

# The Design of the Self-healing Fiber Ring Network System Based on the ARM

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**Abstract:** In order to improve the reliability of power the new energy conversion system, we have used the STM32F107 Ethernet transformer and network switching chip 88E6095F to realize SDH self-healing fiber ring network design method, and using real-time monitoring of network and optimizing network traffic to adapt the new energy substations. Through the introduction of system hardware and interface circuits, we have illustrated the hardware realization of multi-chip network of interconnected, without the cut off of the fault circuit packet, and tackle the problem of signal transmission loss.

**Keywords:** SDH; STM32F107; 88E6095F; Ethernet transformer;

## INTRODUCTION

The rapid development of Internet technology has quickly hit various fields, and the larger user group has posed great challenges to servers. The problem of interrupt and packet loss, brought great inconvenience to users[7]. In the new energy substations system, using Ethernet interface SDH self-healing fiber optic data communications can effectively solve these problems[4]. STMicroelectronics produces integrated STM32F107 Ethernet module, which supports the transmission of Ethernet. A switching chip 88E6095F produced by Marvell provides 100/1000Mb/s Ethernet interface and has universal network interfaces that simplify the software development process, and realize the TCP/IP network protocols[10].

## HARDWARE DESIGN

*The principle and technical features of the system.*

Based on ARM Cortex-M3 nuclear STM32F107 is the main control chips, with a maximum operating frequency is 72MHz, a high speed memory, rich resources of enhanced I/O port and peripherals, Ethernet MAC controller is contained within it, but without the physical layer interface[1]. The 88E6095F as Ethernet physical layer interface device, which P8, P9, P10 port support connection Sedes receiver, an external 10/100/1000M copper phys and 1000base-x fiber ports can be directly connected to the optical amplifier. This ensures the effectiveness, reliability and security of the SDH optical fiber self-healing ring network technology. The self-healing fiber function and it's realization.

*Function and realization of self healing optical fiber*

The self-healing principle of the self-healing fiber ring network is to distribute the equipment information in the two rings in the reversed signal flow[6]. Generally, only main ring is in work, and prepared ring is in alternate state. When the fiber break of a joint break in the ring, the closed two rings automatically turn back through changing the delivery and receive of the data flow. At this time, the ring network is still a close ring, so as to maintain the fluency of the communication path[3]. As shown in the Figure 1. When the failure point link is restored, the prepared ring returned to the backup status. So we can see that when there is a failure point in the network, the optical fiber self-healing ring network can quickly switch channels[9]. The switching time is less than 20ms for 100M Ethernet, and less than 0.5s for 10M Ethernet, thus ensuring the normal communication devices on the network its reliability is higher than dual-line network. Meanwhile, the multilevel in the optical fiber self-healing ring networks has further improved the reliability of the network[8].

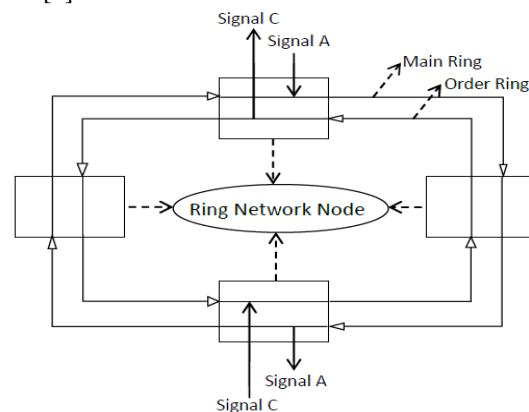


Fig. 1 Diagram of Ethernet self-healing fiber ring

*The overall structure of the system.*

According to the systematic requirements, its hardware structure as shown in Figure 2, and the functions of each module as follows. The stable source module provides stable power for system work; the crystal vibration module provides clock for system and decides the run rate of system; the reset module uses reset chip to reset MCU[5]. The serial communications module outputs debugging information and the part network information

of set; the data storage module is used for large information storage; the network interface module can achieve the Ethernet function; and the RJ-45 interface achieves and network Exchange chip of docking[2].

