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High-performance Pulse Electroplating Power Supply Control System

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Abstract: The tradition electroplating power is large and the output ripple is big. The study presents a multi-waveform pulse electroplating power equipped with Samsung S3C2440. Changing the power pulse frequency, duty cycle and parameters of pulse current work, such as time, direction, size and so on, this completes the kinds of pulse waveform portfolio and average pulse current keeps unchanged. It achieved the long-distance communication and remote display. The design not only increases the life span of electronic components and reliability and enhances coating effects but also can be popularized in other kinds of plating.

Key words: S3C2440, pulse, electroplating, current

INTRODUCTION

In the electroplating process, because of the requirements of different electroplating process, every power has different pulse frequency, pulse width and amplitude and the current and the concentration of the plating liquid may change. So these parameters should be observed and adjusted in time. Multi-pulse power gradually shows advantages, to which double-pulse current and the single-pulse current cannot compare with, for example, enhancement of the ability of anti-fatigue lead. Clearly, the use of multi-wave pulse power has been becoming a trend; a large number of researches show that: Pulse parameters are closely related to the coating structure and properties. To get a better layer deposition, the average pulse current exported from power should not be changed when the parameters are adjusted. In addition, the existing facilities do not have the functions of remote communications and adjustment for the parameters and is not conducive to network management. Because of these, the multi-pulse electroplating power supply system is designed (Xu, 2013).

FUNCTION OF THE SYSTEM AND THE SYSTEM STRUCTURE

Function of the system: The main function of the system,when the average pulse current keep unchanged, by changing the power pulse frequency, duty cycle and parameters of pulse current work, such as time, direction, size and so on, completes the different pulse waveform portfolio. Negative pulse is used for electrolysis and positive pulse is used in electroplating, both of which impose the electrode alternately, which produced a ring-like solid coating. The portfolio for on-time and off-time, alternating run-time of positive pulses and positive pulses comes into being relatively fixed parameters, which is called a specific waveform. According to the presentable time, more specific waveform cycle operation, this is known as multi-waveform. The pulse waveform is produced by the two ports of S3C2440 by connecting some external safe circuit. When electroplating, by real-time acquisition and processing for the pulse current, keeping the average pulse current unchanged, it can improve the quality of the coating. In addition, the pulse parameters can be set to meet the different needs of electroplating industry (Chen *et al*., 2011).

System structure: In the system it chooses the MCU S3C2440 which is made by SAMSUNG CO. This product is designed to provide hand-held devices and general applications with cost-effective, low-power and high-performance microcontroller solution in small die size. To reduce total system cost, the S3C2440 includes the following components separate 16KB Instruction and 16 kB Data Cache, MMU to handle virtual memory management, LCD Controller (STN and TFT), NAND Flash Boot Loader, System Manager (chip select logic and SDRAM Controller), 3-ch UART, 4-ch DMA, 4-ch Timers with PWM, I/O Ports, RTC, 8-ch 10-bit ADC and Touch Screen Interface, IIC-BUS Interface, SD Host and Multi-Media Card Interface,2-ch SPI and PLL for clock generation. The S3C2440 was developed using an ARM920T core, 0.18um CMOS standard cells and a memory complier. Its low-power, simple, elegant and fully static design is particularly suitable for cost-and power-sensitive applications. It adopts a new bus architecture called Advanced Microcontroller Bus Architecture (AMBA). The S3C2440 offers outstanding

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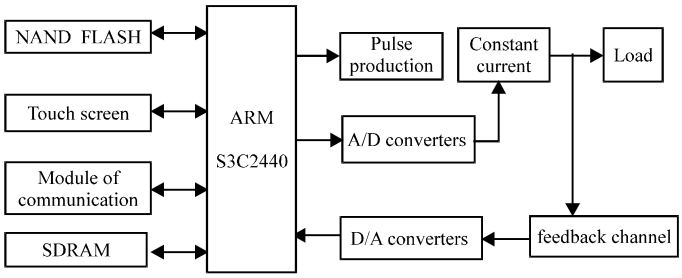

