Research of Ship Electric Propulsion Simulated Loading Experiment's Measurement Platform Based on CC-Link

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Abstract-CC-LINK network and its communication method were researched to build a network remote measurement platform for the simulated loading experiment of the ship electric propulsion system. FR Series inverter controlled the marine electric propulsion motors and FX series Programmable Controller (PLC) controlled and monitored function stations in real time. The platform adopts the idea of field-bus control system. CC-LINK (Control and Communication Link), was a kind of the field-bus control system, which was communication medium of master station (FX series PLC) and slave stations (FX Series PLC& FR- A540 Series Inverters), the communication program was written based on ladder instruction. We realized control & measurement for the simulated loading experiment of the ship electric propulsion system. We also realized the collection and analysis of the data by network remote measurement platform.

Key Words- field-bus control, ship electric propulsion, measurement platform, CC-Link

I. Introduction

With the high speed development of power electronics and computer technology, the electric propulsion system is increasing extensively applied not only for the war vessels and special ships, but also for the large transportation ships, as its advantages of saving energy and the good maneuvering performance [1]. In order to emulate practically the operation property under different operating conditions concerning different types of ship propellers, it is necessary to install a network remote measurement platform for the simulated loading experiment of the ship electric propulsion system in a laboratory [2].

The platform adopts the idea of field-bus control system. CC-LINK (Control and Communication Link, Mitsubishi) was a kind of the field-bus control system that processes both control and information data at high speed, to provide efficient, integrated factory and process automation. Using CC-Link enables to reduce the amount of control and power wiring required in the platform. As one of CC-Links features, RAS* functions such as, stand-by master function, detaching slave station function and auto return function enable recovery from the communication fault and the system debug at start up time. As for test and monitoring function, confirmation of the data link status, hardware test and circuit test are available [3].

II. Measurement Platform Structure

The platform contains FR- A540 series inverter, induction motors, PC and PLC apparatus, which can be used to simulate the stable and dynamical properties of marine propeller operating in different conditions, and provide verisimilar shaft load for propulsive motor. CC-Link was communication medium of master station (FX series PLC) and slave stations (FX Series PLC&FR- A540 Series Inverters). The measurement platform structure diagram is shown in Figure 1.

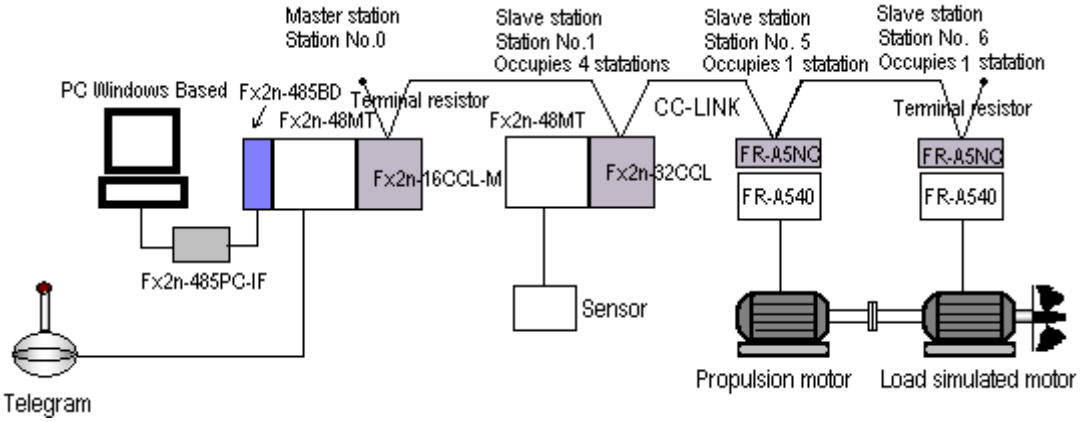

Fig.1. Measurement Platform structure based on CC-Link

The CC-Link master block FX_{2N}-16CCL-M was a special extension block, which assigns an FX series PLC as the master station of the CC-Link system. The CC-Link interface block FX_{2N}-32CCL is an interface block, which connects the FX series PLC as the slave station of the CC-Link system. The CC-Link interface block FR-A5NC is an interface block, which connects the FR-A540 series Inverter as the slave station of the CC-Link system. There are three remote device stations (slave stations) in the measurement platform. FR-A540 Series inverters are used to control the marine electric propulsion motor and load simulated motor, and FX series Programmable Controller (PLC) is used to control and monitored remote device stations in real time. In above CC-Link system, station No.1 occupies 4 stations, station No.5 occupies 1 station and station No.6 occupies 1 stations [4] [6] [7].

