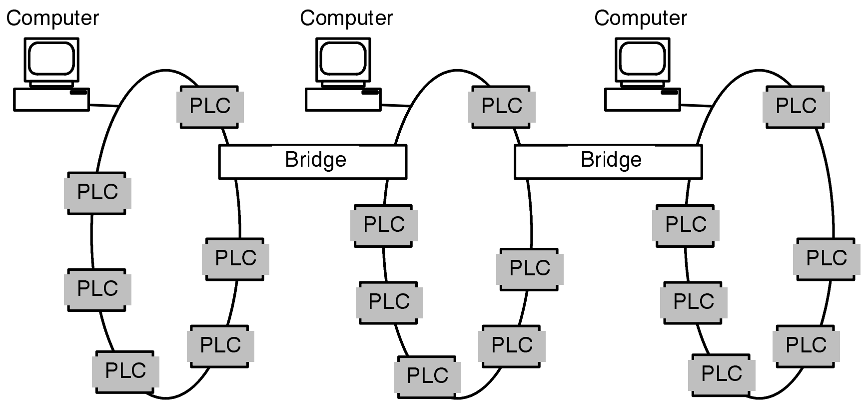
SYSMAC NET

SYSTEM MANUAL

December 1995



Notice:

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

The following conventions are used to indicate and classify warnings in this manual. Always heed the information provided with them.

DANGER! Indicates information that, if not heeded, could result in loss of life or serious injury.

Caution Indicates information that, if not heeded, could result in minor injury or damage to the product.

OMRON Product References

All OMRON products are capitalized in this manual. The word “Unit” is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product.

The abbreviation “Ch,” which appears in some displays and on some OMRON products, means “word” and is abbreviated “Wd” in documentation.

The abbreviation “PLC” means Programmable Controller and is not used as an abbreviation for anything else.

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

1, 2, 3... Indicates lists of one sort or another, such as procedures, precautions, etc.

TABLE OF CONTENTS

SECTION 1 1
Introduction 1
1–1 What is a Control System? 2
1–2 Local Area Networks 3
1–3 System Configuration 4

SECTION 2 7
Components of the SYSMAC Network 7
2–1 Line Server 8
2–2 SYSMAC NET Link Module 9
2–3 Network Support Board 15
2–4 Network Service Module 20
2–5 Bridge 22
2–6 Optical-Fiber Cable 24

SECTION 3 27
Network Communication 27
3–1 Network Communication Software 28
3–2 Communication Format Differences 31
3–3 Data Flow 34
3–4 Routing Tables 35
3–5 Datagram Transmission Times 36
3–6 Data Link Transmission Times 37
3–7 Application Example 38

SECTION 4 43
Troubleshooting Functions of the NSB 43
4–1 Diagnostic Utilities 44
4–2 The Status Read Test 45
4–3 The Echoback Test 45
4–4 The Broadcast Test 46

Appendices
A Standard Models 47
B Specifications 49
C Software Files 51

Glossary 53

Index 57

Revision History 61

About this Manual:

This manual describes the SYSMAC NET local area network. The SYSMAC NET LAN is a powerful and reliable industrial local area network which allows the user to efficiently integrate factory automation activities and to capture production information. Production information can be used to increase quality and productivity while decreasing downtime and unnecessary inventory. Up to 126 nodes may be connected to a network loop, with the option of increasing this number to virtually thousands by the use of Bridges between network loops. The SYSMAC NET LAN can provide a cost-effective path from individual machine control, through cell and area control, to full factory automation.

This manual is organized as follows:

Section 1 gives an overview of the SYSMAC NET LAN and describe example system configurations.

Section 2 introduces each of the Units that provide connection to the network. More specific information regarding any of these Units can be found in the individual manuals.

Section 3 describes methods of transferring information between devices connected to the SYSMAC NET. It also describes some example applications and the programming required for these configurations.

Section 4 introduces each of the three diagnostic tests that are included with the software of the Network Support Board. These tests are effective to identify the cause of an error on the network. For more specific information, refer to the *NSB Operation Manual.*

Appendixes, a ***Glossary***, and an ***Index*** are also included.

Thoroughly familiarize yourself with the contents of this manual before installing the SYSMAC NET LAN.

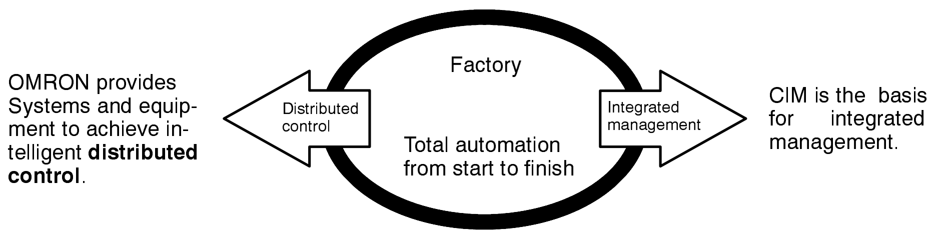
SECTION 1
Introduction

Factory automation simply means that the dull, repetitive work of the factory no longer has to be done manually. The day-to-day tasks are handled mostly by machines, leaving the personnel free to devote more of their time to system improvement, problem-solving, etc. But factory automation is a continuing revolution. Newer and better ways to handle automation are always being discovered.

Distributed control is an automation concept in which control of each portion of an automated system is located near the devices actually being controlled. This means that some of the load is taken off of the central controlling device by having smaller controlling devices distributed throughout the factory.

"Intelligence" in factory automation means that a device is running a user-specified program and is therefore capable of making decisions regarding the process being controlled. Intelligent **distributed control** means that the intelligence is not centralized, but distributed so that it is near the devices actually being controlled. That is, separate programs are running on separate controlling devices in separate areas, instead of one larger program being run on a central controlling device. This means more programs, but each one is smaller and easier to maintain.

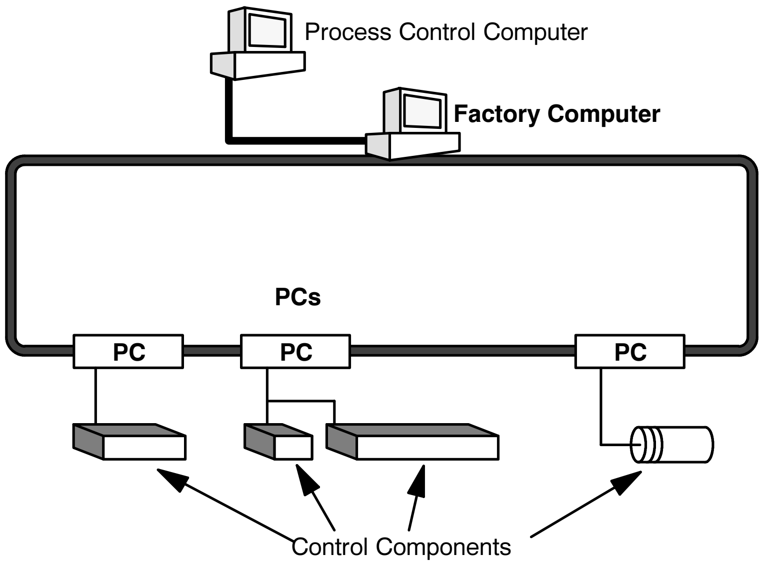
Computer integrated manufacturing (CIM) is an automation concept in which computers are connected to the System not only to exercise direct control, but also for input and output of data regarding the production process. The most important role played by CIM is to provide up-to-the-minute information about current production activities. This makes CIM the basis for new possibilities in the way production is handled.



1–1 What is a Control System? 2
1–2 Local Area Networks 3
1–3 System Configuration 4

1-1 What is a Control System?

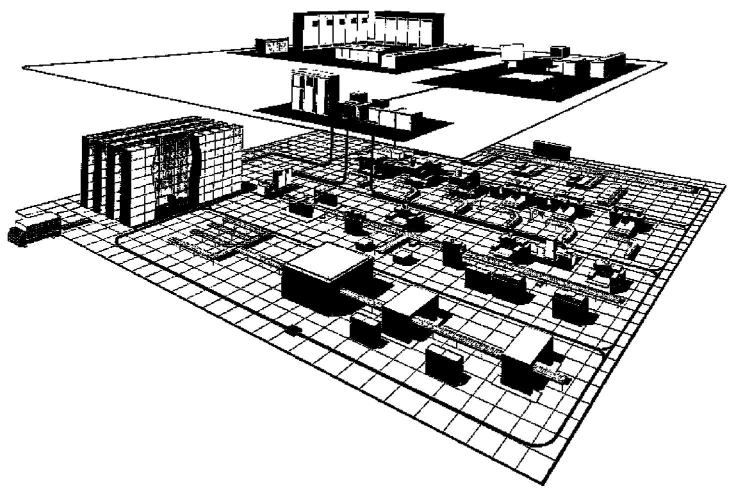
A **Control System** is the electronic equipment needed to control a particular process. It may include everything from a process control computer, if one is used, to the **factory computer**, down through the **PCs** (and there may be many of them networked together) and then on down through the network to the control components: the **switches**, **stepping motors**, **solenoids**, and **sensors** which monitor and control the mechanical operations.



A **Control System** can involve very large applications where many different models of **PC** are networked together or it could be an application as small as a single **PC** controlling a single output device.

1–2 Local Area Networks

What ties the System together is the **Local Area Network** (**LAN**). A Local Area Network is a network of computer equipment interconnected by dedicated communication channels for the purpose of data sharing. Each device connected to a network is called a node. Installing a LAN in a factory is similar to installing a phone system in an office building; while each node, or office, can continue to operate independently, the option also exists for information to be shared. The SYSMAC NET LAN consists of C/CV-series PLCs (programmable controllers) and computers.



Token Ring

The SYSMAC NET LAN works in a loop configuration. Communication among nodes follows a protocol called token ring. The token ring architecture controls network communication by passing a token around the loop. A node can send data only when in possession of the token.

A SYSMAC NET token is generated by the network's Line Server. This Module is the only device on the network that is responsible for generating the initial token and monitoring the token. The Line Server can be set to generate a new token after a specified amount of time if the previous one has not returned. Every network loop must have one, and only one Line Server.

Routing Protocols

Internetwork routing protocols are based on the popular Transmission Control Procedure/Internet Protocol (TCP/IP) which was derived from the U.S. Defense Department's (DoD) ARPANET. Maximum packet size is 2K bytes. This includes up to 2011 bytes of data in ASCII or binary (for numeric data) format. A variety of packet types are predefined, including datagrams, data link, diagnostic and network management functions. These packets may be used with OMRON'S network software to simplify interface of application programs to the SYSMAC NET hardware. In addition, the open architecture of SYSMAC NET allows custom packets and packet definitions to be defined by the user for those who wish to interface directly to the SYSMAC NET hardware. The latter option typically requires an assembly language program.

Network Node

A SYSMAC NET LAN can be composed of up to 126 network nodes. The following are the major hardware components used to interface these devices to a SYSMAC NET.

- Network Support Board (NSB): Interfaces IBM-PC/AT compatible computers with SYSMAC NET.

- Network Link Module (SNT): Interfaces OMRON's Programmable Controllers (PLCs) with SYSMAC NET.
- Network Service Module (NSU): Interfaces to SYSMAC Net through two RS-232C ports. Allows synchronous or asynchronous communications up to 9,600 bps using both ports, or 19,200 bps using only one port. An RS-422 version is also available.
- Local Bridge: Interfaces multiple SYSMAC NET LANs together. A CV PLC can also be used as a bridge.

Node Bypass

Two features are designed into SYSMAC NET's architecture to improve reliability. The first is a node bypass feature which allows communications through a node even if the device is powered-down. A local power supply is required at each node for implementation of this feature.

backloop

The second feature is a backloop function. This feature operates by SYSMAC NET sending all data on a dual-ring configuration, allowing data to flow on a secondary path if an error is encountered along its primary path. The Optical-Fiber Cable is composed of two strands. If a cable is broken or a node is not functioning, then the stations on either side of the failure automatically reconfigure to direct data along the secondary path of the fiber with data flowing in the opposite direction. This backlooping function helps to ensure that there is always a reliable connection between network nodes.

Optical-Fiber Cable

SYSMAC NET LAN nodes are connected to each other by Optical-Fiber Cable. Optical-Fiber Cable is good in factory environments because it is resistant to the electrical interference present around high voltage electrical cables. Optical-Fiber Cable also gives the SYSMAC NET LAN the ability to be extended for loop distances of up to 1 km between nodes with standard cables, or greater distances using special cables or a Repeater Module.

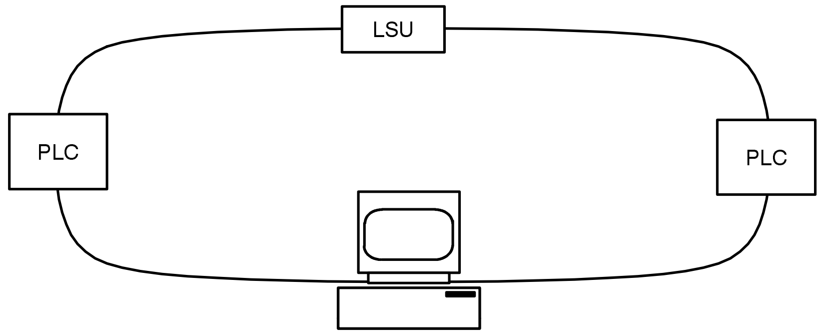
Troubleshooting

Using the troubleshooting software provided with the Network Support Board, the location where backlooping is occurring can be identified. The damaged node or cables can then be corrected. The SYSMAC NET LAN has troubleshooting software packaged with the Network Support Board. Every network should have at least one computer so that this software can be used. The software contains three tests that will isolate network problems. These tests are the Status Read, Echoback, and the Broadcast tests. Refer to *Section 4–1 Troubleshooting Functions of the NSB* for details.

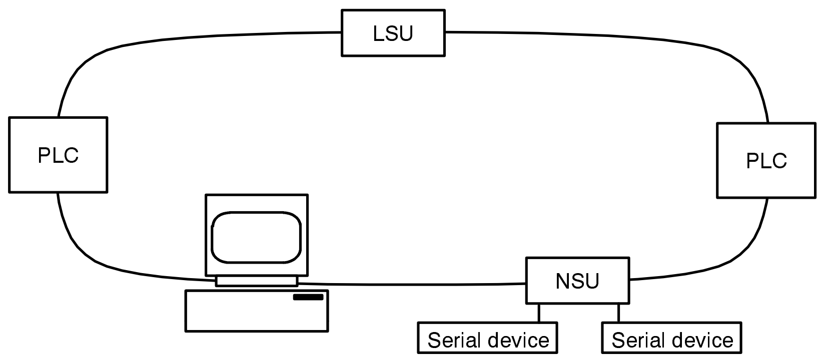
1–3 System Configuration

The SYSMAC Network can be used for high-speed data exchange among PLCs, or for monitoring any network device. PLCs, computers, and serial devices may be added to the network. This section will introduce some possible system configurations but will leave out the specific programming required for operation. Refer to *Section 3–7 Application Example* for more specific examples.

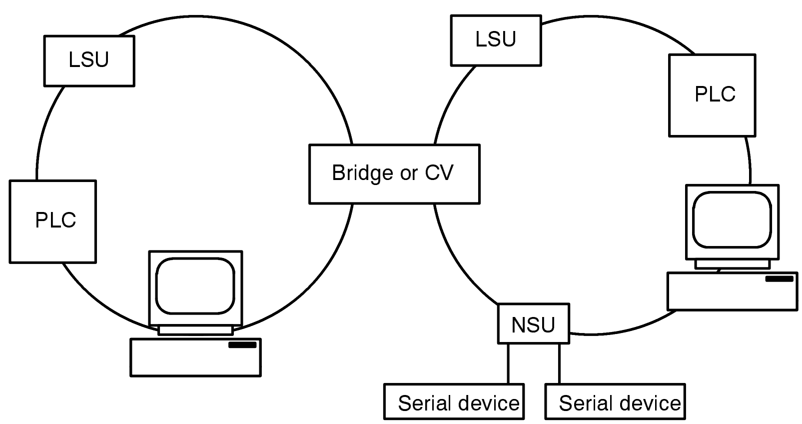
The minimum configuration for communication requires the Line Server and two nodes. One of the nodes should be a computer equipped with a Network Support Board.