Fig. 1: Structure of the system

features with its CPU core, a 16/32-bit ARM920T RISC processor designed by Advanced RISC Machines, Ltd. The ARM920T implements MMU, AMBA BUS and Harvard cache architecture with separate 16KB instruction and 16KB data caches, each with an 8-word line length. (Tian, 2009)

The system uses S3C2440 which has a high level integration as micro control unit and implements the functions of data acquisition, procession, storage, remote communication and the output of the current pulse waveform. The structure of the system is shown in Fig. 1.

HARDWARE DESIGN OF THE SYSTEM

Design of pulse circuit: S3C2440 has high processing speed, short interrupt response time, stable characteristic and its 16 bits timers can produce more precise pulse width. S3C2440 sets the time of the current which is output by the two ports to produce the pulse and through amplification, photoelectric isolation can obtain stable and suitable pulse. The implementation is setting the internal three groups of timers, including per group's running time, Positive (negative) pulse running time, on-time and off-time and so on. The implementation of pulse is shown in Fig. 2.

In fact, positive pulse and negative pulse are all positive to the control system but they are output from different ports. The combinations of the two pulses are completed by follow-up the current (Liang, 2012).

Design of constant-current module: The constant-current module includes A/D converter that is used for acquisition of pulse current, D/A converter that is used for transforming the digital signal of current into the analogy signal, which can stably output the pulse current. After adjusting the pulse parameters, by analysing and processing the data from real-time acquisition, it assures that the pulse current maintains stable during the electroplating. The structure of the module is shown in Fig. 3. In this design of the constant-current module, a

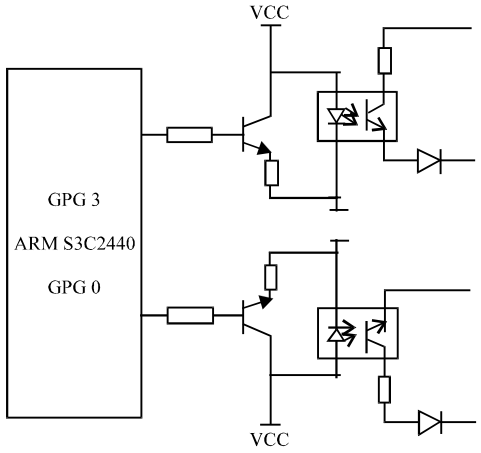

Fig. 2: Schematic for pulse production

12-analog converter chip TLC2543 is chosen for exporting the pulse current required by design, to keep the output accuracy (reaching1 mA). Constant-current diodes made in Zhejiang University are chosen to regulate constant current continuously, which can change in the scope of 0.5 A to 3 A. The important design of the module is the chip of TLC2543, which connects feedback circuit and changes the size of output current.

Circuit design of remote communication: The remote communication mainly completes long-range adjustment and show for the pulse parameters. This design uses the CAN Bus to communicate. Each frame data of CAN Bus has the CRC-tested and other measures factions to guarantee the reliability of data transmission. Its characteristics of short-time transmission, long-distance transmission and low-rate interference decide that it is the best choice for the design. This design uses MicroChip TMCP2510 as the controller of CAN Bus, which can communicate directly with the S3C2440 with a high-speed SPI interface. The implementation of communicate module is shown in Fig. 4.