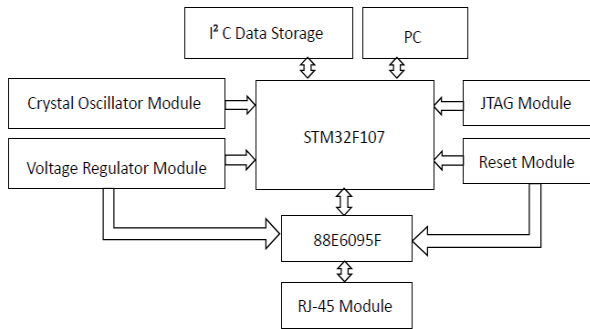


Fig. 2 the overall structure of the system

*The hardware circuit diagrams of the system.*

The entire system is controlled by the master chip STM32F107, and connecting with 88E6095F, the network interface as shown in Figure 3. The 88E6095F provides 8 Gigabit optical port and 3 hundred trillion, and have chip P0-P10 respectively. Every piece P0-P7 of 88E6095F is corresponding to the 1-8 of RJ45 port. P8 and P9 Gigabit port are used for for interconnection between chips[13].

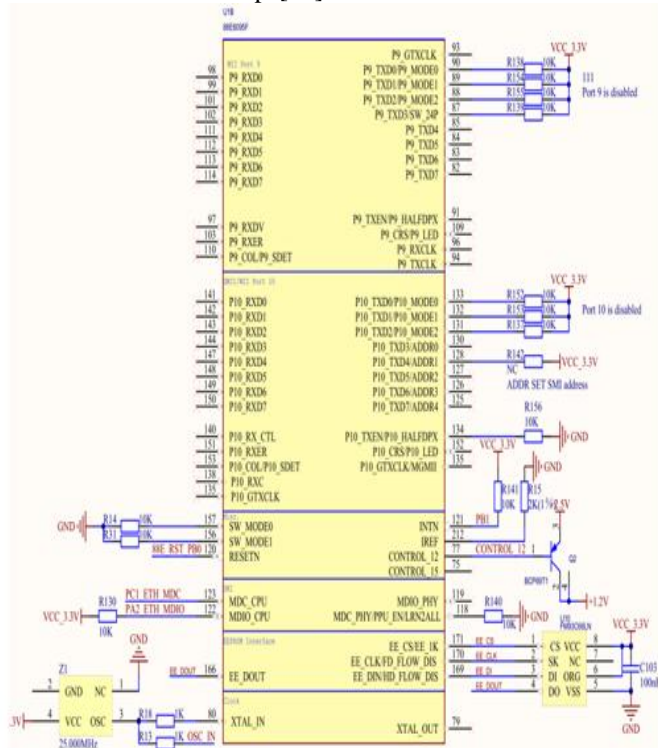


Fig. 3 network switching module

## THE IMPLEMENTATION OF SYSTEM SOFTWARE

*Software and hardware structure of the system*

The system design uses the development environment MDK-ARM, which is specifically designed for micro-controller, providing a perfect C/C++ development environment. Compared with the other ARM development environment, MDK-ARM has advantages of easy access to start, strong functions, and including plenty of middle storage[11]. The hardware and software structure of the system is shown in Figure 4.

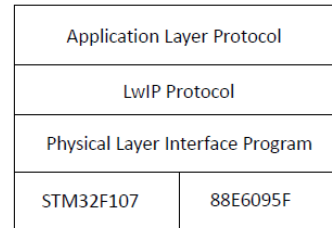


Fig. 4 software and hardware structure diagram of the system

*The design of the software system.*

Mainly accomplish the initial value of the register set and the initial value of the switching modules in all registers of the STM32F107. Before the work of the master chip STM32F107, you must make the necessary initialization, including circuit, reset the clock generator, general purpose register, etc[12]. That shows the main initialization settings for switching chip 88E6095F. The flow chart as shown in Figure 5.