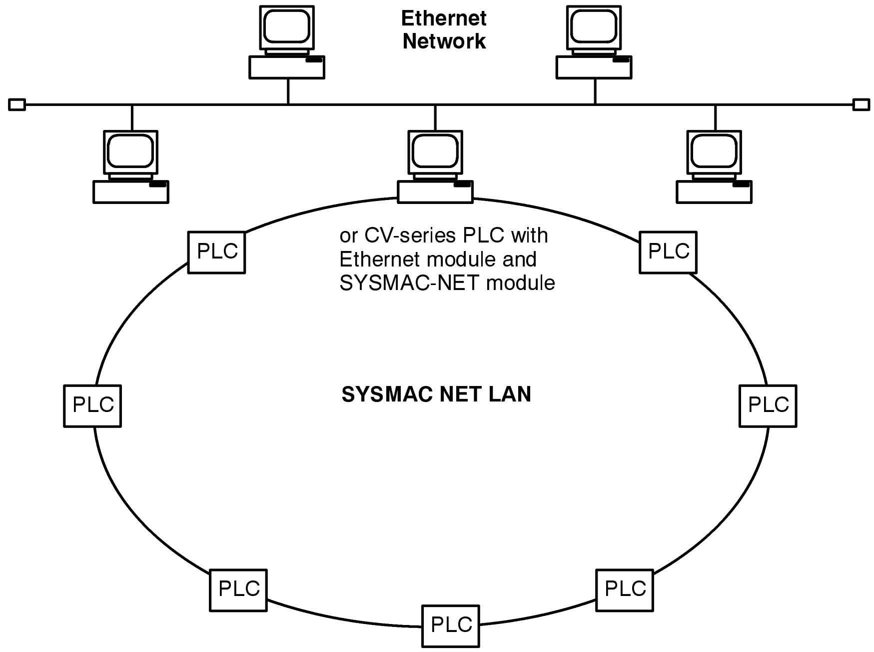
Many networks can be enhanced by use of an RS-232 serial device such as a printer. To attach these devices to the network add a Network Service Module. Each Network Service Module can control two serial devices.



Eventually, it may become advantageous to combine two network loops together so that nodes from one network loop can communicate with the nodes on the other network loop. A Bridge or CV-series PLC is required to connect the two loops. Each of the network loops can have a maximum of 126 nodes including the bridge.



Finally, a computer can be used as a gateway to link the SYSMAC NET LAN to other types of networks. The SYSMAC NET LAN is compatible with TCP/IP (Transport Control Protocol/Interface Program) which allows it to connect to NOVELL SFT (Safety Fault Tolerance) Netware. NOVELL Netware is the most commonly used software for Ethernet Networks. The following example shows an Ethernet Network linked to a SYSMAC NET Network.



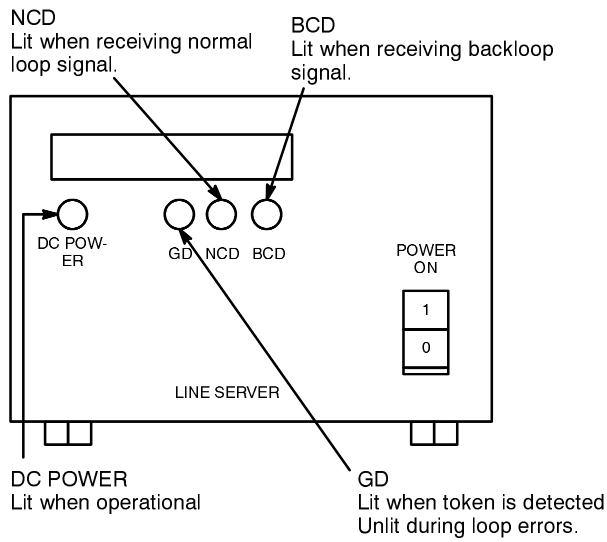
This section introduced local area networks, the SYSMAC NET architecture, and discussed some possible system configurations. *Section 2 Components of the SYSMAC Network* will provide more information about the Line Server, Cables, Network Link Modules, Network Support Boards, Network Service Modules and Bridges.

SECTION 2
Components of the SYSMAC Network

2–1 Line Server 8
2–2 SYSMAC NET Link Module 9
2–3 Network Support Board 15
2–3–1 Network Support Board Hardware 15
2–3–2 Network Support Board Software 17
2–4 Network Service Module 20
2–5 Bridge 22
2–6 Optical-Fiber Cable 24

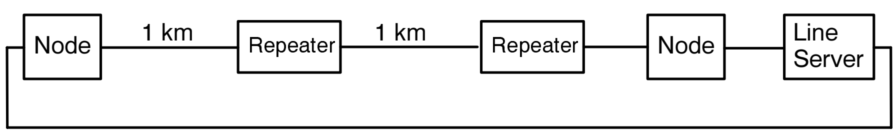
2-1 Line Server

The purpose of the Line Server is to issue the initial token and monitor the network token. Once the token is generated, it travels to subsequent nodes in a **downstream** direction. Downstream is the normal direction the token travels, while **upstream** is the opposite direction. Each network loop must have one and only one Line Server.



Using the Line Server as a Repeater

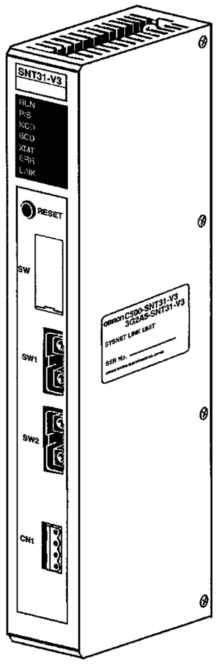
A repeater is required when the distance between two nodes of the network loop exceeds 1 km. When a repeater is required, a Line Server is set to function as a repeater. When functioning as a repeater, the Line Server only receives and re-transmits the token or datagram. The network loop can have up to two consecutive repeaters.



2-2 SYSMAC NET Link Module

The SYSMAC NET Link Module is used to connect a PLC to the SYSMAC NET LAN. Once the PLC is on the network, it can send and receive data from other nodes.

The SYSMAC NET Link Module is mounted to the backplane of the C200H, C500, C1000H, C2000H, or CV-series CPU racks. Like other SYSMAC NET devices, it has an SL1 and SL2 port for connecting the Optical-Fiber Cables.



Note This Section 2-2 is for C-series modules only. For details on CV modules, please refer to Manual W242.

Data Format

The SYSMAC NET Link Module can send information in ASCII or binary format. PLCs must be set for one of these formats, and ASCII is usually chosen because it is easier to use. ASCII must be converted to binary when communicating with the Module's CPU, so binary has a speed advantage. A single network loop can have communication in both binary and ASCII, as long as PLCs share the same format.

Programming

The SYSMAC NET Link Module automatically issues a response when it receives a message from another node. Also, it expects to receive a response when it transmits to another node. The response notifies the Module that the message was received by the node to which it was addressed. If the sending Module does not receive a response, its error flag will turn ON and the ERR LED will light.

Note When communicating between two PLCs, the response is automatic. When sending a message from a computer to a PLC, the SYSMAC NET Link Module's response will be sent and the computer will ignore it unless otherwise programmed. However, if sending from a PLC to a computer, a response must be written into the computer's program so that the PLC receives a response.

Network messages are 2K bytes in length, being composed of a header and data. Command and response information is located in the header portion of the message. The header can be further divided into the subheader code and the completion code. The subheader tells the Module what command it should execute. The completion code is found only in the header of the response.

The following table lists commands for the SYSMAC NET Link Module. Also shown are the valid PLC modes for the commands. For command details, refer to the *SYSMAC NET Link Module Operation Manual*.

Subheader	PLC Mode			Command
	Run	Monitor	Program	
$00	Y	Y	Y	IR/SR Area Read
$01	N	Y	Y	IR Area Write
$02	Y	Y	Y	LR Area Read
$03	N	Y	Y	LR Area Write
$04	Y	Y	Y	HR Area Read
$05	N	Y	Y	HR Area Write
$06	Y	Y	Y	PV Area Read
$07	N	Y	Y	PV Area Write
$08	Y	Y	Y	TC Area Read
$09	N	Y	Y	TC Area Write
$0A	Y	Y	Y	DM Area Read
$0B	N	Y	Y	DM Area Write
$0C	Y	Y	Y	SV Read 1
$0D	Y	Y	Y	SV Read 2
$0E	N	Y	Y	SV Change 1
$0F	N	Y	Y	SV Change 2
$10	Y	Y	Y	Status Read
$11	Y	Y	Y	Status Write
$12	Y	Y	Y	Error Read
$13	N	Y	Y	Force Set/Reset
$14	N	Y	Y	Force Set/Reset Cancel
$15	Y	Y	Y	I/O Register
$16	Y	Y	Y	I/O Read
$17	Y	Y	Y	Program Read
$18	N	N	Y	Program Write
$1A	N	N	Y	I/O Table Generation
$1B	N	N	Y	DM Size Change
$1C	Y	Y	Y	AR Area Read
$1D	N	Y	Y	AR Area Write
$1E	Y	Y	Y	Data Link Status Read
$1F	Y	Y	Y	Data Link Setting Table Read
$20	Y	Y	Y	Data Link Setting table Write
$21	Y	Y	Y	Data Link Start
$22	Y	Y	Y	Data Link Stop
$23	Y	Y	Y	Routing Table Setting
$24	Y	Y	Y	Routing Table Read
$25	Y	Y	Y	Test
$26	Y	Y	Y	Initialize (Command)
$27	Y	Y	Y	FM Data Read
$28	Y	Y	Y	FM Index Read
$29	Y	Y	Y	FM Area Write
$2A	Y	Y	Y	Name Set
$2B	Y	Y	Y	Name Delete

Subheader	PLC Mode			Command
	Run	Monitor	Program	
$2C	Y	Y	Y	Name read
$FF	Y	Y	Y	Undefined Command Error (Response)
$60	Y	Y	Y	Data Transmit*
$61	Y	Y	Y	Data Request*

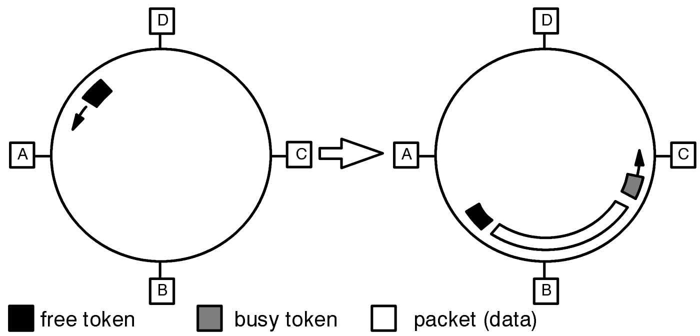
Note
1. *Only transmitted to a PLC
2. Y = available
3. N = not available

The next table lists the completion codes in hexadecimal, with their explanations.

Error Code (Hexadecimal)	Error Contents
00	Normal completion
01	Not executable in RUN mode
02	Not executable in MONITOR mode
03	Not executable in PROGRAM mode
04	Not executable in DEBUG mode
05	Not executable in STANDBY mode
06	Not executable because SYSMAC NET Link Module is busy
07	Not executable with present I/O register
09	Not executable because of changed CPU
0A	Not executable because of "protect"
0B	File memory not initialized (not executable)
10	Format error (parameter length error)
11	Parameter error, data code error, data length error, code error, etc.
12	Instruction not found
13	Address overflow
14	Block number error
20	Not executable due to unexecutable error clear or unexecutable DM size change
21	Not executable by CPU error
22	Not executable because there is no memory mounted
23	Not executable with only 8K bytes of memory
24	Not executable with PROM
25	I/O table generation impossible (unrecognized Remote I/O Module, word over, duplication of Optical Transmitting I/O Module, I/O bus error)
26	Not a Control Module (not executable)
27	Sum check error
28	EEPROM is write-protected
29	Not executable because there is no network path setting
3A	Not executable because of a routing table error
30	Data link table generation is impossible (data link operation, default table)
31	Not executable because of data link start-up
32	Not executable because the data link is not operating
33	Not executable because of a data link setting table error
34	Not executable because the data link setting table has not been registered
35	Not a Master (not executable)

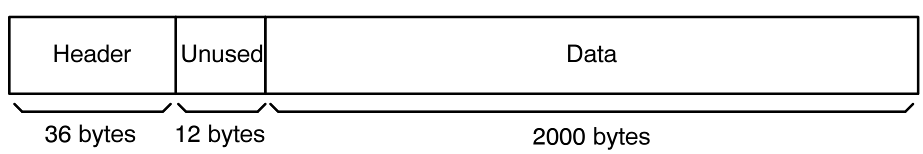
Data Transmission

When a node detects a free token, it has the option to transmit data to any other node. This is the only time the node is allowed to transmit. When a node is ready to transmit data it must wait for a free token. When it detects the free token, it designates the free token as a busy or used token. Then, the transmitting node attaches the data. When the node has completed transmission of the data, it generates and attaches a free token. The free token is then available to the rest of the network. The token ring network allows only the node with the free token to transmit data on the network. However, all nodes have access to the network.



Datagrams

Data is transmitted in the form of a datagram. Datagrams are 2K-byte (2048 bytes) packets that are composed of a header and the data being sent. The 36-byte header contains the address of the sending node and the address of the node that is to receive the datagram. There are 12 bytes unused at present. The remaining 2000 bytes of the packet are available for the data that will be sent to the receiving node.



The 2000 bytes available for information correspond to 500 words of data if using ASCII. If using binary format, they correspond to 1000 words. Sending data in ASCII format is easier because BASIC can be used for programming; however, it is more cumbersome to send this more complex format on the network. The header does not contain information stating whether the data that follows is in ASCII or binary, so this has to be known and programmed. The same network loop can have both ASCII and binary communication, but communication between any two nodes must be in the same format.

Information can be sent to any available memory area of another PLC, or to any other node of the network. Use standard send and receive instructions with datagrams as described in the following diagram.

SEND	← Send request command (@SEND: Differentiated output command)
S	← Send beginning word No. (Sending node)
D	← Receive beginning word No. (Destination node)
P	← Leading word with parameters*

* The following configuration data is written to the three words starting with the word starting with "P"

	4th digit	3rd digit	2nd digit	1st digit
Word n	NUMBER OF SENDING (receiving) words: 0001~01F3(1~499) → If using JIS 8 code. 0001~03E7(1~999) → If using binary code.			
Word n+1	Kind of node – If it is an NSB or SNT: 00 – If it is an NSU: 01		Destination network 0 0 00 for involved or own network	
Word n+2	Port No. – If it is an NSB or SNT: 00 – If it is an NSU: 01 or 02		Destination node (Receiving node) Node No: 01 through 7E (1 through 126)	

Datagrams are sent in 2K-byte packages, whereas the size of a data link is determined by the number of slaves that are established and the delay time set on the master. Datagrams can be sent to any node of a network loop, making the maximum number of recipients of a datagram far exceed possible recipients of a data link. Both data links and datagrams can be sent to other network loops across network bridges.

Data links should be established between PLCs if a group of PLCs will be communicating with each other frequently. If communication is more likely to be with a variety of network nodes, then datagrams should be used. The amount of network traffic makes predicting timing of transfers difficult. When using both transfer types, datagrams have priority with both the sending and receiving Module.

Data links

Data links can be also used to transfer data. Data links differ from datagrams in that data links are more direct. If two PLCs will often be sending information to each other, and seldom sending information to other nodes of the network, then establishing a data link is advantageous. Information is then directed to a memory area of the PLC specified by the SW1 switch or by programming.

