baud rate is defined as 9600, then to define the rule of data delivery. Firstly these parameter data with 16 bits is packaging to 2 pieces of data frame with 8 bits, one is high frame, and the other is low frame. Then low frame is sent priority to high frame while data delivering, adding frame head code and data length code together. When opposite side receives frame head code of OXFF, it will continues to accept the next message and check sum bit again, or it will reject this message. [3]

*Table 1:* Data Frame Format

| Shake hand bit | Start bit | Data bit | | | | | | | | Check sum bit | End bit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0XFF | 0X01 | Cooling Temp. | Eng. Oil press. | Eng. speed | Diesel lever | Pump press. | Hyd. Oil temp. | Hyd. Oil level | Warning value | | 0X0D |

These data is sending and receiving bit by bit, when received the 8th bit of data, there is set to interrupt communication in programming and store these data.

Repeat this step to receive next message. Working flow of data receiving is shown as Figure 9.
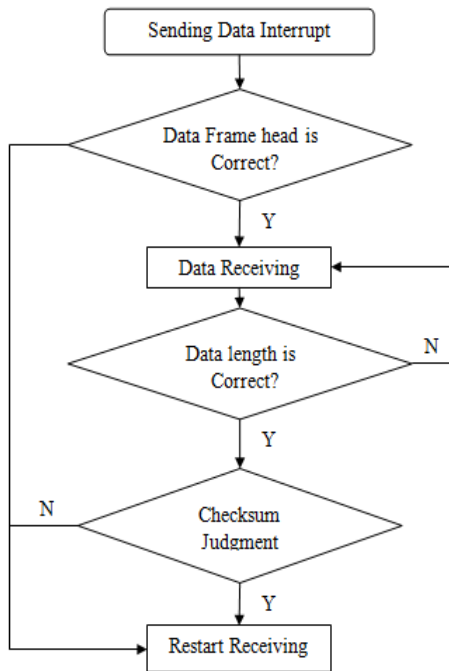Working flow of sending data is shown as Figure 10.
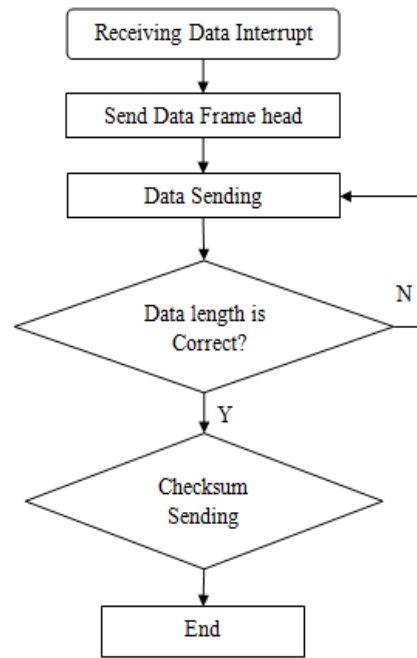
*Figure 9:* Receive Data Flow of Serial Port

*Figure 10:* Sending Data Flow of Serial Port

*h) GPS Module*

GPS module receives data that is to obey the regulation of NMEA-0183 protocol, and it sends this information of location, time, longitude and latitude to ECU via RS232 serial communication circuit. The language statement of NMEA-0183 protocol is complicated, and it is common statement with $GPGGA, $GPGSA, $GPGSV, $GPRMC, $GPVTG and $GPGLL, etc. [4] GPS receiving data flow is shown as Figure 11.

*i) GPRS Module*

GPRS module response to AT order from CPU, and it is the port to connect with GSM network, so remote communication is running with network online as
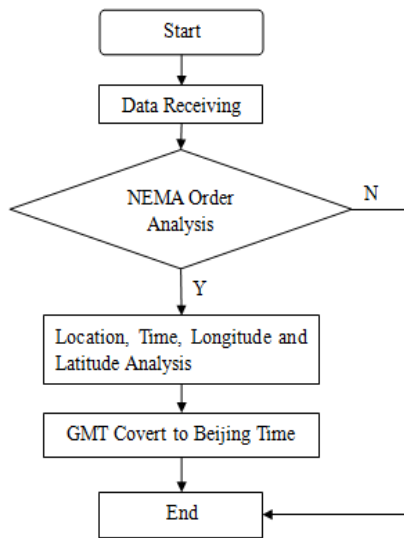
to deliver data successfully from each side. Working flow is shown as Figure 12.
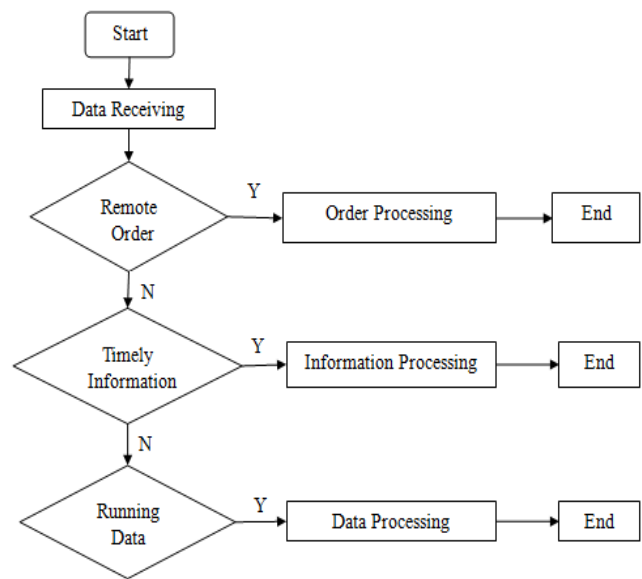
*Figure 11:* GPS Receiving Data Flow Chart



