

Research and Development of Subsoiler's Operation Power Real-time Remote Testing Technology and Equipment

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ABSTRACT

Subsoiler is the main machine type to achieve conservation tillage, it requires larger power consumption, so the power been accurately tested can effectively guide the design and optimization of products, and achieve energy conservation. But now, this kind of equipment's power test is basically wired transmission method, due to bad field environment conditions, parameters changed greatly and other reasons, the testing process is difficult, and the test data is not accurate. This paper adopt advanced mathematical coupling sensors, researched and developed a signal modulation transmitter and receiver system and data acquisition & analysis software, formed a 500m distance wireless data transmission real-time telemetry equipment to test the power of operating in the deep pine.

INTRODUCTION

Subsoiler are the main machine types to achieve conservation tillage, their works always with larger operation power consumption[1]. By the means of accurately test of power, it can effectively guide the design and optimization of products and

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achieve energy conservation. Because the operation of subsoiling is on the move, uncertain working condition, harsh environment, parameters changes a lot, sensor mounting difficulties and other reasons, the test work of these parameters is often difficult, even the result is not measured accurately, only do some kind of estimate by experience in fact. The research and development of equipment that can easily and accurately test these parameters on the above is of great significance [2].

From the remote sensing technology system theory and technical requirements, sensors and wireless transmission systems, data acquisition and processing software and other aspects, we have done the research and development of subsoiler operation power real-time remote sensing technology equipment.

Subsoiler Operation Characteristics and Test System Needs

Subsoiler generally refers to the kind of equipment with a different dynamic mechanical support for the completion of farmland subsoiling operation. The purpose of subsoiling operation is loose soil, breaking plough pan, enhance rainwater infiltration speed and quantity, reduce runoff and water evaporation losses [3]. Since subsoiling operation is only loose soil, not tilling the soil, and after the job only make topsoil chaos, with a small amount of ground-breaking, so it is particularly suited to shallow black soil and the soil should not be plowing jobs. Subsoiling is an important conservation tillage technology in recent years and highly respected, because it not only makes food production increased, but also protects the environment [4].

The Principle and Technical Parameters of Sub Soiling Operation Power Real-time Remote Sensing Technology System

THE COMPONENTS OF THE SYSTEM AND THE BASIC PRINCIPLES

The entire system consists of sensors, transmitting device, receiving device, an anti-aliasing filter, analysis and processing computers, printers and power supply and other components.

The output of the electrical signal is dependent on the pressure sensor mounted on the object to be measured, reached to the radio transmitting device, using FSK modulation transmitter to the wireless receiver, via signal conditioning, passed to capture card, and then by the data acquisition and computer processing, can real-time display or output test results alive. The block diagram of the entire device system shown in Figure 1.

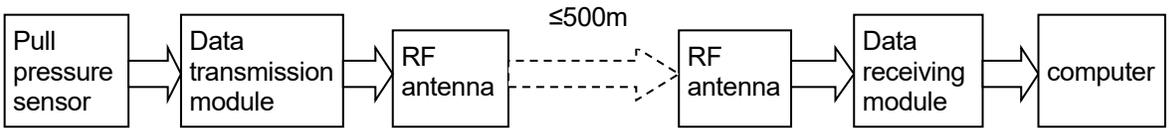


Figure 1. Block diagram of the entire device system.

SYSTEM FUNCTION AND MAIN TECHNICAL DATA

The system is configured with pull pressure sensors, does the power (equipment tractive force) and other parameters’ signal acquisition of the channel signal in real-time two-way wireless data transmission, the transmission distance is 500 meters, and enables the conversion of wireless transmission of data and cable transmission in two ways.

The data processing can do computer-controlled real-time time-domain waveform and other multi-window and multi-signal displaying, data logging, time domain waveforms, power spectral density, probability density, spectral and other multi-parameter analysis, processing, drawing curves chart, direct print out reports. The system unit is modular configuration, can be installed on the test car, and form a subsoiler data acquisition and processing flow test platform..

Main technical data:

- (1) Maximum wireless transmission distance: 500 meters, the relative error $\leq 2.5\%$;
- (2) The repeatability standard deviation pull: pull $\leq 200N$;
- (3) The relative error pull: Wired $\leq 1.5\%$; wireless $\leq 2\%$;
- (4) Subsoiling operation consumption: standard deviation $\leq 2.0kW$.