Data links are established by making one PLC a master and other PLCs slaves. The master is responsible for starting and stopping transmission operation of the slaves. If the data link's master fails, the slaves in the data link will not function. The master of the data link may be set to function as a slave while it is also functioning as master. The setting is done with the PLC's DIP switch. Information is then sent to the same data area of all slaves. The master determines when nodes can begin transmitting, but slaves transfer directly to each other, not through the master.

The following data areas can be used for the data link area.

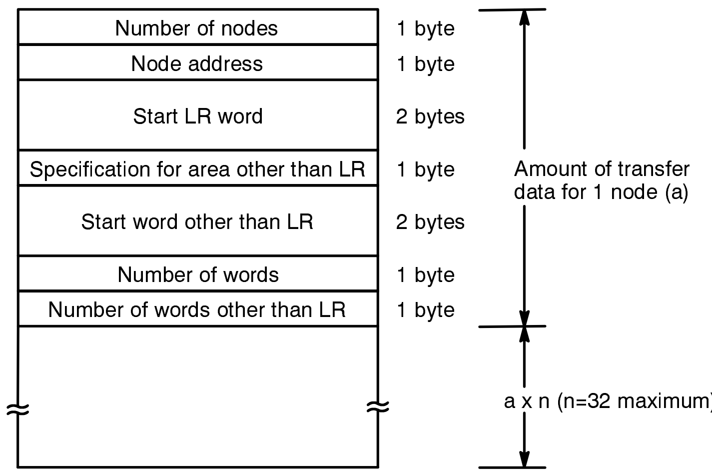
	C200H	C500	C1000H	C2000H Simplex	C2000H Duplex
LR	0 through 63	0 through 31	0 through 63	0 through 63	0 through 63*
DM	0 through 252	0 through 511	0 through 4095	0 through 4095	–

Note * In Modules of 2 words

Up to four masters can be assigned in one network loop. Each of these masters can have up to 32 slaves. The limitation then being the limit of 126 nodes on a network loop. Keeping the number of data links to a minimum makes transfer timing more consistent.

A single network loop can have several data links established. Data links must not overlap.

Data link tables are sent to the master as described in the SYSMAC NET Link Module Operation Manual. The tables can either be set with the Programming Console, the FIT, or the GPC. The master is the only Module on the data link layer with this table. The tables have the following format.



Number of nodes	Nodes in the level (2 through 32)
Node address	$01 through $7E (1 through 126) Do not duplicate
Start LR word	First LR word for the relevant node's data. Set an even word number for the first word.
Specification for area other than LR	0: IR area 1: HR area 2: DM area
Start word other than LR	First word of the specified data area for the relevant node's data. Set an even word number for the first word.

Transmitted data is then sent to the same data area of all slaves. If a PLC is set to receive data into a data area which is not valid, the portion of data incoming to the invalid range is ignored. The SYSMAC NET Link Module's LINK LED will blink, indicating an error on this PLC.

The data link master must have a set time to wait between messages it is directing. Set the length of this time considering how many slaves it is connected to. Setting a 100-ms delay on a master with 10 slaves is recommended.

Note 1. Master accepts node A's request to transfer its data.
2. Node A sends its data to all nodes of data link.

3. Nodes receive the data.
4. Master accepts the request from the next node which wants to transfer data.

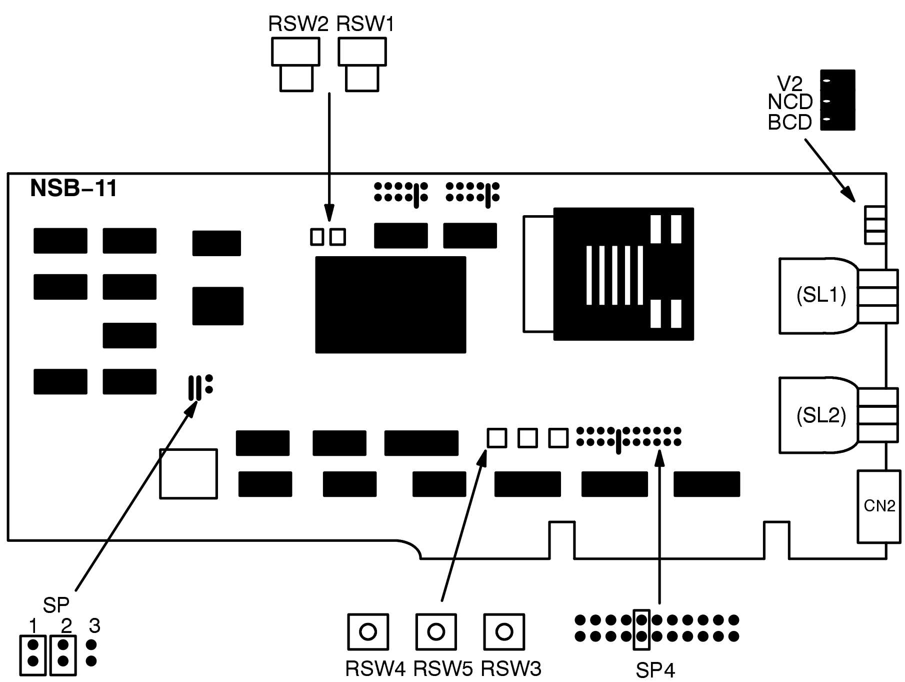
The time required for transfers using data links is determined by network factors such as the number of nodes in the data link. Datagram SEND and RECV instructions are processed before data link instructions. For more information, refer to *Section 3 Network Communication,* or the *SYSMAC NET Link Module Operation Manual*.

2-3 Network Support Board

Network Support Boards are used with PC-AT compatible computers. A similar board is available for the FC-series computers in Japan. These interface boards allow the computer to exchange data with other nodes on the SYSMAC NET local area network. The board occupies a single full-sized slot in an AT computer and links the computer with the optical LAN. The Network Support Board is shipped with software for data exchange and troubleshooting. This section introduces the Network Support Board, with more specific information available in the Network Support Board Operation Manual.

2-3-1 Network Support Board Hardware

The Network Support Board (NSB) operates with MS/PC-DOS versions 2.xx or higher on computers with a minimum of 256K bytes of RAM. It has the following appearance.



Three LED indicators can be seen from the back of the computer when the board has been installed. During normal operation, the NCD and BCD should be lit. This indicates that both normal and backloop paths are functional. The V2 LED indicates that power is being supplied from the Local Power Supply.

The NSB transfers data between the SYSMAC NET and the computer using 15 2K-byte receive buffers and one 2K-byte send buffer. The computer is accessed via DMA (direct memory access). Node number, interrupt vector, and I/O address are set using the switches present on the board. Set these before installing the board in the computer.

Settings

The hexadecimal node number is set with rotary DIP switches 1 and 2. A number 01H through 7EH is valid. There are 126 valid addresses in this range and each node on the network loop must have a unique address.

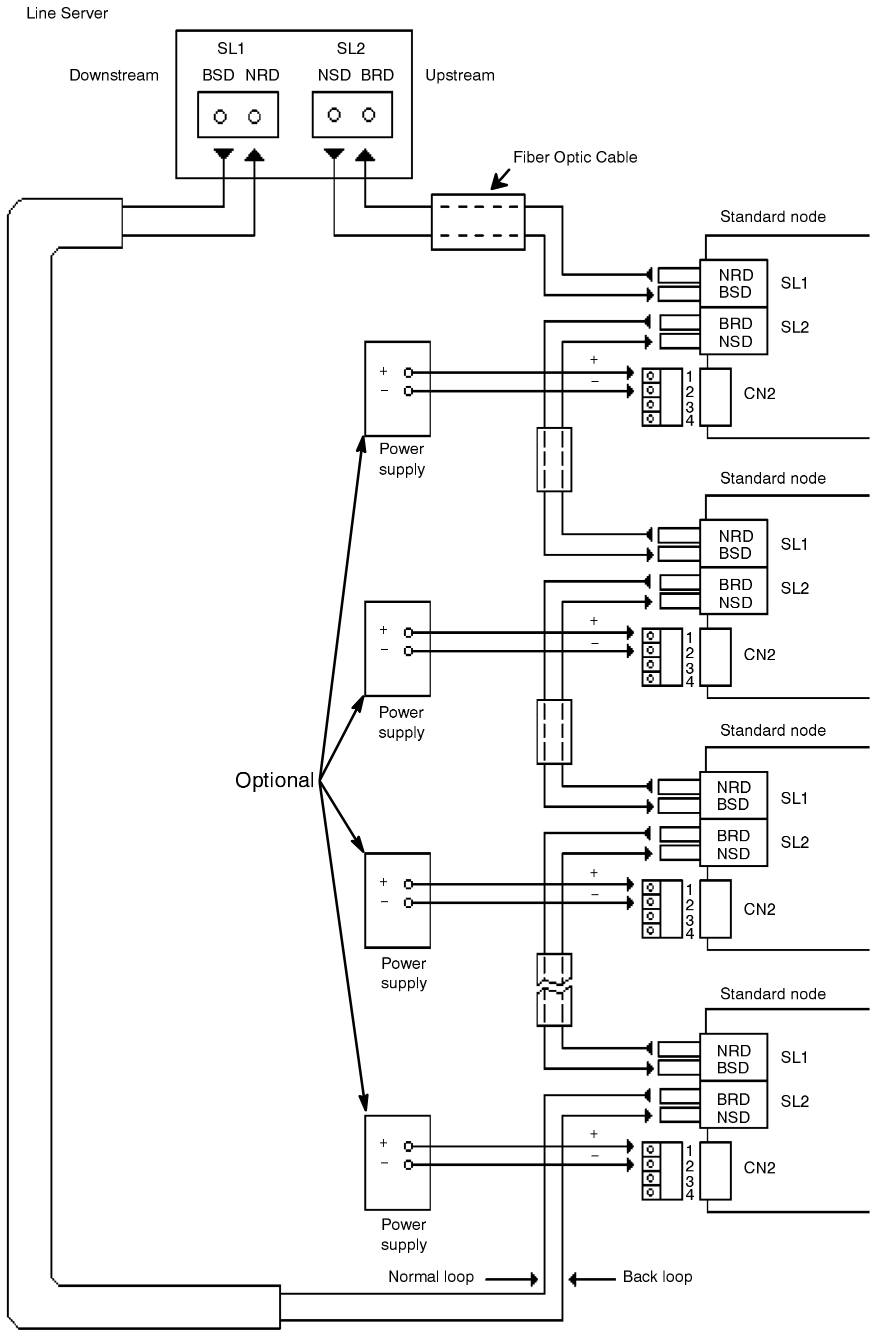
The interrupt vector is set with switches SP4 and RSW3. The switches should be set to the same value in a range from 3 through 10. IRQ10 is the standard setting. Use this setting unless it conflicts with other boards in the computer.

The hexadecimal I/O address is set with switches RS4 and RS5. Valid addresses are 0300H through 030FH.

Switches SP1, SP2, and SP3 are used to set the receive buffer.

Connectors CN1 and 3 are used to connect the board to the Local Power Supply. The last Module should be connected to CN1 and 2. If power is not available from this source, power will be delivered to the board via the computer's internal power supply.

After all settings are complete, insert the board into a slot of the computer. Attach the Optical-Fiber Cables to the SL1 and SL2 ports. The following diagram shows how four computers with NSBs are attached to the SYSMAC NET LAN.



Each network loop should have at least one computer with an NSB installed so that network diagnostics can be used. The next section introduces the software used with the NSB.

2-3-2 Network Support Board Software

Software included with the Network Support Board provides datagram and diagnostic functions.

Install the BIOS software onto the computer's system disk as directed in the NSB Operation Manual. Use a line editor to modify the CONFIG.SYS file. Reboot the computer and verify that the message "S3200 Diagnostic Service Loaded" appears on the first screen.

Once the software is installed, eight utilities are available as well as the datagram service accessed from BASIC.

Utilities

The following utilities are included with the NSB software.

VER32: Displays the version number of the S3200 BIOS for DOS. Execute by entering VER32 followed by the ENTER key.

STAT32: Displays the node's address, loop status, and power supply status. Execute by entering STAT32 followed by the ENTER key.

CUT32: Cuts user packets (80H-FFH). Execute by entering CUT32 followed by the ENTER key. (Similar to the close function in Basic).

DIAGMT32: Executes node diagnostics to confirm that all nodes in the network are operating properly. The file must be registered on all nodes of the network loop. The utility checks their loopback, and power supply status. It can also request a memory dump from a node.

LTEST: Checks the topology of the network by transmitting 2K bytes of data which is then returned and checked against the original transmission. An error history can be viewed by printing a log of the errors. Execute by entering LTEST/E followed by the ENTER key.

RTSET, RTREAD: Used to establish routing tables for nodes in the SYSMAC Net. Routing tables are used to transfer information between network loops. Execute by entering RTSET/E or RTREAD/E followed by the ENTER key.

CONF32: Used to set the node's configuration on the SYSMAC Net. Execute by entering CONF32/E followed by ENTER.

Note LTEST, RTSET, RTREAD and CONF32 require a "/E" after the filename to execute the programs with English text screens.

Device Drivers

The BIOS, Basic Input/Output System, is the file handling routine for routing information for the data packets. Its format is: DEVICE=CP__3200.COM, IOaddr, NETaddr. IOaddr stands for the I/O port address and is set using the rotary DIP switches 4 and 5 on the NSB. It is in hexadecimal, e.g. 300H. The NETaddr stands for the node's network, e.g. 01H. When setting up this driver, an example for the NSB might be DEVICE=CP__3200.COM,300H,NET01H.

The DGIOX file is used for datagram service. Its format in the CONFIG.SYS file is as follows: DEVICE=DGIOX.COM bufsiz, bufct, msg. Here bufsiz stands for buffer size. It should be set to R2000 for SYSMAC NET's 2K-byte buffers. The second argument, bufct, specifies the number of buffers. This is normally set to 15. The third argument, msg, specifies the language set being used. Set this to M1 for English. A typical format for the DGIOX file is DEVICE=DGIOX.COM R2000,15,M1.

The DIAG file provides diagnostic functions. Its format in the CONFIG.SYS file is: DEVICE=DIAG32.COM.

The NAME file is used for assigning names to the network nodes. Its format in the CONFIG.SYS file is: DEVICE=NAME32.COM.

It is possible to view and change the device drivers in the CONFIG.SYS file using a line editor such as DOS Editor.

Note No path has been given in the above examples. Please include the path when writing the CONFIG.SYS File.

Datagram Service

SYSMAC NET's datagram service is accessed from BASIC using the DGSUB.EXE file. Either a BASIC interpreter or compiler may be used. Load the routines by entering this statement: DF SEG=xx: BLOAD "DGSUB.BIN", 0:DEF SEG The xx determines the starting address where the routines will be loaded. It is determined when the DGSUB.BIN file is created from DGSUB.EXE.

The routines are then called as follows: SUB=(function #) *3 : DEF SEG=32xx CALL SUB (arguments): DEF SEG

Arguments:

00 DINIT, used to initialize datagram service and clear send buffers. Execute this subroutine once at the beginning of the program. (Similar to OPEN in BASIC).

01 DSTAT, used to perform a status read on a node of the network.

02 DREC, used to request data from another node into this node's receive buffer. This subroutine waits until the ESC key is pressed or data is received.

03 DREC, used to request data within a specified time period into this node's receive buffer.

04 DSEND, used to transmit data to a specified node. Broadcast to all nodes may also be done with this command.

05 DCUT, used to close the datagram service. This subroutine should be called at the end of the program. (Similar to CLOSE in BASIC).

For the format of these arguments, consult the NSB operation manual. Remember to save the function number, e.g. 05 * 3 = 15, (not the name) before running. Examine the programming present in the DG test to see an example. (From BASIC load DGTEST and enter LIST.)

If CONF32 is used to enter this routine, the settings must be saved before resetting. After either a remote or local reset, the the changes made before the reset become valid.