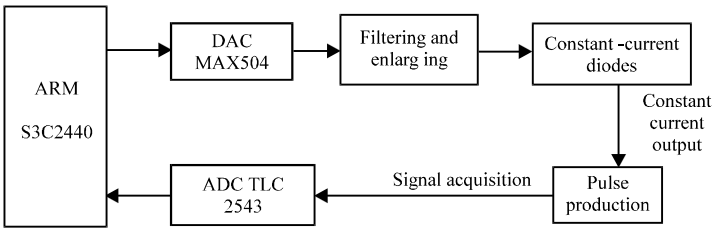

Fig. 3: Schematic for frequency radio

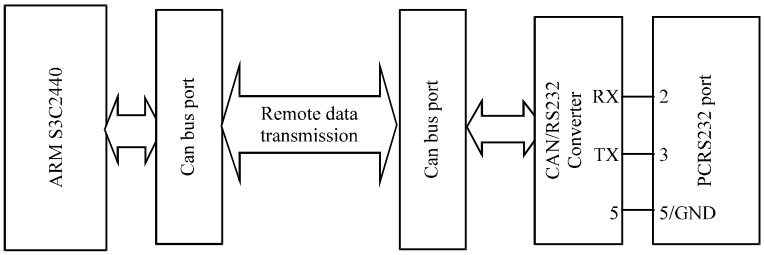

Fig.4: Schematic for Can bus communications

SOFTWARE IMPLEMENTATION

Software implementation adopts modular structure and includes four modules as follows:

Pulse generator module: The model is used to time-lapse turn-on and cut-off the two ports of the chip with the timer by the way of programming. The both positive and negative pulses are produced by the latter electricity without mutual interference after photoelectric isolation. The ten groups of pulse are produced by adjusting the parameters in the control of the ports. (Kuo *et al*., 2010)

Constant current module: Average pulse current keeps constant during electroplating in order to attain much better electroplating quality. In the study a shunt collects real-time current data in electroplating, which is computed from voltage data collected through A/D converter. According to analyzing and handling the current data, then handling through a feedback circuit and constant current diodes, average pulse current maintains constant so as to good coating (Liu *et al*., 2009)

Remote communication module: The module achieves remote communication using CAN Bus. It mainly programs for the SPI interface of CAN controller MCP2510 connected the SIO interface of S3C2440, which can also achieve the function of long-range adjustment and display.

Input and display modules: Entering data into S3C2440 by the touch screen to set the pulse parameter of the

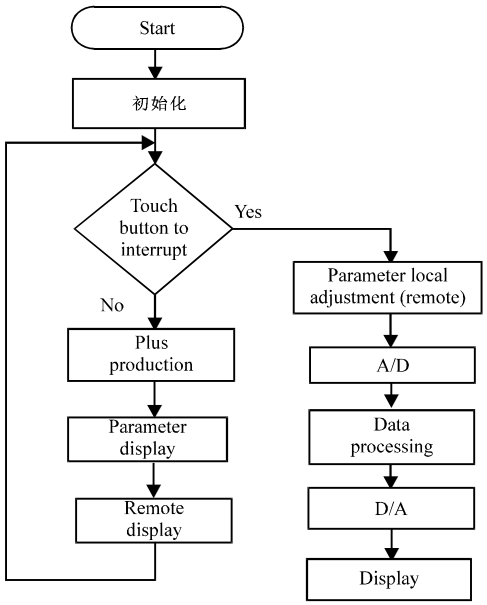

Fig.5: Software flow chart

electroplating, as well as the start and stop state of the system. Controlling the touch screen can display the interface according to a certain format in which modify the pulse parameters. Meantime, it achieves real-time display for the parameters in the operation.

In the entire software design, main program mainly achieves multi-waveform pulse and deployment of the pulse parameters. And the interrupt subroutine mainly set the pulse parameters so as to satisfy the different needs of electroplating industries. The main program flow chart is shown in Fig. 5.

CONCLUSION

The design achieves the functions of keeping the average pulse current unchanged during adjusting the pulse parameters,long-distance communications and adjustment and display for the parameters.

The control core of the design uses S3C2440, a low-price, low-power, high-performance and high-processing speed (up to 400 MHz to 466 MHz),which provides a wealth of internal equipment reduces the external devices of design and makes the design more conveniently and concisely for consumer. And we remain a lot of interface to extern the other external equipment such as video camera that can take the photo of the coating at some time. The design meets the accuracy requirements of the output waveform and ensures that the power supply works stably and reliably. It can be popularized in other kinds of plating.

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