III. Data Communication in real time

A. Initialization for CC-Link

The communication format in inverter must be set using the contents of parameter register before the CC-Link system running. In table 1, there is a simple example to show make a communication format in inverter [7].

Table.1

Number of Parameter	Setting	Content of parameter
Pr.79	1	PU or external operation mode
Pr.340	1	CC-Link operation mode
Pr.338	0	Operation command write
Pr.339	0	Speed command write
Pr.180 to Pr.186 Selective functions	0	Low-speed operation command (RL)
	1	Middle-speed operation command (RM)
	2	High-speed operation command (RH)
	3	Second function selection

The table.2 show the items set in the buffer memory " parameter information area" in the master station

for the CC-Link system through PLC instruction [6].

Table.2

Setting item	BFM# Hex.	Description and Setting value
Number of connected modules	1H	Sets the number of remote station modules (including reserved stations) connected to the master station. Setting value: **3**
Number of retries	2H	Sets the number of retries executed when communication error occurs. Setting value: **3**
Number of auto. return modules	3H	Sets the number of remote station modules which can recover in one link scan. Setting value: **3**
Operation specification against CPU down	6H	Specifies the data link status when an error occurs in the master station PLC CPU. Setting value: **0**(stop)
Reserved station specification	10H	Setting value: **0**
Invalid station specification	14H	Setting value: **0**
Station information	20H to 2EH	Sets the type of connected remote device station. Setting value: 20H(1st slave station, PLC) 1401H; 21H(second slave station, FR-A540) 1105H; 22H(third slave station, FR-A540) 1106H

In order to build CC-Link between master station and remote device stations, a program for parameter setting in master station is wrote. Figure 2 shows the basic programming procedure flowchart for communication between the master station and remote device stations. In the program below, CC-Link automatically starts when the PLC starts to run.

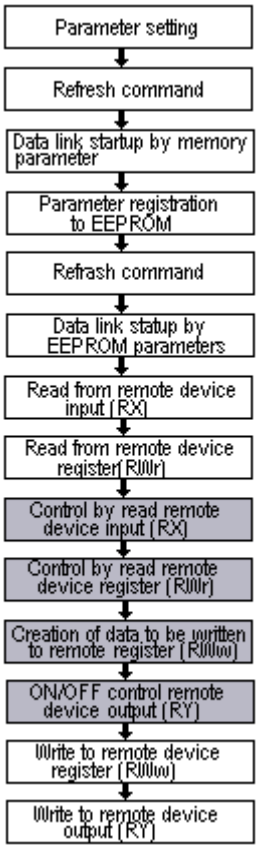

Fig.2. The basic programming procedure flowchart for parameter setting

B. Data communication between the master station and the remote device stations

The CC-Link status should be read from the master station buffer memory. It is necessary to make sure that data link is being executed in master station and remote device stations (station No.1, station No.5, station No.6) before data communication between the master station and the remote device stations. There is a simple example to show how to design data communication program based on ladder instruction. In figure 3,the instruction shows that the master station reads the inverter status of the remote device station No.5 (inverter 1) to M0-M7 and writes the control command to the remote device station No.6 (inverter 2) in real time when data link between the master station and remote device stations is being executed.