The DGIOX, datagram service software, file installed in the CONFIG.SYS file is used by the NSB to transfer data between the SYSMAC NET BIOS and the application resident on the computer. If a problem occurs during datagram transmission, the error will be reported. A re-try will not be attempted unless it has been programmed.

When a message arrives at the NSB node, the BIOS checks the message's header. If the message is to be delivered to this node, then the BIOS delivers it to the appropriate part of the resident software. If this software is not present then the message is ignored. If the computer is busy, then the message is brought into the hardware buffer and the computer's interrupt flag is turned ON. When the interrupt is activated, the message is brought into the software buffer.

Because AT-compatible computers are not multi-tasking, if the computer is running a word processing or other application, then the message is directed to the resident software without being processed. If a low level language such as C is used, this may be altered.

A virtual circuit may be established by sending datagrams between NSB-equipped computers. Likewise, data links may be established between SYSMAC NET Link Modules. A computer may not participate in a data link, but its node may be positioned between two SYSMAC NET Link Modules which have a data link established.

Node Diagnostic Software

The Network Support Board software includes a utility for node diagnostics. This is effective software for troubleshooting the SYSMAC NET local area network. For more information on this refer to *Section 4 Troubleshooting,* or the *NSB Operation Manual.*

2–4 Network Service Module

The Network Service Module converts SYSMAC NET optical-fiber transmissions to either RS-232C or RS-422 serial communication. The Module also converts transmission going the other direction: from serial communication to SYSMAC NET optical-fiber signals. This Module allows any intelligent devices, such as computers, robots, CNC machines, work stations, bar code systems, etc., to access the SYSMAC NET via their serial communication ports. The Network Service Module is available with two RS-232C ports or one RS-232C and one RS-422 port. Both offer selectable synchronous/asynchronous operation. Transmission speed is selectable up to 9600 baud.

The two serial ports on the rear of the Module have pin assignments as described in the following table. This information can be used to build a cable between the Network Service Module and a serial device such as a modem.

Pin No.	Signal Abbr.	Signal Name
7	SG	Common Return Line
2	SD	Send Data
3	RD	Receive Data
4	RS	Request to Send
5	CS	Ready to Send
6	DR	Dataset Ready
20	ER	Equipment Ready
8	CD	Carrier Detect
15	ST2	Send Timing 2
17	RT	Receive Timing
24	ST1	Send Timing 1
9	V1	12 V
10	V2	–12 V
18	V3	5 V
25	(RT1)	Receive Timing

The Network Service Module communicates at a baud rate set with DIP-switch pins 1 and 2. Rate is selectable among 1200, 2400, 4800, and 9600 baud. Two serial devices communicating between two different Network Service Modules do not need to be set to the same baud rate.

The serial device connected to port 1 of the Network Service Module has access to the Module's DMA controller. Thus it is possible to communicate at speeds above 9600 baud with proper programming. The serial device connected to port 2 does not have access to DMA and its maximum speed is 9600 baud.

With a computer connected to the Network Service Module, the Module functions like a modem. If a modem is connected, the Network Service Module functions like a PC-AT terminal.

The Network Service Module uses a Motorola 68000 chip, but does no processing. Its purpose is solely to convert serial electrical signals to optical signals.

A computer equipped with a Network Support Board can communicate with a serial device connected to the Network Service Module. Communication from the computer to the Network Service Module can cross network bridges.

The Module's SYSMAC NET side has 1 send buffer and 15 receive buffers, and messages are processed one at a time. On the serial port side, messages are transferred in 8-byte Modules.

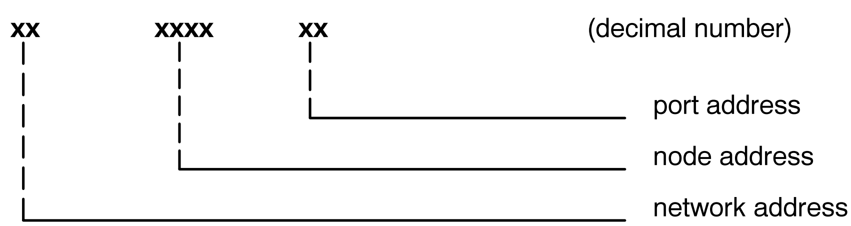
DMA (direct memory access) moves these messages through the Module as fast as possible. Serial communication is generally the slowest part of SYSMAC NET transfers. It is best to send a few messages, wait for a response, and repeat this process until finished transmitting.

The Module is set at the factory to network 00. Settings must be initially set from within the Module's own network, but can then be changed from a computer located on another network loop. Of course, remote resets interrupt the Module's operation, so check with someone at the Module's site to be sure the Module is not busy. Settings for the NSU are stored in SRAM, so they are saved even after power has been turned OFF.

The Module's two ports are addressed as logical port 1 and 2, i.e., LP1 and LP2. The Network Service Module accepts the commands listed in the following table. These commands are sent from a computer on the network loop.

Command	Function
Mail	Transmit data
Show	View this node's parameters
Set	Set this node's parameters
Quit	Enter idle mode
?	Help
Examine	Query any name's address
Diagnostic	Diagnose nodes attached to the loop

The SET command listed above is used to set the names and addresses assigned to the Module's serial ports. A name is composed of up to 8 characters beginning with a letter, e.g., TTY100. The address is also 8 characters, and it lists the port address, node number, and network address. Generally, the network address should be set to the same address the Network Service Module is using. The address is of the following format:



The SET command also determines other communication parameters such as parity. Refer to the *Network Service Module Operation Manual* for details.

The MAIL command sends data to a specified destination. There is no confirmation of the transmission. Up to 2000 bytes of data can be sent with the destination's network, node, and port address.

The SHOW command displays the Network Service Module's current communication parameters.

The HELP command displays the format required for all the Module's commands.

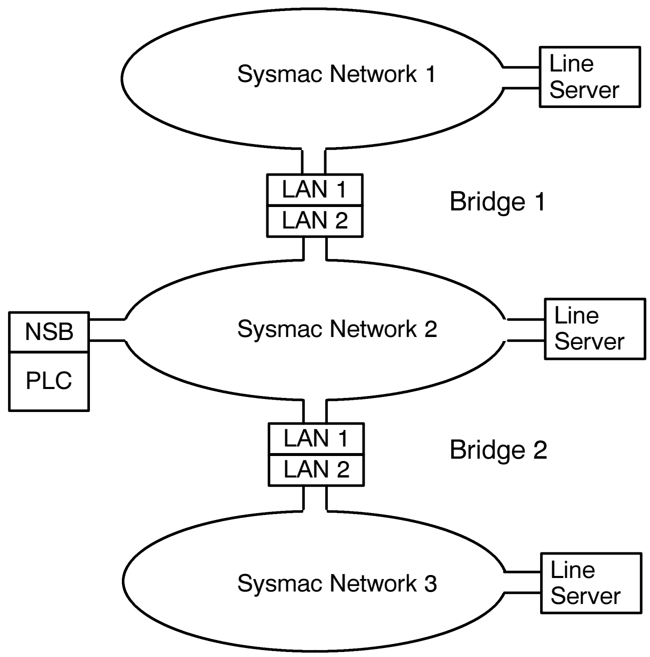
The DIAG (diagnostic) command is used to send a specified diagnostic request to a selected node. The diagnostic request could be a status read, memory dump, echo back or memory write. A LOOP ERROR message is displayed if a problem is encountered. For more information, refer to the *Network Service Module Operation Manual.*

2-5 Bridge

The Bridge Module is used to interconnect two individual SYSMAC NET local area networks. Each network loop can support up to 20 Bridges, and each Bridge counts as one network node.

The Bridge Module's back panel has ports for connecting both LANs.

When the Bridge is set up in the network, it will allow nodes on separate network loops to communicate. The Bridge accomplishes this by becoming two network nodes, one for each of the LANs being connected.



The computer equipped with the Network Support Board is required to set the network address and routing tables. A computer node is required for each bridge so that the NSB's configuration software can be used. In the system shown above, one computer can set the required information for both bridges serving the three network loops. This is true because the LAN 2 side of Bridge Module 1 and the LAN 1 side of Bridge Module 2 are both on network 2.

Computers are also required to set the network addresses and routing tables. Only nodes that will be communicating outside their network loop require routing tables to be established. All nodes require the same network address to be set for their own network loop. Different bridged network loops require unique addresses.

The Bridge is given a node and network number for both LANs that it is connecting. When setting up the routing table for network nodes to communicate across a Bridge, make the table with the following information.

Own Network	Destination Network	First Hop Address
Network 1	Network 2	Bridge 1 (LAN 1) node number
	Network 3	Bridge 1 (LAN 1) node number
Network 2	Network 1	Bridge 1 (LAN 2) node number
	Network 3	Bridge 2 (LAN 1) node number
Network 3	Network 1	Bridge 2 (LAN 2) node number
	Network 2	Bridge 2 (LAN 2) node number

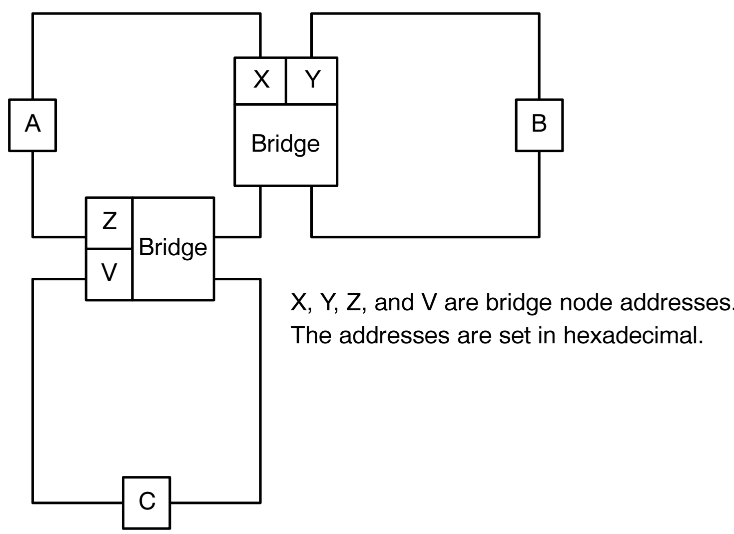
The node numbers for each of the Bridges' network loops, are set with the rotary DIP switches on the Module's back panel, and with programming sent from an NSB-equipped computer. The hardware and software settings must agree. The Bridge must have the software command sent only once, since it stores this information in static RAM (SRAM.)

The Monitor LEDs on the Module's front panel indicate operational status. If any of the first 5 LEDs are lit, an error has occurred. LED's 6 and 7 indicate the type of error. Refer to the Bridge's Operation Manual for identification. LED 8 is lit when the Module is running. If an error has been detected and the error LEDs are lit, they will remain lit until the error has been fixed and the Bridge's reset has been pressed.

The Module's initialization switch, located on the DIP switch, is used to reset the SRAM information back to its default settings. Use this switch to clear SRAM information and re-enter new settings.

The Module's Trace switch, also located on the DIP switch, slows Bridge performance and should usually be kept disabled. When the Trace is operating, it watches and records transmissions passing through the Bridge. It uses hexadecimal notation to show origins, destinations, and an overflow counter. Refer to the Bridge's Operation Manual for the format of the Trace information.

Refer to the following diagram for an example of how a Module communicates with a node located on a separate network loop.



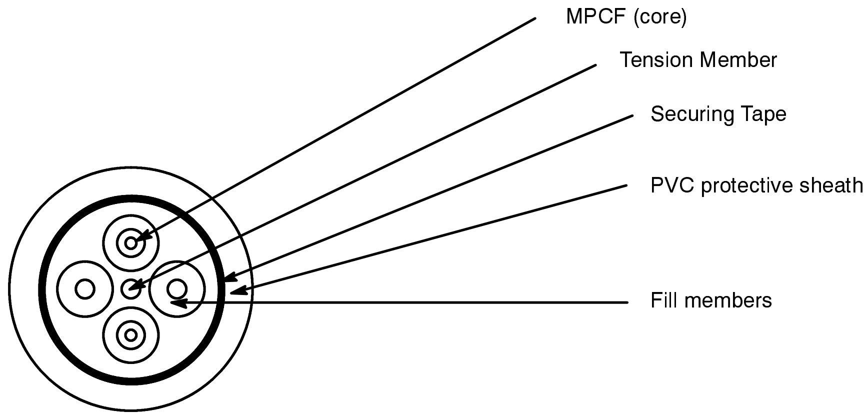
If node A of network 1 wants to communicate with node B of network 2, three processes occur in the exchange. First, node A sends information to X, the Bridge's node address on network 1. Then node X transfers the information to node Y, the same Bridge Module but a different network. Finally, node Y transfers the information to node B. The response is then directed back to the sending PLC along the same path.

SYSMAC NET requires that routing tables be established and stored in the BIOS. Other manufactures do not require routing tables. They have the sending node do a broadcast to determine routing to the message's destination. By keeping the routing table in the BIOS, transfers are faster and dependable.

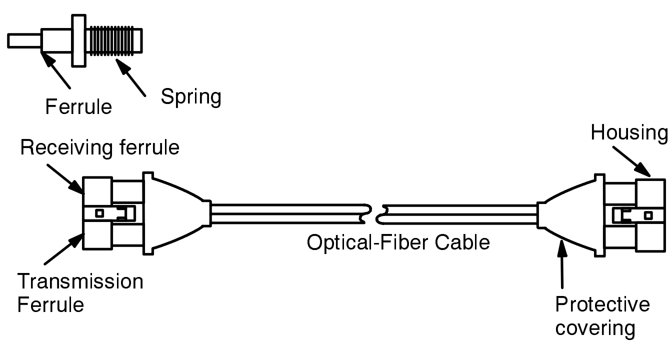
2-6 Optical-Fiber Cable

The SYSMAC NET LAN uses Optical-Fiber Cable for data transmission between the nodes of the network. These cables were chosen instead of traditional electrical cables because of their immModuley to electrical interference and because they electrically isolate each of the nodes they connect.

The cables are constructed of Acrylic-Clad, Glass Core Fibers. Each cable contains a tension member to provide longitudinal support. Connectors for these cables are assembled on location.



Assembly of connectors requires the tool kit which is included in the cable set. The set also contains the parts used in assembling the connector: ferrule, collar, spring, housing, and boot. A good connection on both ends of the cable is essential for proper operation, so carefully follow the directions given in the manual included with the cables. After completing assembly, use the power meter to test the cable.



Cable is generally delivered on a spool with 1 km of material. It is possible to order shorter cables in one-meter increments.

Power Meter

The power meter is used to test the assembly of the connector. A 10-dB loss between nodes is acceptable. Good connector assembly can make it possible to stay within this range at distances of up to 1 km. Both the normal and backloop conductors of the cable should be tested.

Assembly and Installation of Optical-Fiber Cable

The two optical-fiber conductors in the cable are used to carry normal and backloop signals. One conductor is marked with white dots. When assembling connectors for the cable, keep this conductor carrying either the normal or backloop signal.

Once the connectors are assembled onto the cables, they can be attached between the network nodes. Connect SL1 from one node to SL2 of the next node downstream. Doing this will connect the normal send data (NSD) to the normal receive data (NRD). The second conductor of the cable will connect backloop send data (BSD) to backloop receive data (BRD).

Nodes should be added sequentially in a direction away from the Line Server. Verify that the connection to the last node is satisfactory before adding the next node. By adding the nodes sequentially from the Line Server, troubleshooting the construction is greatly aided. Refer to the manual included with the cables to verify LED status.

SECTION 3
Network Communication

3–1 Network Communication Software 28
3–2 Communication Format Differences 31
3–3 Data Flow 34
3–4 Routing Tables 35
3–5 Datagram Transmission Times 36
3–6 Data Link Transmission Times 37
3–7 Application Example 38

3–1 Network Communication Software

SYSMAC NET's network architecture conforms to the OSI (Open Systems Interconnect) reference model of ISO (International Organization for Standardization). SYSMAC NET devices provide "hooks" into the layers of this model.