Research on Sensors and Wireless Transmission Systems

PULL PRESSURE SENSOR

Pull sensor is a kind of resistance strain sensor, and a part of the load cell series, it transforms physical signals into electrical output and makes them measurable, it uses two transmitting section pull power transmission, in its structure contains two force pull-sensitive devices and transmitting portions, of the piezoelectric sheet comprising force-sensitive device, the piezoelectric chip wafer, which contains the substrate and the edge portion of the force transmission portion, characterized in that the two ends of pull transmitting portions are fixed together with the role of the lateral surface between the ends of the clamping force-sensitive device, the piezoelectric shims on one side of the pressure, and in the central area of the

piezoelectric sheet substrate portion located on the other side of the piezoelectric sheet edge portion of the force transmission and close between the piezoelectric sheet, use as one of its scales to replace the rod hook chessboard [5].

The actual working environment is crucial to the correct selection of tension sensor, it is not only related to the pull sensor can work properly or not, but as well as its safety and service life, even the whole weighing the reliability and security [6].

According to the principle of the bridge, the bridge connects and pastes in the four strain resistance strain sensor beam wiring diagram shown in Figure 2, the internal sensor wires have already connected. When the elastic strain beam is applied an external force, pasted beam strain resistor changes, the bridge out of balance, get a force proportional to the voltage signal from the output terminal. The transmitter with a small sensor signal precision amplifier circuit, internal voltage regulator circuit, constant current for the bridge, voltage and current conversion, impedance adaptation, linear compensation, temperature compensation, the amount will be converted into mechanical standard current and voltage output signal, 4~20mA, 0~10mA, 0~5V, 1~5V direct and automatic control device is connected or networked computer, transmitter with standard signal induce to zero, induce a gain of function. Wire transmitter shown in Figure 3, three-wire transmitter shown in Figure 4.

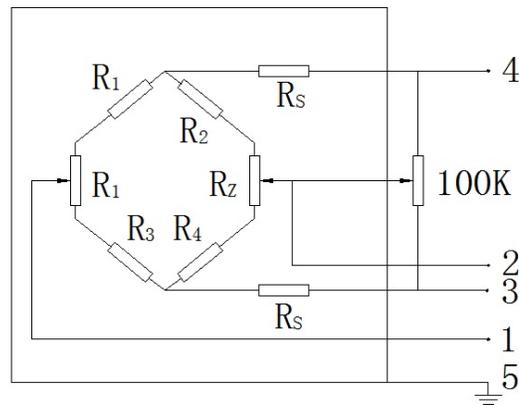


Figure 2. The four strain resistance strain sensor beam wiring diagram.

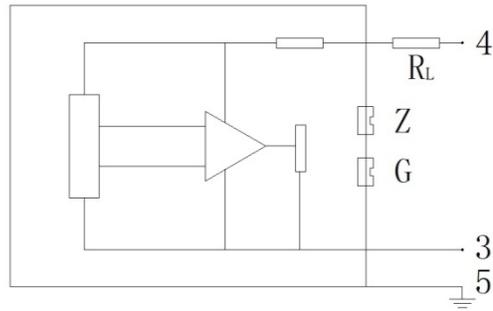


Figure 3. Wire transmitter.

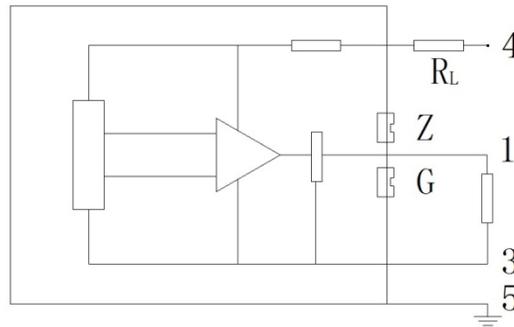


Figure 4. Three-wire transmitter.

THE WIRELESS TRANSMISSION SYSTEM

(1) System components and principles

The system includes four parts: transmitter signal modulator, demodulator receiver, antenna and power supply battery.

It makes external modulation signal into two signals of different frequencies firstly, the transmitter signal modulation signals transmitted out, and then demodulates the received signal from the received signal, and then the acquisition system do acquisition and processing.

In order to avoid interference with the tractor engine transmitter, the transmitter modulation frequency circuits are isolated and closing. Transmitter power is provided by an internal lithium battery and double the measured power tool battery, the receiver is also provided by an external power supply lithium battery inside, computer analysis and processing power provided by the battery via the inverter. Signal modulation transmitter block diagram shown in Figure 5, the demodulating block diagram of the receiver shown in Figure 6.

