

## Design and application of marine boiler control system based on PLC and touch screen

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**Keywords:** PLC; touch screen;marine boiler control system

**Abstract.** PLC technology and touch screen technology is combined together in order to design a marine boiler control system which realizes the remote visual control.Using PLC and EM235 module realizes analog signal control in order and make the control process stable and feasible. The automatic control module PLC is explained in detail,along with analog signal transmission module EM235 and human-computer interface module MCGS,the hardware architecture and software architecture of the whole system.Therefore,the experimental results show the feasibility and effectiveness of the system . this system prove that it can improve control function of boiler.

### Introduction

Traditional marine boiler uses relay-contactor control system. The control process requires a lot of mechanical contact; the system wiring is complex; fault diagnosis and elimination are difficult; the reliability is not high.Once a fault occurs,it will affect the use of marine power plant and delay shipping, resulting in economic losses.Although after a series of optimization by manufacturers, the problem of low reliability is still difficult to solve.

PLC has many advantages which the traditional relay lacks, including fast response,convenient communication,reliability,redundancy, security, and editing characteristics.This design uses the PLC to control the boiler water level, steam pressure,combustion, water quality,excessive air discharge and alarm system,which can effectively improve the reliability of the control system of the boiler and ensure the normal operation of marine power plant.

### Design Principle

The The core of boiler automatic control system is PLC. All the data of the sensor are sent into the PLC input channel.PLC control boiler water level, steam pressure, water quality, combustion and alarm according to the predetermined procedures, realizing automatic start, stop and switch of water pump and oil pump and maintaining the normal operation of the boiler.When the boiler parameters exceed the set value,the system can automatically open sound and light alarm.When the steam pressure is high but not automatically stop the boiler,the steam pressure high alarm sounds firstly, then the steam pressure extra high alarm forces shutdown, and boiler steam excessive release device is started automatically to release stream to the condenser and meanwhile makes continuous alarms. At the same time in order to ensure safety, the system also includes emergency stop button to ensure that at any time a key stop can work.

### Hardware composition

Boiler automatic control system includes PLC control module,boiler water level control module,steam pressure control module,combustion control module,water quality monitoring module,steam excess monitoring and release module,centralized alarm module and visual operation module.

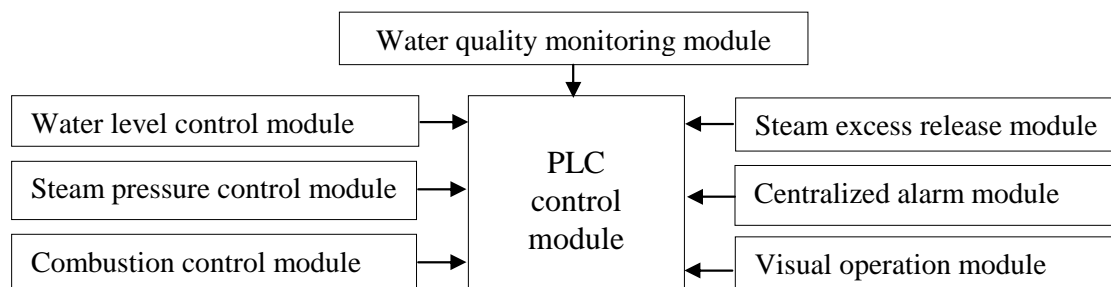


Figure 1 Automatic control system diagram

### PLC control module

According to the system design, PLC control module is mainly composed of SIEMENS S7-200PLC. According to the needs of I/O points, we choose the CPU226. At the same time the PLC adds two EM235 extension modules. It adds 1 EM232 extension module. PLC communicates with other peripherals using module EM277. We chose EM277 to connect S7-200 to the PROFIBUS-DP network.

### Boiler water level control module

The boiler water level control module is composed of the liquid level transmitter, the boiler water level display instrument, feed pump control box and so on. It can realize the boiler automatic feeding water pump, switch, water level real-time display and liquid level abnormal alarm. The model of the liquid level transmitter is CLT-ISOL-24, which is responsible for the detection of water level and transmission of level signals. Boiler water level display instrument selects WL-T803-01-23-HLP model, installed in the control desk of the engine control room.

