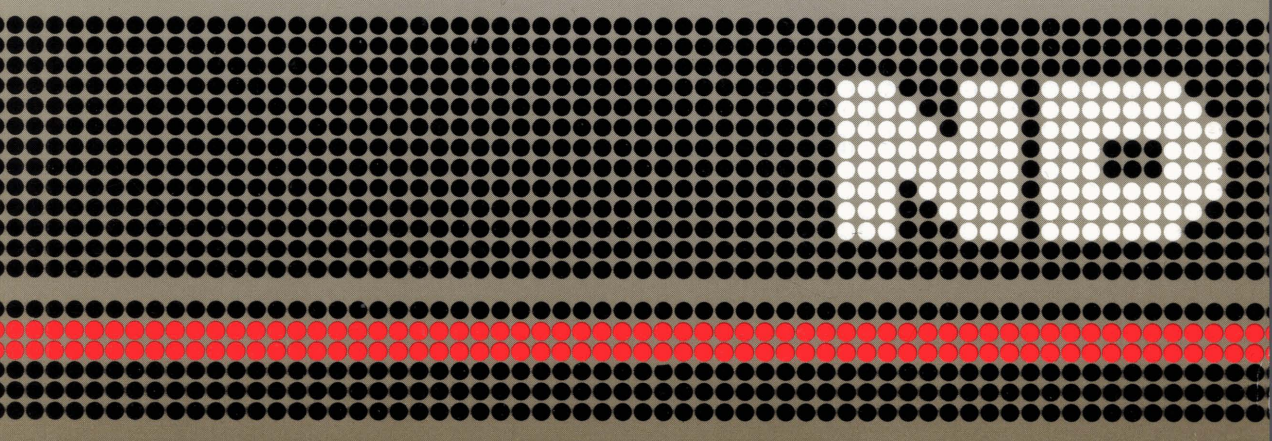
Ethernet II Controller

ND-12.055.1 EN



Ethernet II Controller

ND-12.055.1 EN

Preface

The product

The Ethernet* II controller (ND number 110063).

The reader

This manual is intended for all personnel who require information about the Ethernet II Controller.

Assumed background

The reader is assumed to have a general knowledge of digital hardware design.

The manual

This manual outlines the main features of the Ethernet controller and its installation. It is divided into the following three sections:

- 1. Introduction - a general overview, including an outline of the Ethernet protocol
- 2. The Controller - what it does and how
- 3. Installation - what you need to use and how to install the Controller

The appendices include a glossary of terms, Ethernet protocol details and an ND Ethernet product guide.

Related manuals

The following manuals may be useful:

ECMA 57/TC12/83/51 Technical Report TR19 - Local Area Networks Safety Requirements.

IEEE Std 802.3-1985 (ISO/DIS 8802/3) Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

Data sheets for:
LANCE (Am7990) - AMD reference number 05698
SIA (Am7992B) - AMD reference number 03378
MFP (68901) - various vendors (Motorola, Mostek)

* Ethernet is a trade mark of the Xerox Corporation.

Notation

hex	Where possible hexadecimal notation of numbers has been used.
octal	Octal numbers, commonly used by ND-100 users, are denoted by the subscript: $_8$.
binary	Binary numbers have the subscript: $_2$.
bits	Bits within registers are also described using subscripts e.g. Ethernet control register$_2$ is bit 2 of this register. In the COSMOS Monitor example (pages 45-9), the following notation is used:
highlight	Highlighted text will be displayed by the computer.
underline	Where underlined text is shown, information is to be entered by the user. ↲ denotes carriage return.