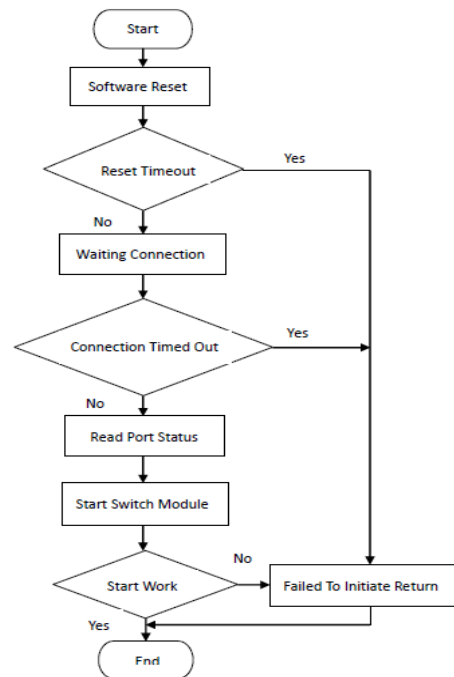


Fig. 5 flow chart of network switching chip initialization

*The implementation and application of the LwIP protocol stack*

Lightweight IP (Light Weight IP, LwIP) protocol is an implementation of the TCP/IP protocol stack. It can be transplanted to a variety of operating systems, can also be run

without support independent of the operating system. The focus of the LwIP implementation is on the basis of maintaining the main functions of the TCP/IP Protocol reduced memory footprint and code size[17]. LwIP has implemented an integrated IP, CMP, UDP, TCP protocol. It has the functions such as super time estimates, rapid recovery and replay, window functions, etc. The protocol stack provides a set of API functions for the application, making the programming convenient[15]. The LwIP initialization code is as follows:

```
void LwIP_Init(void)
{
    struct ip_addr ipaddr;
    struct ip_addr netmask;
    struct ip_addr gw;
    uint8_t macaddress[6]={0,0,0,0,0,1};
    mem_init();
    memp_init();
    #if LWIP_DHCP
    struct ip_addr=0;
    netmask.addr=0;
    gw.addr=0;
    if(!STM_EVAL_PBGetState(Button_TAMPER))
    {
        Server=SELECTED;
    }
    Else
    {
        Server=NOT_SELECTED;
        Macaddress[5]=CLIENTMAC6;
    }
    #else
    IP4_ADDR(&ipaddr,192.168.0.8);
    IP4_ADDR(&netmask,255.255.255.0);
    IP4_ADDR(&gw,192.168.0.1);
    #endif
    Set_MAC_Address(macaddress);

netif_add(&netif,&ipaddr,&netmask,&gw,NULL,&ethernetif_in
it,&Ethernet_input);
    netif_set_default(&netif);
    #if LWIP_DHCP
    dhcp_start(&netif);
    #endif
    Netif_set_up(&netif);
}
```

### TCP communication protocol

TCP is a connection-oriented protocol, firstly based on the IP address and port number to establish a SOCKET connection[16]. Establishing a SOCKET connection has TCP-server and TCP client. TCP server waits for the end connection request (SYS packets), and establish a SOCKET connection when the connection request is received (passive open). TCP client makes a connection requests actively, and to establish a connection (active open). UDP is a connectionless datagram communication protocol, supporting unicast, broadcast and multicast traffic[18]. TCP initialization code is given below:

```
void Tcp_Server_init(void)
{
    Struct tcp_pcb*pcb;
    pcb=tcp_new();
    tcp_bind(pcb,IP_ADDR_ANY,1025);
    pcb=tcp_listen(pcb);
    tcp_accept(pcb,SrcData_accept);
}
Void Tcp_Client_init(void)
{
    struct tcp_pcb*pcb;
    struct ip_addr ipaddr;
    IP4_ADDR(&ipaddr,192.168.0.10);
    pcb=tcp_new();
    tcp_bind(pcb,IP_ADDR_ANY,1025);
    tcp_connect(pcb,&ipaddr,1025,TcpCli_connected);
}
```

### EXPERIMENTAL ANALYSIS

The self-healing fiber ring network design uses network switching chips combined with the STM32F107. Although the cost is slightly improved, but it has brought the substantial increase in performance. It provides an RS232 interface, and two redundant input 220V AC/DC power supply, which can realize 4 100BASE-T RJ45 interface and 2 100BASE-FX ST. It has very good reliability, strong anti-interference ability. Users can use the software to switch the configuration parameters, increase flexibility; and can also through cascading 88E6095F chip, extend Ethernet interface, configure one of your own self-healing fiber ring network system.

### SUMMARY

With the development of electric power optical fiber communication system, the Ethernet using optical fiber self-healing ring backbone as a substation can greatly improve the communication within the station's speed and stability and reliability, so as to meet the requirements of substation automation system communication performance. Optical fiber self-healing ring network based on embedded technique in substation integrated automation system in engineering practice has been applied and achieved good operating results.

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