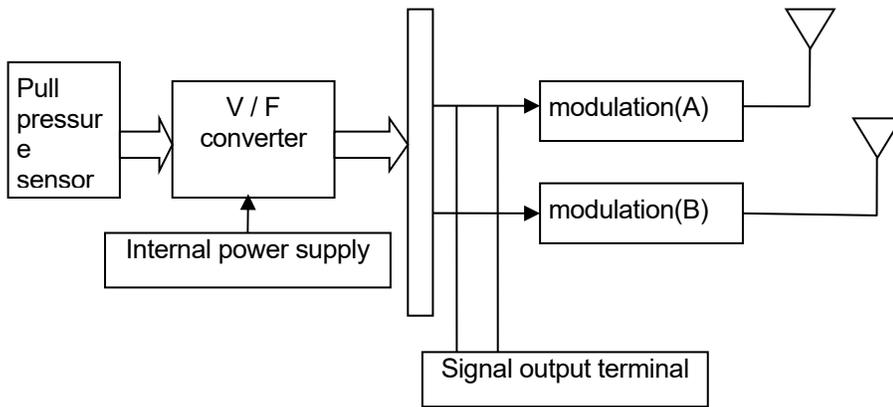


Figure 5. Signal modulation transmitter block diagram.

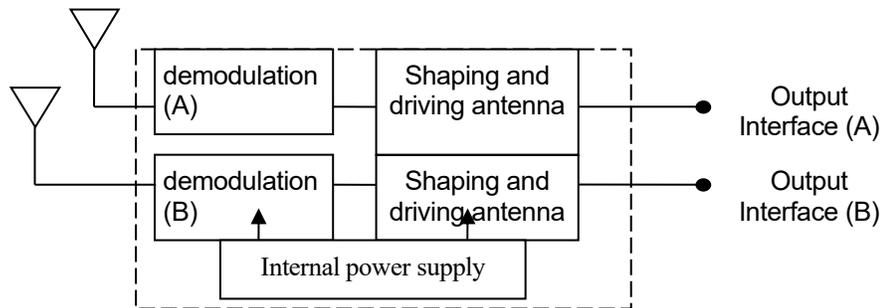


Figure 6. demodulating block diagram of the receiver.

(2) System technical performance indicators and parameters

Comprehensive indicators: Communication distance: 500 meters; data transmission rate: 9600bps;

Working frequency: 300.000MHz~400.000MHz; channel interval: 300kHz; Frequency Tolerance: ± 5 ppm; Operating temperature: 30 °C~+ 60 °C.

Signal modulation transmitter main technical indicators:

Modulation method: FSK;

Transmitting power: 120MW; Residual FM: ≤ -40 dB; harmonic suppression: ≥ 40 dB;

Emission current: ≤ 450 mA; Power supply: DC 12V.

The received signal demodulates main technical indicators:

Sensitivity: $\leq 4 \mu V$ (20Db SINAD); Intermodulation Immunity: ≥ 40 dB; Power supply: DC 12V.

Data Acquisition and Processing Software

THE MAIN FUNCTION OF THE SYSTEM SOFTWARE AND DATA COLLECTION PROCESSES

For the requirements of subsoiling mechanical's work, the data acquisition, analysis and processing dedicated system software have been researched and developed, which sets the signal acquisition, signal Conditioning, amplify, filter, A / D conversion and data analysis in one, it can display and handle multiple different types of road data simultaneously. System software provides the voltage, charge, strain signal entrance tests for different types of signals, and in the input signal interface provides a dynamic display bar, real-time observation of the input signal size, easy to adjust the signal range. The system comes with a variety of graphics display Word and paste the graphic interface, data could be formed Word text report immediately after treatment.

(1) The main function of the system software

Real-time collection and analysis; data preprocessing; time-domain data analysis; frequency domain data analysis; array operation; sine and random digital signal generator; sine and random analog signal output; graphic data management and replication. The data collection process diagram shown in Figure 7.

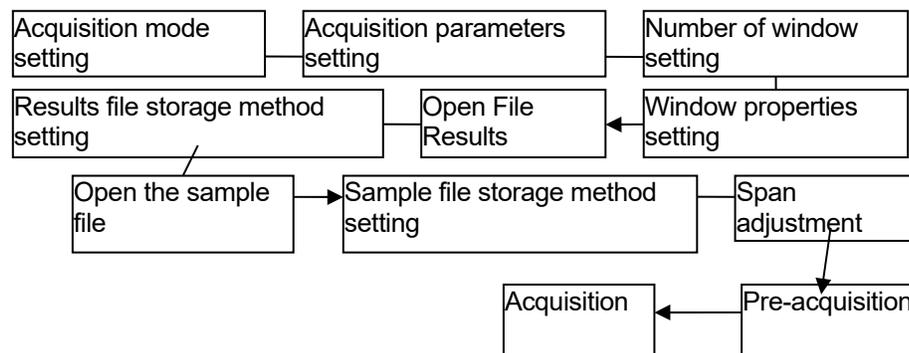


Figure 7. Data collection process diagram.