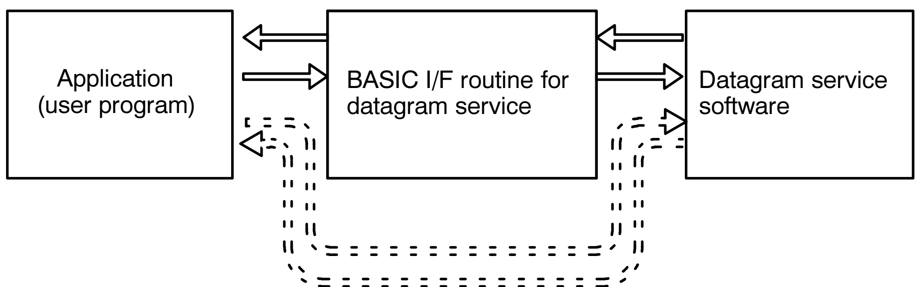
Three files of the Network Support Board software enable data to be passed through the OSI model. This section will describe the functions of each of these files so that the user can better understand how a data packet is received and processed by a SYSMAC NET node. For more information refer to the *Network Support Board Operation Manual*.

NETBIOS: CP3200

The data link layer, layer 2, of the OSI model uses the BIOS to interface between the physical layer and the upper layers. A custom device driver can be written in assembly language to work with the CP3200 BIOS. The different packet types handled by the BIOS include datagrams, data links, and diagnostics.

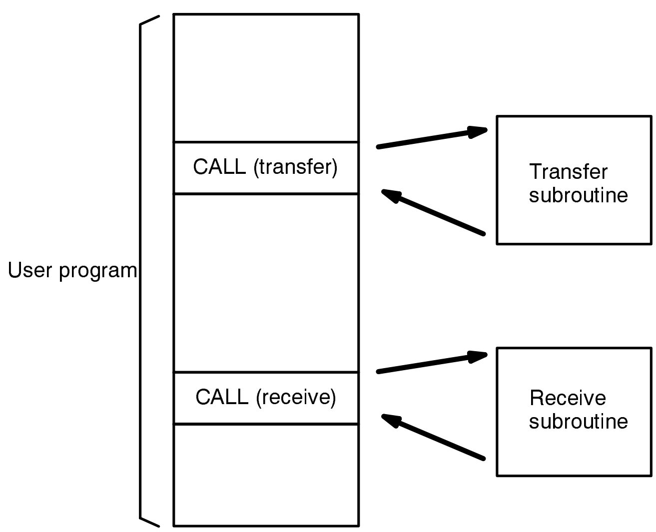
DGIOX and DGSUB

The DGIOX.COM file provides datagram service. These files are generally used through a BASIC interface, but other languages may also be used. They use binary format for interpreted BASIC calls.



Calls are statements like send, receive, and status read. Calls include the command, an address, and data. When addressing a single node, the network, node, and port number are specified. A broadcast has a code to address all nodes/ports of the network.

The DGSUB.EXE file may use the BASIC "CALL" command to create a machine language subroutine for accessing the BIOS directly.



The call uses one of six types of subroutines numbered 0 through 5. Sequentially, these are DINIT, DSTAT, DREC, DRECT, DSEND, DCUT. For more information regarding these subroutines refer to *Section 2–3–2 Network Support Board Software*.

The data portion of a call is separate from the address. Data includes messages, data files, or any other variables one wishes to transmit. The data is in a packet of 2000 bytes or smaller. It is in ASCII or binary format.

Examples of information that is in the data portion of a packet include: read/write memory locations, changes to operation mode of a PLC, uploading/downloading of PLC programs, forced set/reset/clear of a timer or counter, read/write of I/O tables, FM transfers, alarm/error monitoring, and device name set/read.

The following is an example program using calls.

```
100  CLEAR & H200
110  DEF SEG=&XXXX
120  BLOAD "DGSUB.BIN",0
130  DEF SEG
:
:
500  DSEND=4
510  CALL DSEND (NA%, DA%, PA%, D$, RST%)
520  DEF SEG
:
:
600  DRECT=3
610  CALL DRECT (NA%, DA%, PA%, D$, RST%, RC%, TIM%)
620  DEF SEG
```

CALL DSEND arguments:

- (input) NA%: destination network address
- (input) DA%: destination node address
- (input) PA%: destination board address
- (input) D$: command
- (input) RST%: return status

CALL DRECT arguments:

- (output) NA%: transfer source network address
- (output) DA%: transfer source node address
- (output) PA%: transfer source port address
- (input) D$: receive buffer
- (output): CT%: number of receive data
- (output): RST%: returns status
- (output) RC%: number of remaining data
- (input) TIM%: timer value setting reception wait time

Calls also may include control or error flags. A timeout signal would be returned in the data portion of a packet in these instances.

CONF32

This software is used to set the configuration of a Bridge or a Network Service Module. The CONF32 software is packaged with the Network Service Module, and must be run from an PC-AT compatible computer.

CONF32 sets the routing tables for Bridges and Network Service Modules remotely because these Modules do not use DIP switches for this purpose.

When shipped from the factory, the Modules have the network number set to 00. A computer must then run the CONF32 software and change these default parameters if they will be assigned to a network or node number different from the default. The Network Service Module must be set initially from within its own loop, but once it has been set it can be changed from another loop. Until a routing table is sent to these Modules from a computer, they will only be able to access other nodes on their own network loop.

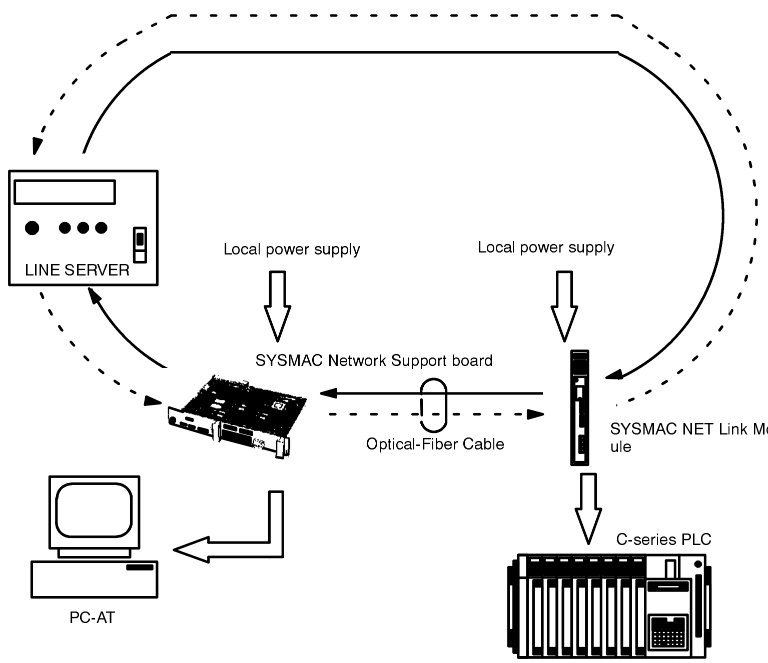
The Bridge Module's LAN 1 and 2 sides can be set from either LAN side.

Settings for NSU and bridge are stored in backed up RAM. Information is thus saved after power is shut OFF.

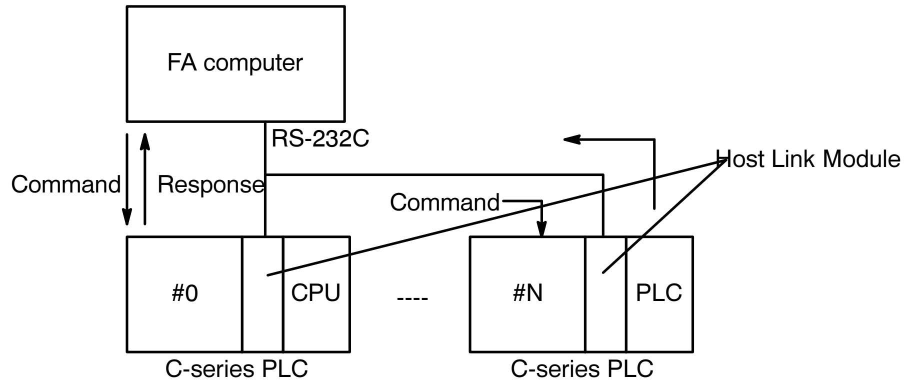
Communication Alternatives

A network has several alternative methods of communication that may be used between devices. A PLC may be connected to a network where it receives datagrams, but also connected to other PLCs in a data link. For more information on datagrams and links, refer to *Section 2-2 SYSMAC NET Link Module*. Other communication alternatives are listed below.

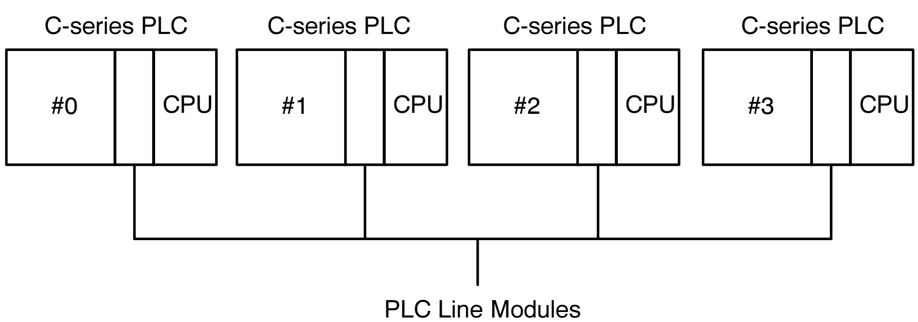
For all devices on the optical-fiber network loop, datagram communication can be used. Messages are passed along a token ring architecture.



For communication involving computers and PLCs, a Host Link Module can be used. Host Link Modules can connect up to 32 nodes, and transfer up to 128 bytes of data at one time. A Host Link Module uses RS-232C or RS-422 serial communication.



For communication strictly between PLCs, PLC Link can be used. Up to 32 PLCs may be connected on a single level. PLC Link uses a serial cable between the devices.



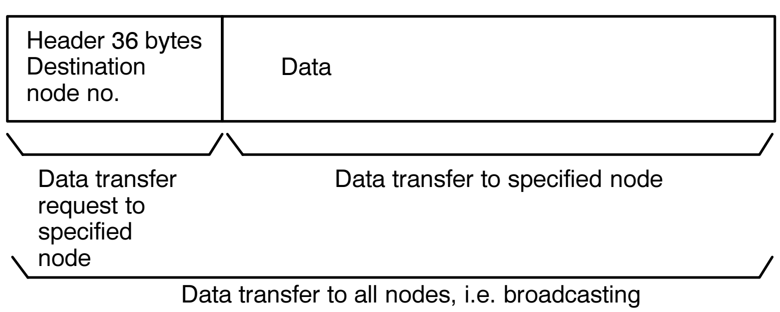
For communication between a Remote I/O Module and a PLC, a remote I/O system can be used. Remote I/O systems use RS-485 serial or optical-fiber communication.

3–2 Communication Format Differences

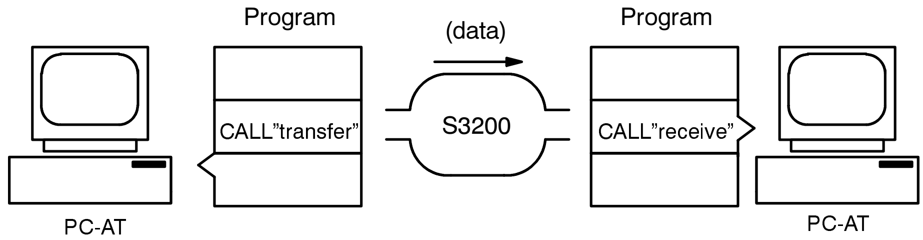
Communication is possible between any network nodes in a functioning network. The particular format of the packet is slightly different depending on which devices are communicating.

Network Exchanges between Computers

Two computers use datagram packets of the following format:



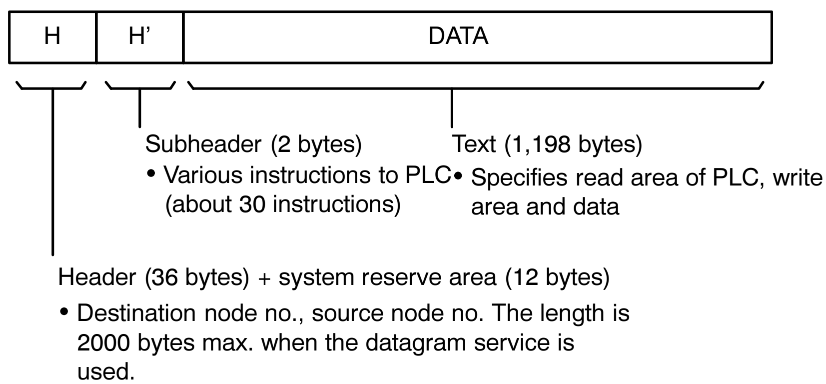
The computer node which receives this packet is not required to issue a response. The CALL command from BASIC is used.



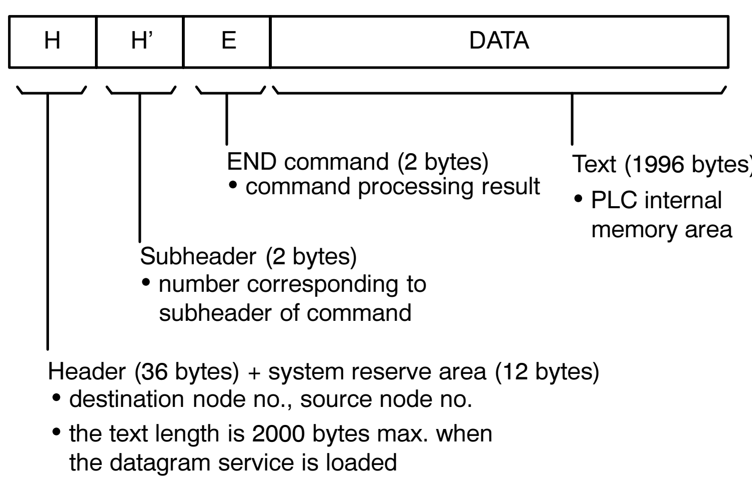
Network Exchanges from Computers to PLCs

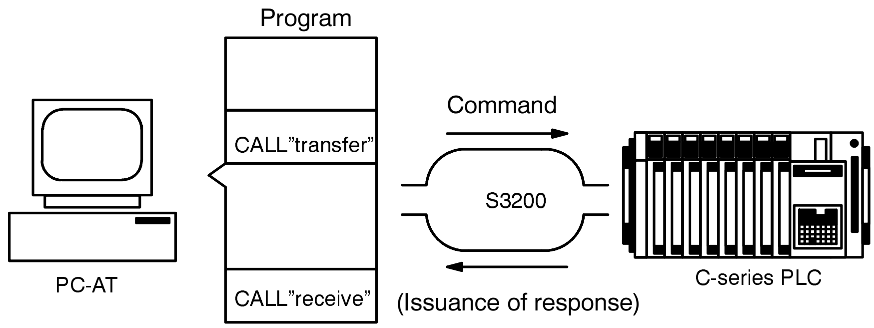
Computers can communicate with any PLC on the network that is equipped with a SYSMAC NET Link Module. When a computer sends a command to the SYSMAC NET Link Module, the SYSMAC NET Link Module will automatically issue a response. The computer can ignore this response. If the SYSMAC NET Link Module is sending data to the computer, then the computer must be programmed to issue a response.