### Boiler steam pressure control module

The boiler steam pressure control module is composed of steam pressure transmitter and so on. Steam pressure transmitter uses MF1567-3CA00-1AA1 model. The steam pressure signal is converted to 4 ~ 20mA current signal to PLC. PLC controls the size of the burner air duct opening. At the same time, the burner start or stop signal is issued to the combustion program controller, and the boiler steam pressure value is displayed. When the steam pressure is high, the alarm sounds.

### Boiler combustion control module

The boiler combustion control module is composed of an air door regulator, an oil pump variable frequency motor and an oil pump speed sensor. PLC monitors the boiler steam pressure. When the steam pressure is lower than the low pressure setpoint 0.45Mpa it sends boiler lighting signal. When the pressure reaches the high pressure set 0.7Mpa value, it sends out the stop signal, completely automatically controlling the boiler operation. In addition, PLC controls the size of the burner air door opening according to the steam pressure signal in the 4 ~ 20 ma. The speed of the oil pump and the fuel injection quantity are controlled by the frequency converter, so the size of the flame can be calculated according to the steam pressure of the boiler. Oil pump speed, whether the flame is normal and so on issue abnormal alarm or shutdown command through the corresponding monitoring device.

### Boiler water quality monitoring module

Boiler water quality monitoring module comprises a conductive electrode, the water content 15PPM alarm device, the conductivity of conductive electrodes to detect the boiler water, boiler water

salinity monitor to transmit the signal to the resolution. When the salinity is too high, alarm signal is sent to PLC alarm system.

### Centralized alarm module

All alarm and indication signals controlled by PLC get into the PLC computer system. After being dealt with by CPU, alarm and lighting display signals are sent to output channel for alarm and light show, and meanwhile sent to the engine room itinerant detection system.

### Visual operation module

Use the touch screen to operate the whole process, display the input and output, check the alarm and adjust the parameters. Touch screen selection model: MCGS TPC7062Ti Cortex-A8 CPU, Kunlun Tongtai, 7 inch four wire resistive touch screen display with embedded integration, with powerful display and data processing functions.

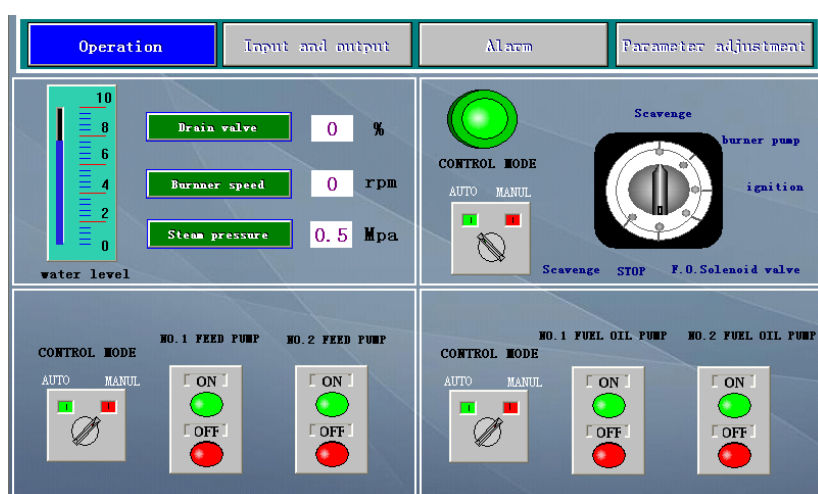


Figure 2 Automatic control system interface

### Boiler steam excess release module

Boiler steam excess release module consist of the I/P signal conversion device, steam release device, etc. When the PLC detects that the stream pressure reaches 0.7Mpa, the output signal of the steam discharge device is transferred to the I/P analog conversion device, and the excess steam is released by the STEAM DUMP VALVE,when the steam pressure is too high, the alarm is sent out.

### Software design

#### System communication

This system mainly uses STEP7-Micro/WIN32 as programming software, modular programming of the system implementation process, S7-200 CPU uses EM277 PROFIBUS-DP module to connect the PROFIBUS-DP network and uses S7-200 CPU EM277 to read / write data.