(2) DSPS System Components

DSPS system configuration diagram shown in Figure 8.

CONCLUSION

Subsoiler's operation power real-time telemetry equipment described in this article using the signal modulation transmitter and receiver system theory, research and development of signal transmitter, signal receiver, data acquisition, analysis and

processing dedicated software, the entire technical equipment is modular configuration, carry out the signal reception and data acquisition, processing, printing devices are also configured in the test car, formed a flow field test platform.

This equipment's transmission distance is 500m, speed and accuracy can meet the test requirements, the system operation smoothly, high precision, safe and convenient operation, low cost, free from outside influence communications system, to meet the test requirements of subsoiler and solve the problem of deep pine work tools' power, pull-pressure test and other performance indicators testing uncertainty, the application is prospect.

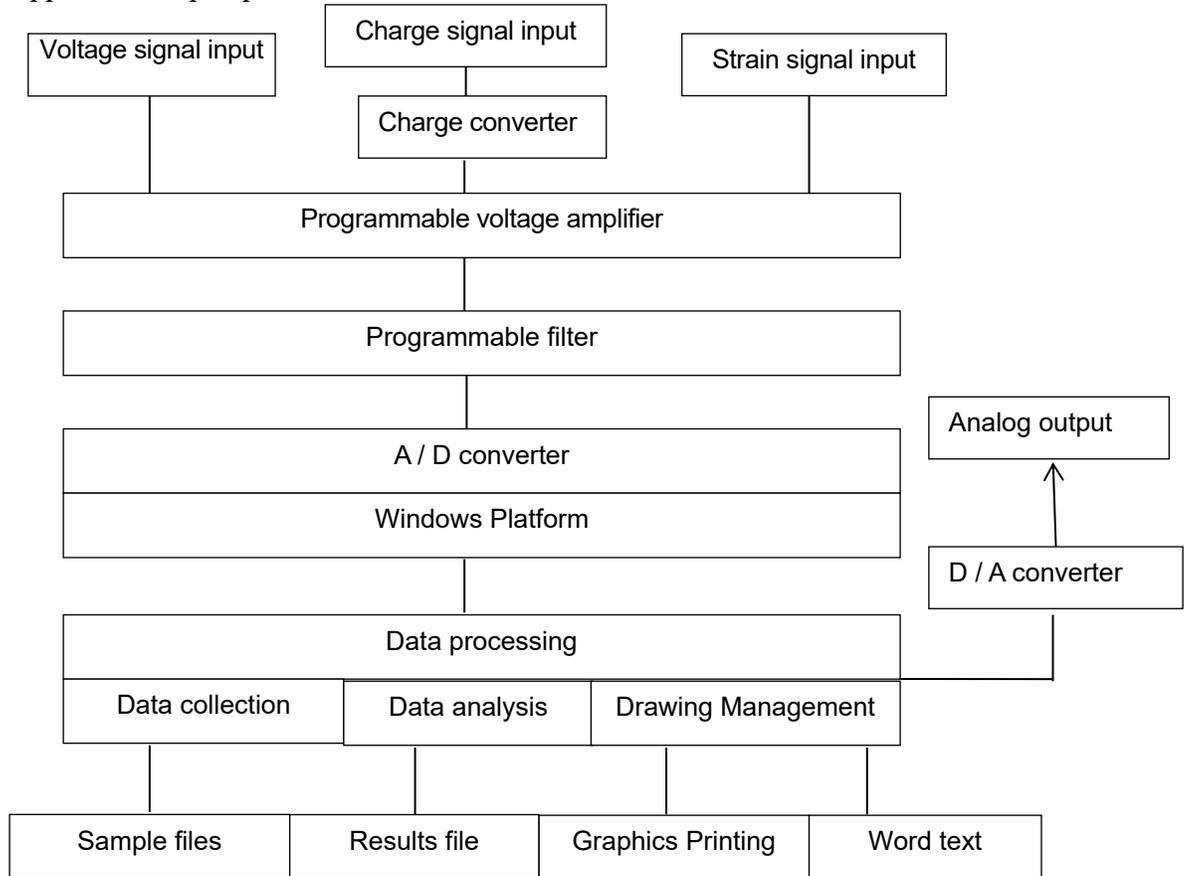


Figure 8. DSPS system configuration diagram.

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