The format of the command is 2K bytes long, and of the following format:



The format of the response is also 2K bytes long, and of the following format:

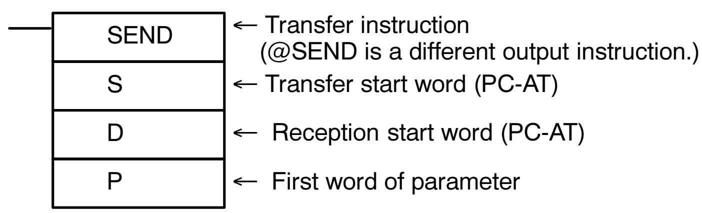




Network Exchanges from PLCs to Computers

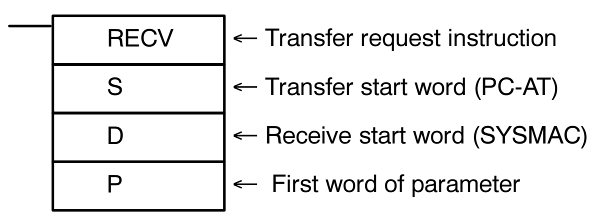
The programmable controller can request data from a computer or Network Service Module. The format of the data packet is the same as data packets going in the opposite direction.

To transfer data from a PLC to a computer or NSU, write a SEND or @SEND in the PLC's program. The command has the following components.



The computer which receives this command must then issue a response to the SYSMAC NET Link Module.

When a PLC is requesting information from a computer, a RECV or @RECV command must be written in the PLC's program. The command has the following components.



PLC communication with a Network Support Board differs slightly from communication with a Network Service Module. The P section of the SEND and RECVs should have the following information written before specifying the word.

Digit 4	Digit 3	Digit 2	Digit 1	
Number of send/receive words				**Wd n**
Node type NSB: 00 NSU: 01		Network No: 0 through 7F		**Wd n + 1**
Port No. NSB: 00 NSU: 01 or 02		Send or receive source Node No: 01 through 7E		**Wd n + 2**

Network Exchanges from PLC to PLC

Two PLCs equipped with SYSMAC NET Link Modules may exchange data over the network using datagrams. The format of the 2K-byte data packet consists of the header, subheader, and data as described above. Responses have the same 2K-byte addition.

To transfer data from a PLC, use SEND or @SEND in the program of the source node PLC.

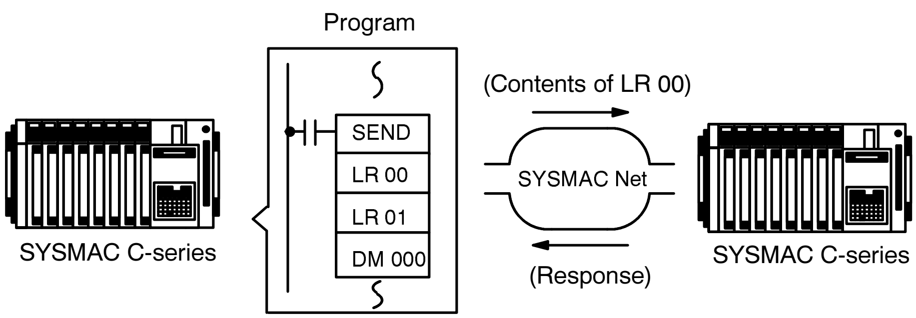
SEND	← Transfer instruction
S	← Transfer start word (source node)
D	← Reception start word (destination node)
P	← First word of parameter

PLCs require a response to be returned, and this response will be generated from the destination PLC automatically.

To request data to be transferred from another PLC, use RECV or @RECV in the programming of the destination PLC. No programming is necessary at the source PLC node.

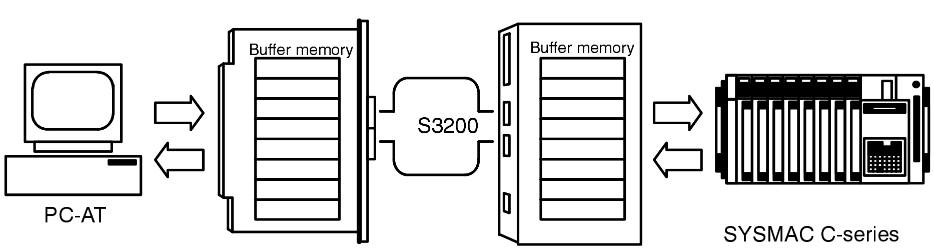
RECV	← Transfer request instruction
S	← Transfer start word (source node)
D	← Reception start word (destination node)
P	← First word of parameter

Schematically, the procedure works as follows:



3–3 Data Flow

Data moves through buffers to reach its destination. The following example illustrates how DM data is transferred from a computer to PLC.



To begin the transfer, the DM data is transferred by the program of the computer to the 2K-byte send buffer of the Network Support Board. When a free token is detected, the DM data is sent to the network.

The data packet is received by the destination node in an empty receive buffer. The SYSMAC NET Link Modules have 15 2K-byte receive buffers and data is processed on a first in-first out basis. Data is transferred to the CPU during the link service time of the scan.

Note Link service is a part of peripheral service within the scan.

The PLC will next generate a response to be transferred back to the computer. The response moves from the send buffer when a free token on the LAN is detected.

The response is received by the computer in one of the 15 empty receive buffers. The process is complete.

3–4 Routing Tables

Note Section 3-4 pertains to bridge and C-series modules only. For CV-series modules, refer to W213.

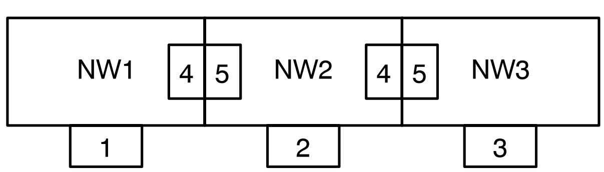
To communicate between multiple SYSMAC NET local area networks, Bridges and routing tables are required. A different routing table may be stored for each node and up to 20 networks. Each of these listings includes the network address and the path the data must take to reach that destination network.

The contents of the routing table are stored in the HR memory area in words HR0 through HR20. A maximum of 20 Bridges may be set up within one network loop.

The first word in the HR area, HR0, determines how many routes are available from this node, and this node's network number. For example, HR0 0201 means that there are two routes available from this node and this node is on network number one.

The second word in the HR area, HR1, determines the node number of the Bridge and the target network number. For example, HR1 0204 means that this node should use node number 4 (a Bridge) to access network number 2.

A system configuration joining three network loops would have the following routing table.



WD	NW1	NW2	NW3
HR0	0201	0202	0203
HR1	0204	0105	0105
HR2	0304	0304	0205

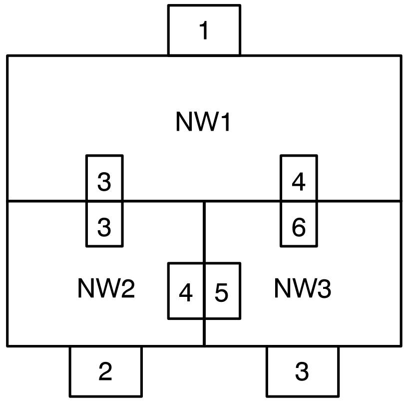
1st line for NW1: From network number 01, two routes are listed

2nd line for NW1: From network number 01 via bridge node 04 to network 02

3rd line for NW1: From network number 01 via bridge node 04 to network 03

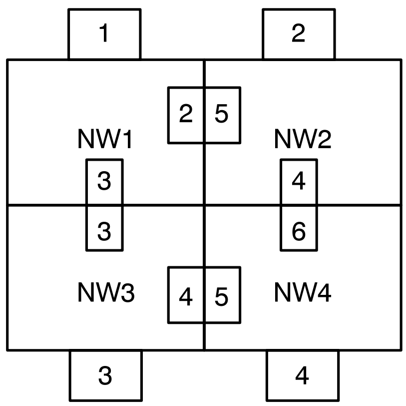
If more than one route provides access to another network loop, select the one that is anticipated to have the least amount of network traffic. A node may not be set to have more than one route to another network loop.

The next figure shows three network loops and the routing tables required.



WD	NW1	NW2	NW3
HR0	0201	0202	0203
HR1	0203	0103	0106
HR2	0304	0304	0205

The next figure shows an example of an indirect connection between network 1 and network 4.



WD	NW1	NW2	NW3	NW4
HR0	0301	0302	0303	0304
HR1	0202	0105	0103	0305
HR2	0303	0404	0404	0206
HR3	0402	0305	0203	0105
	or alternative for 4th line			
HR3	0403	0304	0204	0106

Data from node 1 of network 1 will be sent to node 4 of network 4 via node 2 of network 1 according to the routing table of NW1. Then via node 5 and node 4 of NW2 according to the routing table of NW2.

Note For information on programming the Bridge Module, contact your local OMRON representative.

3–5 Datagram Transmission Times

The SYSMAC NET local area network transfers data at a rate of 2M bit/second. Data is transferred in 2K-byte packets, with an average of 50 ms required to transfer information between two PLCs on a network with light traffic. When 2K bytes of data are transferred with datagrams, the delay time is calculated with the following factors.

Td: Delay time

Ts: DMA transmission time 0.2 ms

Tg: Permission to transmit detection time

T: Data transmission/reception time 2.2 ms

ns: Number of nodes

Tn: Time/node 0.2 s per 4 bits of data

To: Delay for optical-fiber cable 5.0 s

ls: Cable length

Tls: Delay at Line Server 0.0 s (20 bits of data)

Tr: Reception DMA time 0.2 ms

Formula

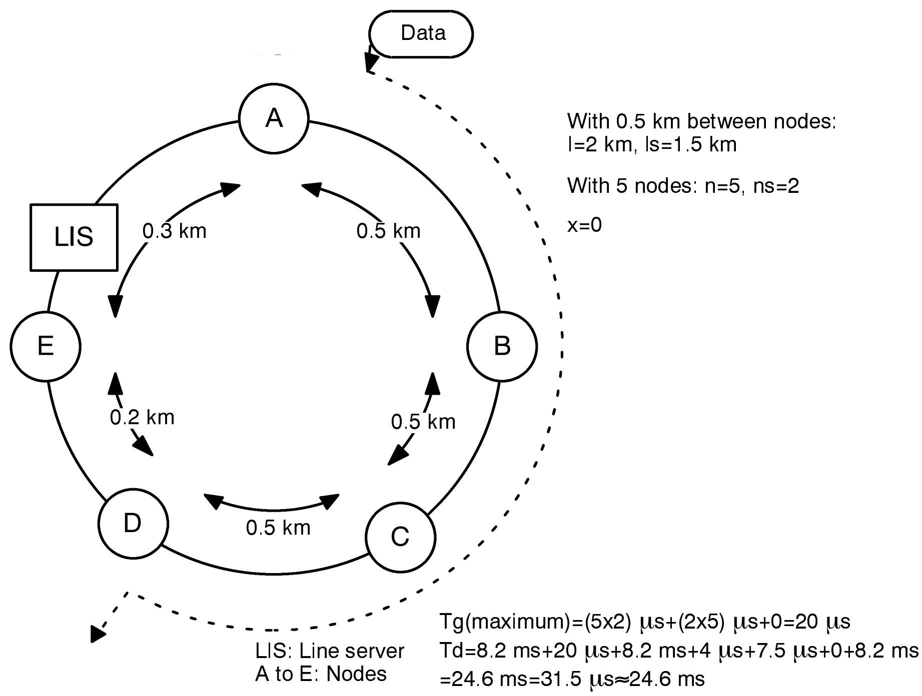
Td = Ts + Tg + T + (ns x Tn) + (To x ls) + Tls + Tr

The maximum value for Tg is calculated as follows:

Tg (maximum) = To x l + Tn x n + Tls + T x x

l: Total length of loop's cabling
n: Total number of nodes
x: Number of other nodes waiting to transmit

Example



Processing time required to transfer data between the NET Link Module and another node involves making the header, scan time, and times listed in the above formula. The processing time required by the NET Link Module is the largest portion of the delay time. Data is generally delivered to the NET Link Module in ASCII format, and the conversion into binary requires 50 ms for 2K bytes of data. If data is input to the NET Link Module in binary, processing is hastened.

3-6 Data Link Transmission Times

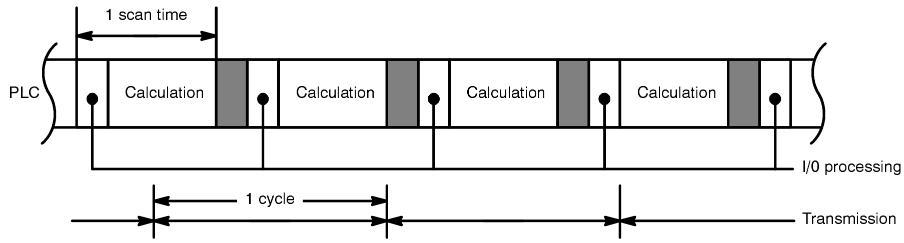
The amount of time required by the network to complete one cycle of data transmission depends on the data transmission delay time, the number of slave nodes, the amount of data, and the delay time of the network. The time can be calculated by the following formula:

1 cycle (T) = Ti x P + Td

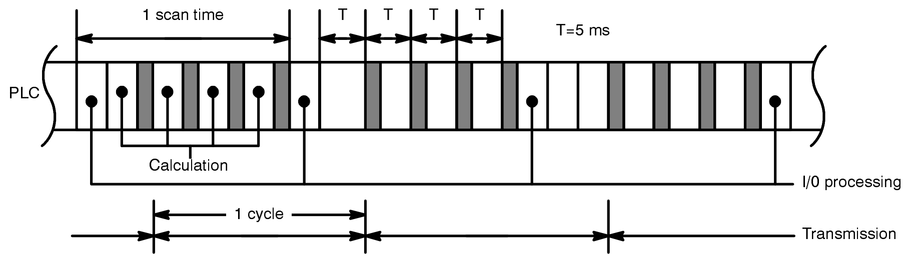
Ti: Data transmission delay time (set by DIP switch SW3)
P: Number of slave nodes
Td: Delay time of the network

The transmission of data links and the PLC calculations are not performed at the same time. The timing is as shown in the following diagram.

C200H/C500/C2000H Duplex



C1000H/C2000H Simplex

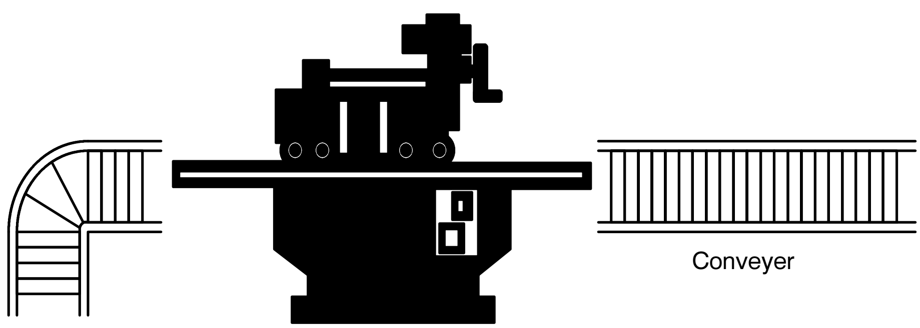


The shaded area indicates data exchange timing between a PLC and the Net Link Module's buffer memory. If datagram service is requested at the same time, only one node's data is exchanged at a time (in the order of entry).

If datagram servicing, data link levels, node applications, etc., cause problems for system operation, the error flags in the SR area will turn ON. If these flags turn ON repeatedly, check the settings and timing of the system to determine the cause.

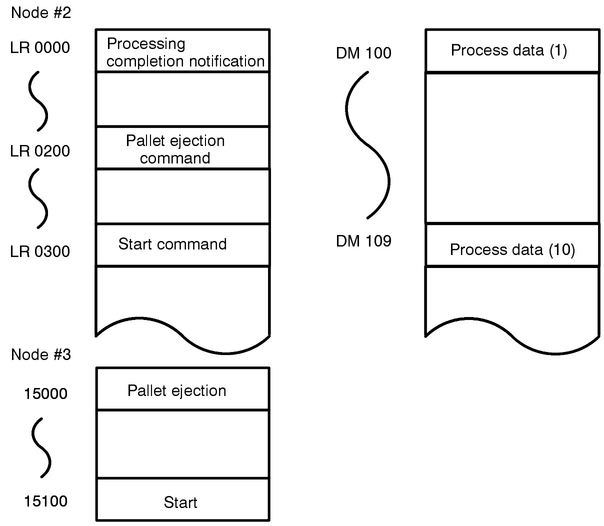
3–7 Application Example

In this example, data is transferred between a machining center and a computer. A start signal is also transferred between the machining center and a conveyer.