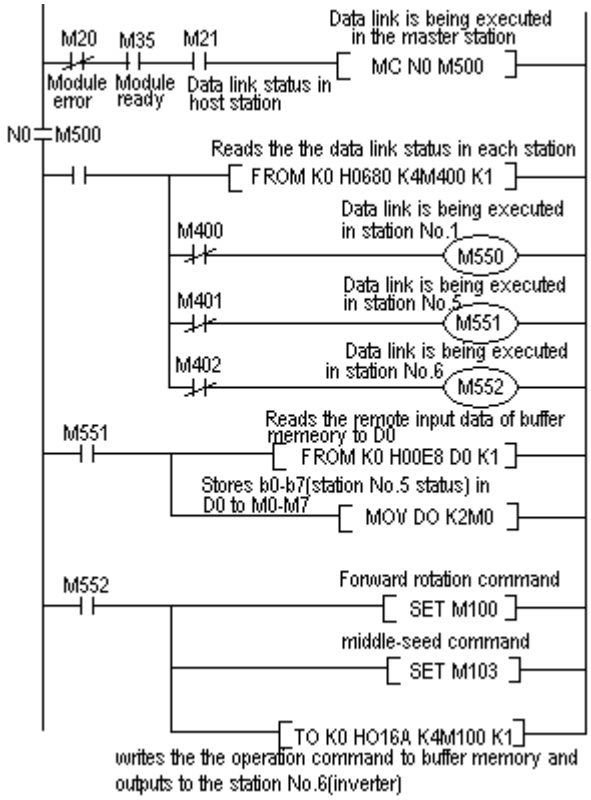

Fig.3. Data communication program

C. Data communication between PC and the master station

In VB6.5 there are many customize control components, the MSCOMM32.OCX is the control component of serial communication. It is used to design communication applications. There is a simple example to show how to design a serial communication initialization program [8].

```
Private Sub Form_Load()
MSComm1.CommPort = 2        ‘useCOM2
MSComm1.Settings = "9600,n,8,1"        ‘9600 baud rate，no parity check， 8data bit，stop 1bit
MSComm1.InputMode = comInputModeText      ‘confirm input property
MSComm1.PortOpen = True      ‘open port
```

End Sub

Using the calculation model of ship-propeller system [8], the measurement platform can show and analyses the data of the propulsion performance on real time. The Figure 4 shows the friendly interface of the measurement platform. A series data about the propulsion motor's working condition, the simulated motor's working condition, the inverter's working condition and propeller revolution and troupe can be inputted into the measurement platform by the serial communication between PC and the master station, etc, then the propulsion performance data can be calculated and displayed on the friendly interface.

The serial communication between PC and the master station is achieved under integrated developing surrounding of Visual Basic 6.5 in operating system of Windows 2000, which has successfully used in marine electric propulsion simulation system. Through the serial communication, we realized the collection and analysis of the data by the network remote measurement platform [5].

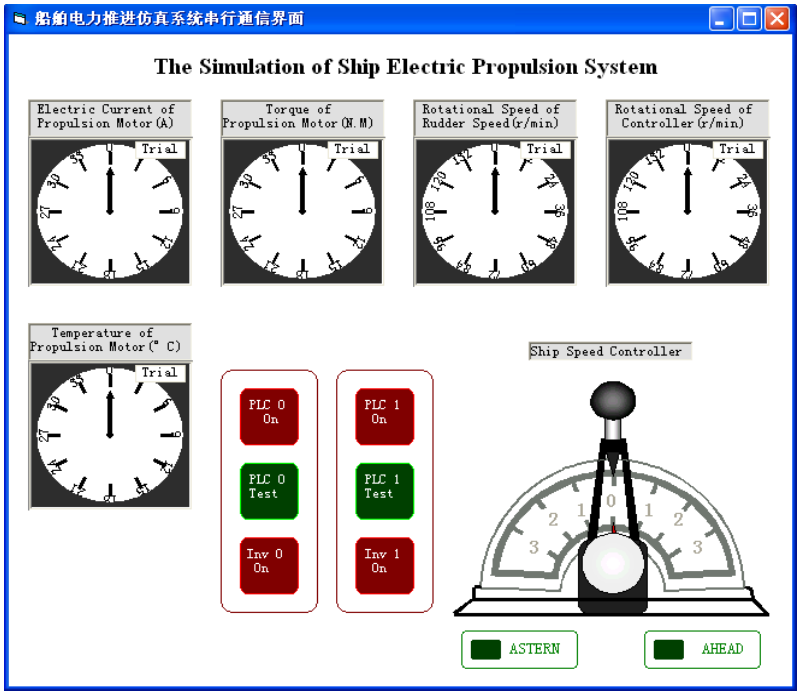

Fig.4. The friendly interface of the measurement platform

IV. Conclusion

The paper introduces the ship electric propulsion simulated loading experiment's measurement platform based on CC-Link. It can be used to monitoring the real time data, to calculating electric propulsion system's transportation energy performance, and to analysis the propulsion performance. However, we just have developed this measurement platform in lab at simulated condition. As one of a future task, this measurement platform will be installed in an actual ship to achieve the monitoring of propulsion performance, etc. of a ship.

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