*Figure 12:* GPRS Data Processing Flow Chart

## IV. SYSTEM TESTING IN MACHINE

### a) Communication System Simulation

Set a simulating experiment to test communication system in lad, and engine speed signal is from one square-wave generator (3kHz,8V), the rest signals of Engine cooling temperature, engine oil pressure, diesel level, hydraulic pump pressure hydraulic oil temperature and hydraulic oil level are connecting with respective analogue loader. Then to set the position of RXT and TXT is right reversed in each connection port between ECU and GPS. Only to connect correctly with each other, they can perform communication successfully. The simulation testing is shown as Figure 13.



*Figure 13:* Simulation testing In Lab

### b) Data Validation

After registering the GPS terminal code and SIM code on monitoring screen together, we can see machine running information listing here. Next to comparison between real machine parameter and monitoring data, we check out whether they are totally correct and precise. In the end after removed GPS terminal in 3 minutes, there is shown the information of shutdown engine on monitoring screen. We always use serial port tooling to check out these data whether they meet the protocol. This tooling screen is shown as Figure 14.
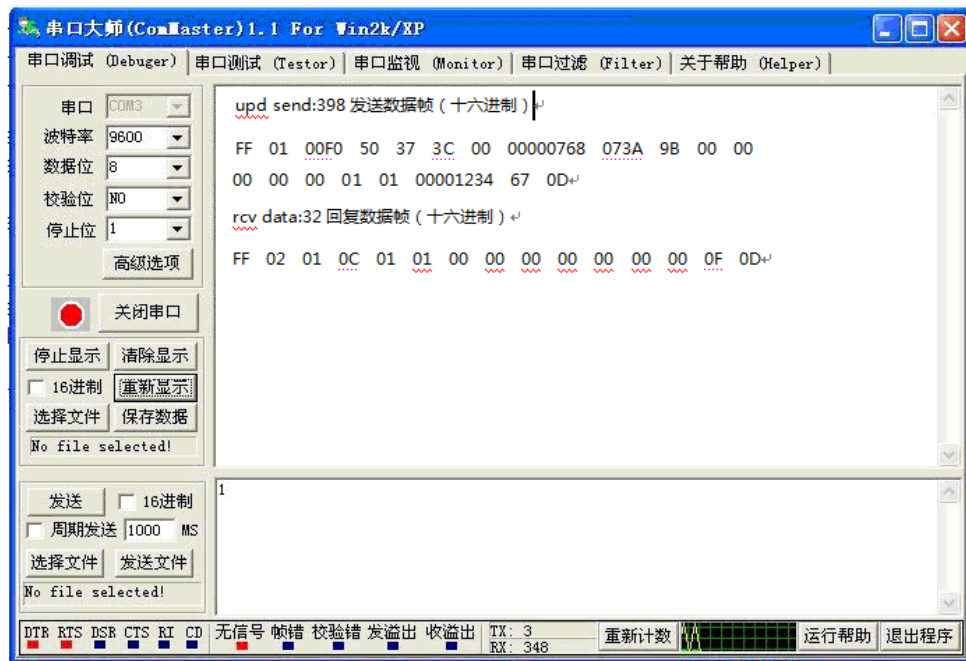
*Figure 14:* Serial Port Tooling Screen

Below is the analysis for answer code:

FF: Data frame head
02: Device address （GPS terminal）
01: Shutdown engine
0C: GPS cover is opening
01: Valid password input
01: Restore shutdown function
00: Backup
00: Backup
00: Backup
00: Backup
00: Backup
00: Backup
00: Backup
0F: Checksum
0D: End mark

*c) Testing Review*

After hours of testing, the data is sent and received regularly between ECU and GPS terminal without any data package lost. After sending shutdown order to GPS terminal, ECU responses immediately and demands engine to stop while engine speed is idling. Moreover, after removed GPS terminal from communication circuit, ECU forwards order to stop engine automatically in 3 minutes. Then we come to a conclusion as below:

1) This communication system works well with data correct completely. When one side receives data requesting from the other, each time it always answers with the rule of communication protocol.

2) After departed from each other between ECU and GPS terminal, ECU demands engine to stop immediately in 3 minutes. And it informs GPS terminal to send this shutdown information back to monitoring website. So this result meets the requirement of communication protocol also.

## V. CONCLUSION

Due to meet current marketing requirement of GPS/GPRS technology application, this article is to design and experiment on GPS/GPRS communication system with RS232 serial communication protocol in construction machinery. The design clue is to define communication protocol for RS232 serial communication circuit firstly, including data type and format definition. Then ECU sets up to communicate with GPS terminal regard to mutual agreement protocol, if it can't receive the message from GPS terminal in 3 minutes, it will demand engine to stop at once. In this way this system not only provides the function of remote monitoring and anti-demolition for supplier, but also improves the maintenance and service quality for construction machine. Last step is to set experiment and validate the function of this communication system on real machine, and testing conclusion approves that this design is feasible. Next continues to study the function of remote trouble-shoot and pilotless driving base on GPS/GPRS technology in construction machinery.

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