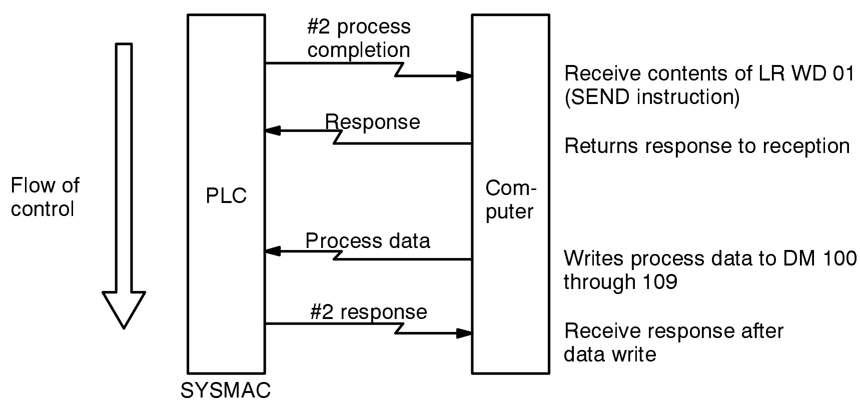
1, 2, 3...
1. When node #2 has completed processing the data, the computer is informed. The computer then transfers the process data of the next job to node #2.
2. Node #2 transfers a pallet ejection command to node #3 which controls the conveyer. From node #3, a start command is transferred to node #2.
3. When a machining center alarm is generated by node #2, it informs the computer that controls node #1 and is displayed on the computer's CRT.

Memory Assignment

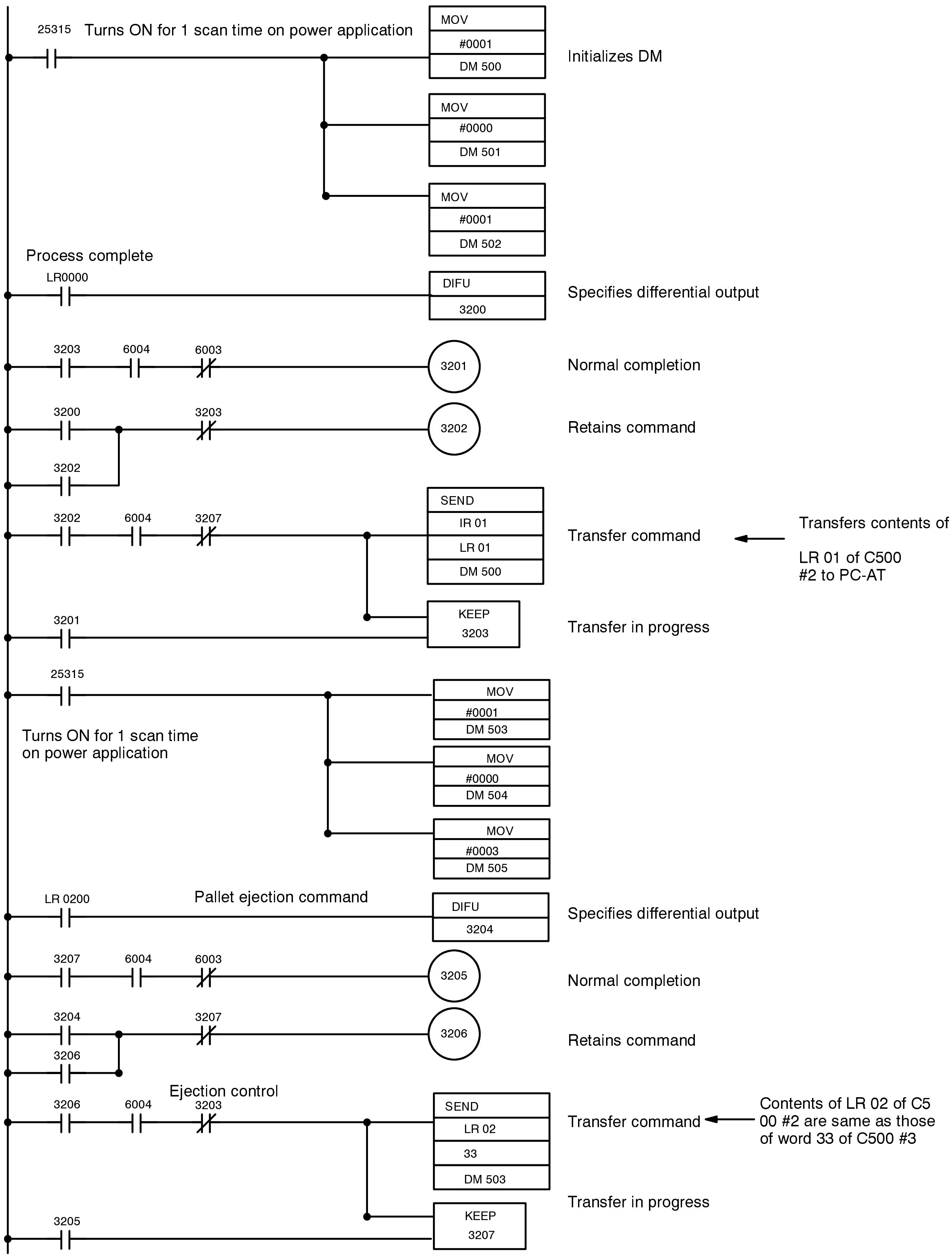


Software of Computer

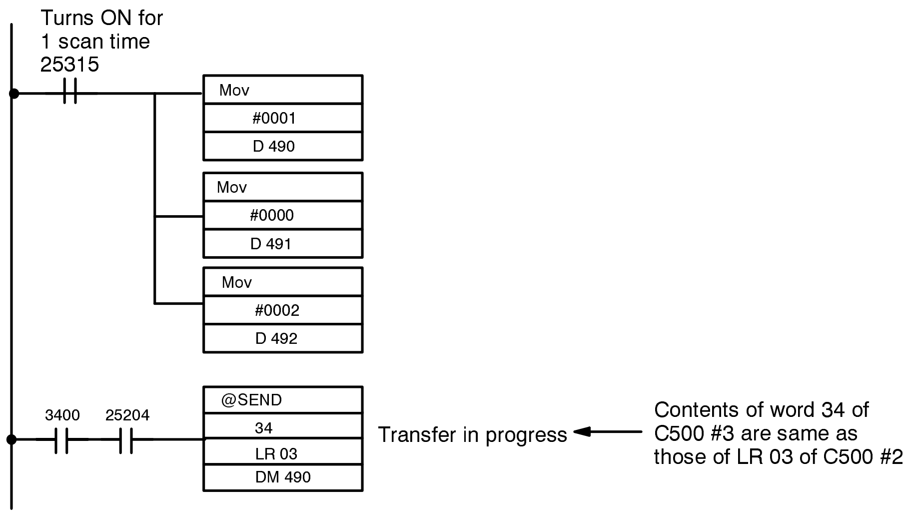
The computer (PC-AT) sends the following commands and responses to create an application program:



Software of SYSMAC



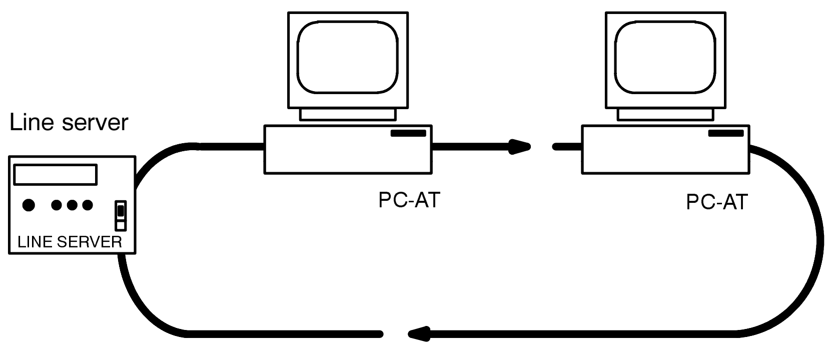
Software of node #3



I/F Routine for Datagram Service

In the following example, a simple data transfer/reception test is conducted between two FA computers (PC-ATs) by using the BASIC I/F routine for datagram service.

System Configuration

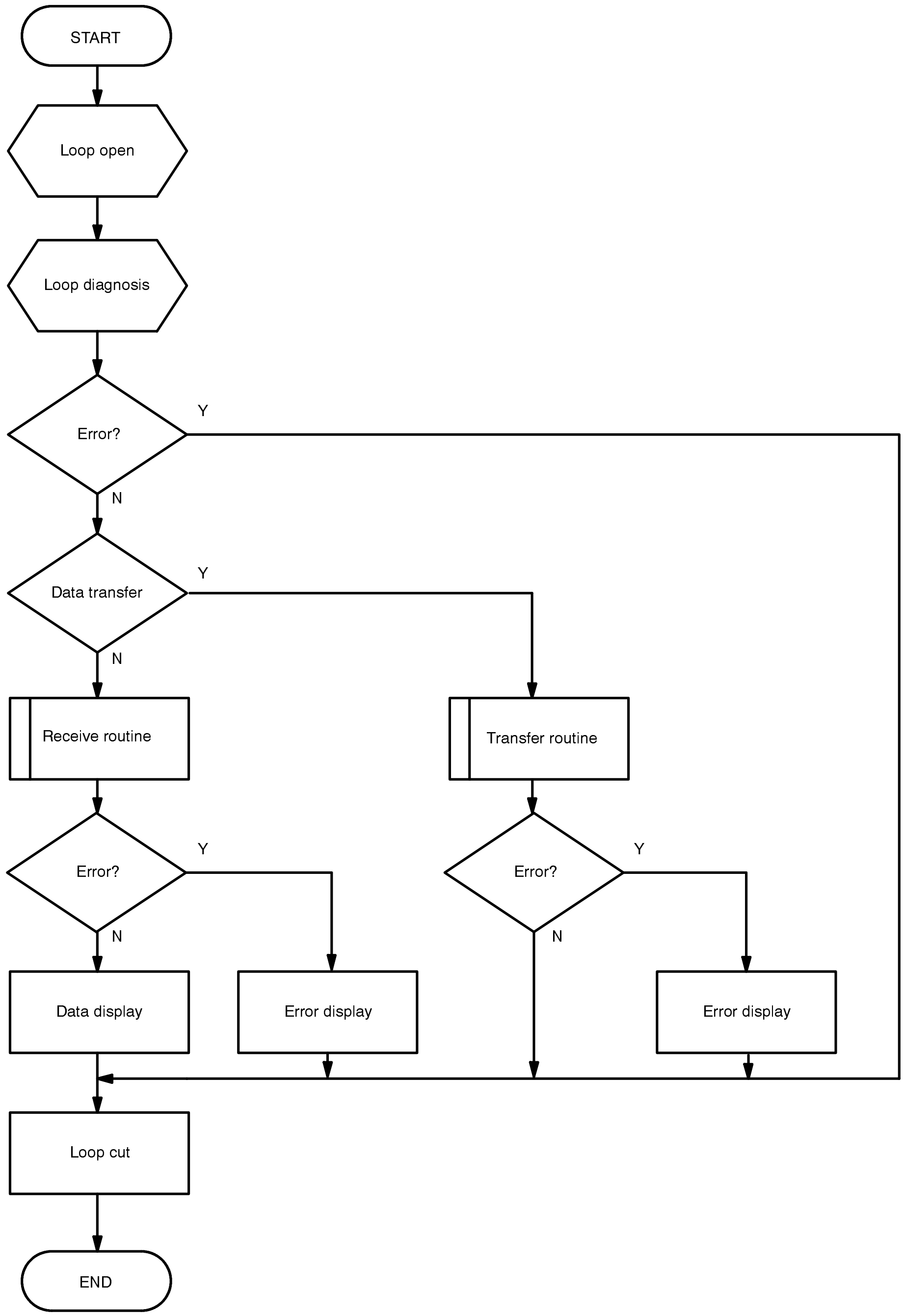


System Outline

1, 2, 3...
1. Preparation is made so that the datagram service can be used on the FA LAN and a loop is opened.
2. Data of specified length is transferred to the destination node the specified number of times.
3. Data transferred to the receive node is displayed.

I/F Routine Flowchart

The following flow chart shows completion of a datagram using the BASIC I/F routine



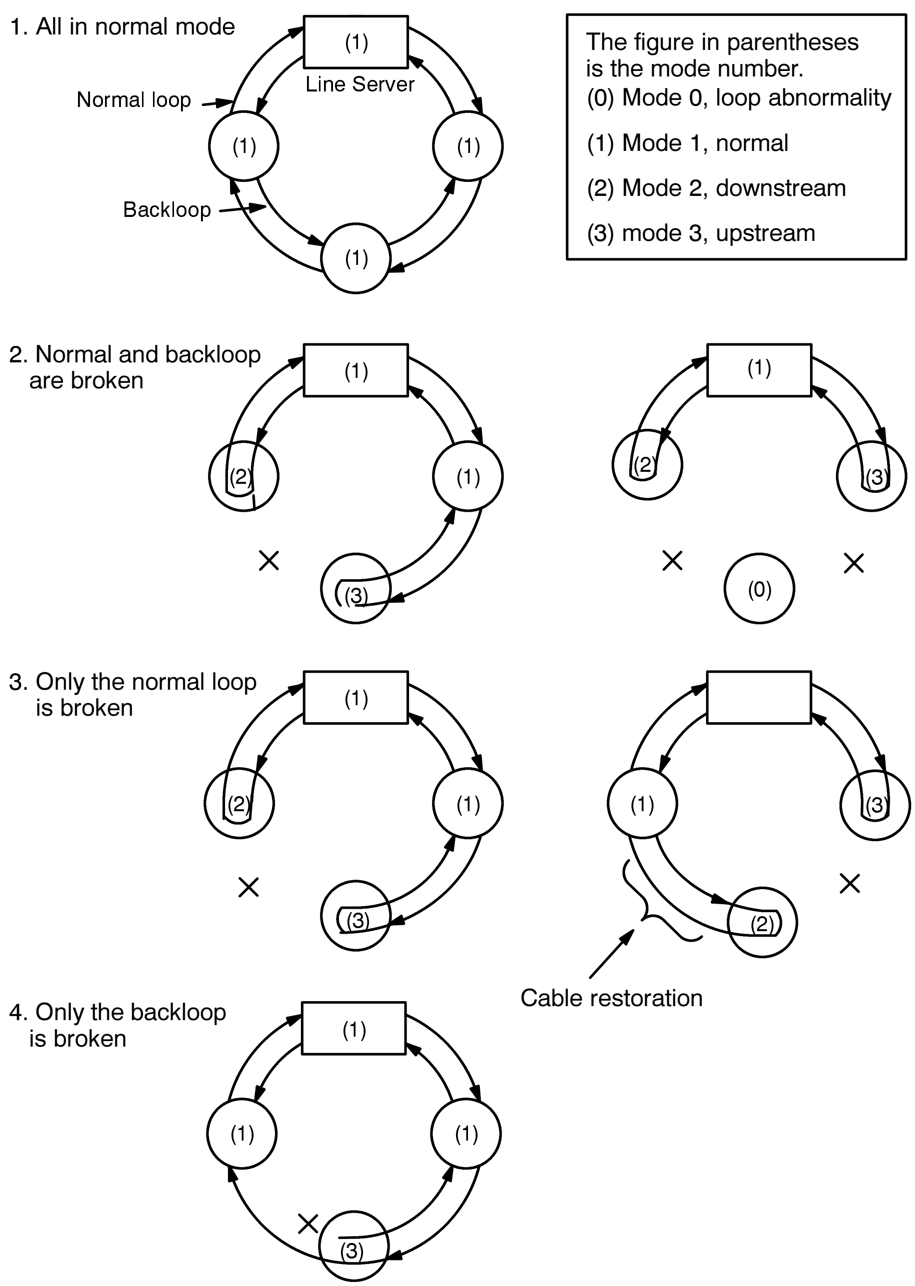
SECTION 4
Troubleshooting Functions of the NSB

4–1 Diagnostic Utilities 44
4–2 The Status Read Test 45
4–3 The Echoback Test 45
4–4 The Broadcast Test 46

4–1 Diagnostic Utilities

The diagnostic utilities available for troubleshooting the SYSMAC NET LAN are effective for identifying network problems. The utilities are run from a PC-AT computer node, so it is highly recommended that each network loop have at least one of these nodes. The three software tests shipped with the Network Support Board are the Status Read Test, the Echoback Test, and the Broadcast Test. This section will describe each of these diagnostic utilities. For more detailed information about these tests, refer to the *Network Support Board Operation Manual.*

If the network encounters a problem at one of the nodes along the loop, the last node that is properly functioning will reverse the direction of data so that the loop remains functional. The next diagram shows how a network functions in the event of a break in the Optical-Fiber Cables.



However, if the network has two breaks in the cable, then one group of nodes will be isolated from the Line Server. The Line Server's responsibility is to issue the initial token and monitor the network loop's token. When a group of nodes is isolated from the Line Server, there is a possibility that the token was within the isolated group when the second break occurred. In this instance, the Line Server would re-issue the token to its side and the backloop function would insure communication works properly on this side.

When reconnecting these network loops, make sure that SL1 goes to SL2 and vice versa. If problems are still encountered after connecting the isolated loop back to the Line Server, disconnect the cables connecting each node so that no light is being passed. Then reconnect them SL1 to SL2 and vice versa.

Intermittent Errors

Intermittent errors are the most difficult to identify, but even these can be found and fixed. If it is suspected that the level of light reaching a node falls in the narrow range between ON and OFF, the echoback test is the best test to execute. Use the broadcast test to find suspicious nodes followed by the echoback test for verification. If all else fails, the network can be disconnected and reconnected sequentially from the Line Server.

Note Check that electrical noise is not causing a node to malfunction. The Optical-Fiber Cables are noise resistant, but high voltage current may disrupt the network components themselves.

4-2 The Status Read Test

The Status Read Test is accessed from the computer by inputting DIAGMT32/E followed by enter. The file uses the DEVICE=DIAG32.COM, of the CONFIG.SYS file, the DIAGMT32.EXE, and the DIAGMT32.DAT files. If the diagnostic start up menu does not appear after inputting the DIAGMT32 command, verify that those files have been loaded.

The startup menu has the following appearance:

```
*** S3200 DIAGNOSTIC UTILITY PROGRAM ***

                              VERSION 4.02

1. READ NODE'S STATUS
2. DUMP THE MEMORY
3. SET COMMENT
4. ECHOBACK TEST
5. BROADCAST TEST
6. CONFIGURATION



          Enter your requirement.
          Press [ESC] key to exit.
```

If the NCD and BCD LEDs indicate that a timed-out node is functioning suitably, but the status read test indicates an error at this node, then verify that the cables are connected properly. They should be connected from SL1 of one node to SL2 of the next.

The status read test will check any specified node, or any range of nodes. It displays the power supply status of a node, and other information as has been specified from the Diagnostic startup menu.

4-3 The Echoback Test

The most difficult network problems occur when a node intermittently has errors. The status read test checks a node's status once, and thus would not identify an error that occurs only once out of one thousand times. The echo-back test has functions to identify these types of errors.

This tests operates by sending 2K bytes of data to a specified node and then checking it against what that node returns. A properly functioning node will return exactly the same data back to the testing node. The testing will continue operating until it is discontinued by pressing the ESC key. A bad node will have many timeout errors. This may indicate that the connection here is bad. Check this possibility first.

```
***                     ECHO BACK TEST                         ***
Network No.      0        Node address    80        Optical  LAN   D3




                 Enter Network No.                 ______
                 Enter node address of Dest.         2
                 Press [ESC] key to exit.
```

4-4 The Broadcast Test

This test functions by sending the same data to all nodes of the network loop simultaneously. Each node will count how much data it has received. A status read should then be executed to determine how much each node has counted. If one node has too little data, the problem is here. Check that the connection to this node is not faulty.

The number of broadcasts and the interval between the broadcasts is determined from the test's startup menu. Two computers within the same network loop should not attempt to do broadcasts at the same time.

```
***                     BROADCAST LOOP TEST                              ***
Network No.      0                  Node address  80   Optical  LAN   D3

            Class        (A-Z)                         :A
            Count        (Max = 9999)                  :100
                         (0 = Aging)                   :
            Interval     (Max = 9999)                  :1
                         ( [0.1msec] )
    -----------------------------------------------------
            Start     :87/08/07              08:45:50
            Send         :87/08/07           08:46:09
            Stop      :87/08/07              08:46:09
    Press [ESC] key to exit.
```

If the network appears to have a node with intermittent problems, this test is the best one to identify it. The suspected node can then be addressed with the echoback test. The advantage of the broadcast test over the echoback test is that all nodes in the network do not need do be tested one by one to find the bad one.

Appendix A
Standard Models

Name	Model
Line Server	S3200−LSU03−01E
Network Support Board and software	S3200−NSB11−E
Network Support Board for FIT	FIT10−IF401
Net Link Unit for C500, C1000H, C2000H	C500−SNT31−V4
Net Link Unit for C200H	C200H−SNT31
Network Service Unit	S3200−NSUA1−10E
Network Bridge	S3200−NSU−G4−10E
Optical-Fiber Cable Optical-Fiber Cable Connectors	Contact OMRON representative for information

Appendix B
Specifications

Communication Method	Token ring (n:n communication)
Transmission rate	2M bps
Transfer method	Manchester code/baseband
Distance between nodes	Max. 1 km (3 km with repeater)
Transmission line	Optical-Fiber Cable, with or without power feeder lines
Message length	2K bytes
Number of nodes	Maximum 126 + 1 Line Server Unit
Node types	C-series SYSMAC Net Link Unit PC-AT with Net Support Board Bridge Net Service Unit (synchronous/asynchronous, 9600 bps max., full duplex, 2 serial ports/Unit)
Number of networks	Max. 20 networks with direct connection using bridge
Error handling	Automatic loopback and Node bypass with Local Power Supply Unit
Ambient Temperature	Storage Temperature: −20° to 65°C Operating Temperature: 0° to 50°C
Humidity	35 to 85% RH non-condensing
Dust	Must be relatively dust−free
Atmosphere	Must be relatively free from corrosive gases
Power requirements	Network Support Board: Power is supplied form Local Power Supply or power supply of computer. Network Service Unit: Power is supplied from Local Power Supply or power supply rated at 1 A 24 VDC max. Line Server Unit: 0.5 A 24 VDC max.
Basic communication functions	Communication between nodes, broadcasting, Communication protocol conversion, baud rate conversion with NSU, Code conversion (EBCDIC, ASCII, JIS7, JIS8) with NSU

Appendix C
Software Files

The following files are used by SYSMAC Net.

Software	Function
CP_3200.COM	Computer BIOS driver
DGIOX.COM	Datagram service driver
DIAG32.COM	Diagnostic service driver
NAME32.COM	Name service drive
DIAG32.COM	Diagnostic for loop status
LTEST.EXE	Loop test status
DGSUB.OBJ	Interface to BASICA for datagram service
DGSUB.BIN	Interace to other languages

Glossary

area computer A factory computer used to control automation over a wide area. This area is usually only one part of a larger factory.

ASCII code [A(merican) S(tandard) C(ode for) I(nformation) I(nterchange)]. A standard computer code used to facilitate the interchange of information among various types of data-processing equipment.

back–up A copy of existing data which is valuable if data is accidentally erased.

baud rate Transfer speed between two devices in a system measured in bits per second. For example, an optical sensor might be configured to send its information to the FIT at 9600 baud. It is important for both of the devices to be set to the same baud rate.

bit The smallest piece of information that can be represented on a computer. A bit has the value of either zero or one, corresponding to the electrical signals ON and OFF. A bit is one binary digit.

central processing unit A device that is capable of storing a program and data, and executing the set of instructions contained in the program. In a PC System, the central processing unit executes the program, processes I/O signals, communicates with external devices, etc.

Centronics Interface Physical design of cable connector allowing a parallel device such as a printer to be attached to the FIT.

communication cable Cable used to transfer data between components of a control system and conforming to the RS–232C or RS–422 standards.

CPU An acronym for central processing unit.

data area An area in the PC's memory that is designed to hold a specific type of data, e.g., the LR area is designed to hold common data in a PC Link System.

data disk Floppy disk used to store information such as programs or I/O tables. The data disk should be used in drive B of the FIT.

data link Allows for the connection of up to 32 PCs in a System where each is contributing information to a common memory area. Data links may be established in the LR and/or DM memory areas.

debugging The process of checking for errors in a program.

EPROM [E(rasable) P(rogrammable) R(ead) O(nly) M(emory)] A type of ROM in which stored data can be erased, by ultraviolet light or other means, and reprogrammed.

factory computer A general-purpose computer, usually quite similar to a business computer, that is used in automated factory control.

flag A bit that is turned ON and OFF automatically by the system in order to provide status information.

hexadecimal Number system used to represent numbers in base 16 with digits 0,1,2...9,A,B...F.

host computer A computer that is used to transfer data to or receive data from a PC in a Host Link system. The host computer is used for data management and overall system control. Host computers are generally small personal or business computers.

IBM PC/XT or AT, or compatibles A computer that has similar architecture to, and is logically compatible with an IBM PC/XT computer; and that can run software designed for that computer.

LAN An acronym for local area network.

LOAD instruction Starts the operation of a line of programming. Each new line off the bus bar has an address number, a LD instruction, and a relay number.

local area network A network consisting of nodes or positions in a loop or trunk arrangement. Each node can be any one of a number of devices. This kind of network usually operates over a small area such as a group of offices or a factory floor.

MS−DOS Operating system that many computers use for internal functioning. The FIT has MS−DOS on its hard disk allowing the same ladder support software written on a GPC or personal computer to run on the FIT.

PC An acronym for Programmable Controller.

PC Link Unit A Unit used to connect two or more PCs together so that they can exchange data through their LR areas.

PLC See PC.

Power Supply In OMRON terminology a Unit that mounts to a Backplane in a Rack PC. It provides power at the voltage required by the other Units on the Rack.

Programmable Controller A small, computer-like device that can control peripheral equipment, such as an electric door or quality control devices, based on programming and peripheral input devices. Any process that can be controlled using electrical signals can be controlled by a PC. PCs can be used independently or networked together into a system to control more complex operations.

RAM [R(andom) A(ccess) M(emory)] RAM will not retain data when power is disconnected. Therefore data should not be stored in RAM.

ROM [R(ead) O(nly) M(emory)] A type of digital storage that cannot be written to. A ROM chip is manufactured with its program or data already stored in it, and it can never be changed. However, the program or data can be read as many times as desired.

RS−232 interface An industry standard connector for serial communications.

RS−422 interface An industry standard connector for serial communications.

scan time The total time it takes the PC to perform internal operations, i.e., reset the watchdog timer, read the program, receive input data, send output data, and execute instructions. Scan time is monitored by the watchdog timer within the PC, and if it takes longer than a certain specified amount of time, an error message may be generated, or the CPU may just stop. Scan times will differ depending on the configuration of the system.

system configuration The arrangement in which Units in a System are connected. This term refers to the conceptual arrangement and wiring together of all the devices needed to comprise the System. In OMRON terminology, system configuration is used to describe the arrangement and connection of the Units comprising a Control System that includes one or more PCs.

system disks Floppy disks containing MS–DOS and other information the computer uses for internal functioning.

token ring network A special type of network with all the devices on the network connected in the shape of a ring. A special signal (“token”) is passed around the ring, and messages are carried on this signal.

Unit In OMRON PC terminology, the word Unit is capitalized to indicate any product sold for a PC System. Though most of the names of these products end with the word Unit, not all do, e.g., a Remote Terminal is referred to in a collective sense as a Unit. Context generally makes any limitations of this word clear.

word In digital circuits, a group of bits. Usually a word consists of four, eight, or sixteen bits. In C-series PCs, a word consists of sixteen bits. Words can be used to store data, or they can be used for I/O.

word operand The numerical address of a word allowing it to be used in programming.

Index

B

Backloop, 4

BCD Indicator, 8

BIOS, 18

Bridge, 22

Broadcast Test, 46

Busy Token, 12

C

CALL Command, 28

CIM, 1

Communication Format Differences, 31

CONF32, 18, 29

control components, 2

Control System, 2

CUT32, 18

D

Data Link Tables, 14

Data Link Transmission Times, 37
- C1000H/C2000H Simplex, 38
- C200H/C500/C2000H Duplex, 38

Data Transfer Processing Time, 37

Data Transfer Times, 36
- Cable Length, 36
- Data Transmission/Reception Time, 36
- Delay at Line Server, 36
- Delay for Optical Fiber Cable, 36
- Delay Time, 36
- DMA Transmission Time, 36
- Number Of Nodes, 36
- Number of Other Nodes Waiting to Transmit, 37
- Permission to Transmet Detection Time, 36
- Reception DMA Time, 37
- Time/Node, 36
- Total Length of Loop's Cabling, 37
- Total Number of Nodes, 37

Datagram, 12
- Basic Routines, 18
- From Basic, 18

DC Power Indicator, 8

DGIOX, 18

DGIOX AND DGSUB, 28

DIAGMT32, 18

distributed control, 1

Downstream Direction, 8

E

Echoback Test, 45

F

factory computer, 2

Free Token, 12

G

GD Indicator, 8

H

Host Link Unit, 30

I

I/F Routine for Datagram Service, 41

Intermittent Errors, 45

International Organization for Standardization, 28

ISO, 28

L

LAN, 3

Line Server, 8

Local Area Network, 3

local area network, 3

LTEST, 18

M

Master PC, 13

Message Passing, 12

N

NCD Indicator, 8

NETBIOS: CP3200, 28

Network Communication Software, 28

Network Link Unit, 9

Network Service Unit, 20

Network Service Unit's Commands, 21

Network Support Board, 15

Node, 3

Node Bypass, 4

NSB, 15

NSB Settings, 16

O

Open Systems Interconnect, 28

Optical Fiber Cable, 24

P

PC Link, 31

PC–DOS, 15

process control computer, 2

R

Repeater, 8

Routing Table, 22

Routing Tables, 35

RTREAD, 18

RTSET, 18

S

Slave PC, 13

STAT32, 18

Status Read Test, 45

System Configurations, 4

T

Token Ring, 3

U

Upstream Direction, 8

V

VER32, 18

Revision History
SYSMAC NET
System Manual

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.

Cat. No. W178-E3-1

Revision code

The following table outlines the changes made to the manual during each revision. Page numbers refer to previous version.

Revision code	Date	Revised content
1	October 1990	Original production
	January 1991	Converted the format. Content remains unchanged.
E3-1	December 1995	Changed PC to PLC, and Module to Unit. **Page 3:** Referenced CV series. **Page 4:** Added information to last bullet. **Pages 5 and 6:** Referenced CV series. **Page 17:** Changed artwork. **Page 19:** Deleted section 2-4. **Page 27:** Revised artwork and text. **Page 31:** Revised text. **Page 32:** Revised artwork. **Page 37:** Inserted a NOTE under section 3-4. **Page 42:** Deleted callout in the artwork. **Page 59:** Revised Index.