1 INTRODUCTION ——— 1

Architecture 4
Ethernet protocol 6

2 THE CONTROLLER ——— 9

2.1 68000 local processor 11
68000 interrupt levels 12
2.2 LANCE 13
Error reporting 14
2.3 SIA 15
2.4 Local memory 16
2.4.1 Local DRAM 16
DRAM access priority 16
Byte parity on memory 17
Parity errors 17
Power failure 18
Local SRAM - DRAM protection 19
2.4.2 EPROM 20
2.4.3 Address decoding 21
Addresses of other devices in the I/O address space 22
2.4.4 Ethernet transceiver power control 25
2.4.5 Multifunction Peripheral (MFP) 26
MFP after RESET and initialization 28
2.4.6 ND-100 interface 28
Ethernet control register 29
Ethernet status register 30

3 INSTALLATION ——— 31

3.1 What you need 33
Ethernet transceiver 34
Fan-out unit 34
Transceiver cable 34
Coaxial cable 35
Coaxial accessories 36
Repeaters 37
Point-to-point cable 38

3.2 What to set 39
Thumbwheel selection of memory bank 40
Thumbwheel selection of Ethernet number 41
3.3 How to connect to the network 42
3.4 How to upgrade to an Ethernet II 44
3.5 Ethernet statistics 45
Description of COSMOS Monitor statistics 47

Table of appendices

Appendix A: GLOSSARY ——— 51

Appendix B: ETHERNET PROTOCOL DETAILS ——— 55

Frame format 57
IEEE 802.3 - Ethernet differences 58
Frame terminology 58
Manchester encoding 62

Appendix C: ND ETHERNET PRODUCT GUIDE ——— 63

Ethernet accessories 65
OSI model and ND's implementation 66

Index ——— 67

List of figures

1. The implementation of Ethernet II - OSI standard 4
2. Block diagram of Ethernet II 5
3. Block diagram of the LANCE 13
4. Memory protection 19
5. The Multifunction Peripheral (MFP) block diagram 26
6. A point-to-point link 38
7. LED activity and thumbwheel selection on an Ethernet II card 39
8. Connecting to the Ethernet 42
9. A typical multi-station, multi-segment Ethernet 43
10. Upgrading from an Ethernet I 44
11. Calling Ethernet statistics from the COSMOS Monitor . . . 45
12. Typical Ethernet statistics returned by the COSMOS Monitor 46
13. Examples of Manchester-encoded signals 62

List of tables

1. Addresses used in the I/O address space 22
2. Thumbwheel selection of memory banks 40
3. Thumbwheel selection of Ethernet address 41

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

The Ethernet II controller is implemented on a single-card for ND-100 based systems. The controller conforms to the IEEE 802.3 and ISO/DIS 8802/3 standards.

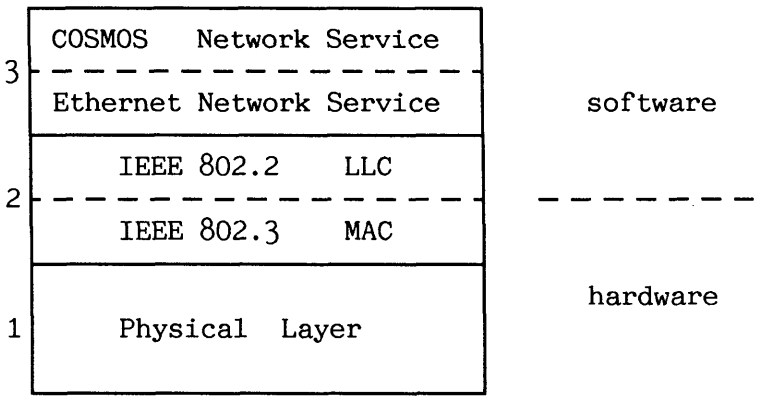
Systems using the two-card Ethernet I from Norsk Data can be upgraded to this single card option (see Section 3.4). ND-100 based systems can drive a maximum of four Ethernet II controllers.

This chapter outlines the basic features of the controller and of the protocol required for communicating on an Ethernet.

Architecture

The Ethernet controller implements the three lowest layers of the OSI seven layer model for system communication. The network layer (level 3) is implemented by software running on the Ethernet controller with the controller's hardware and external transceiver implementing the data link and physical layers (levels 2 and 1).

A complete overview of the seven layers is given in Appendix C.



LLC : Logical Link Layer
MAC : Medium Access Layer
COSMOS: proprietary software

Figure 1. The implementation of Ethernet II - OSI standard

The Ethernet II controller has the following hardware architecture:

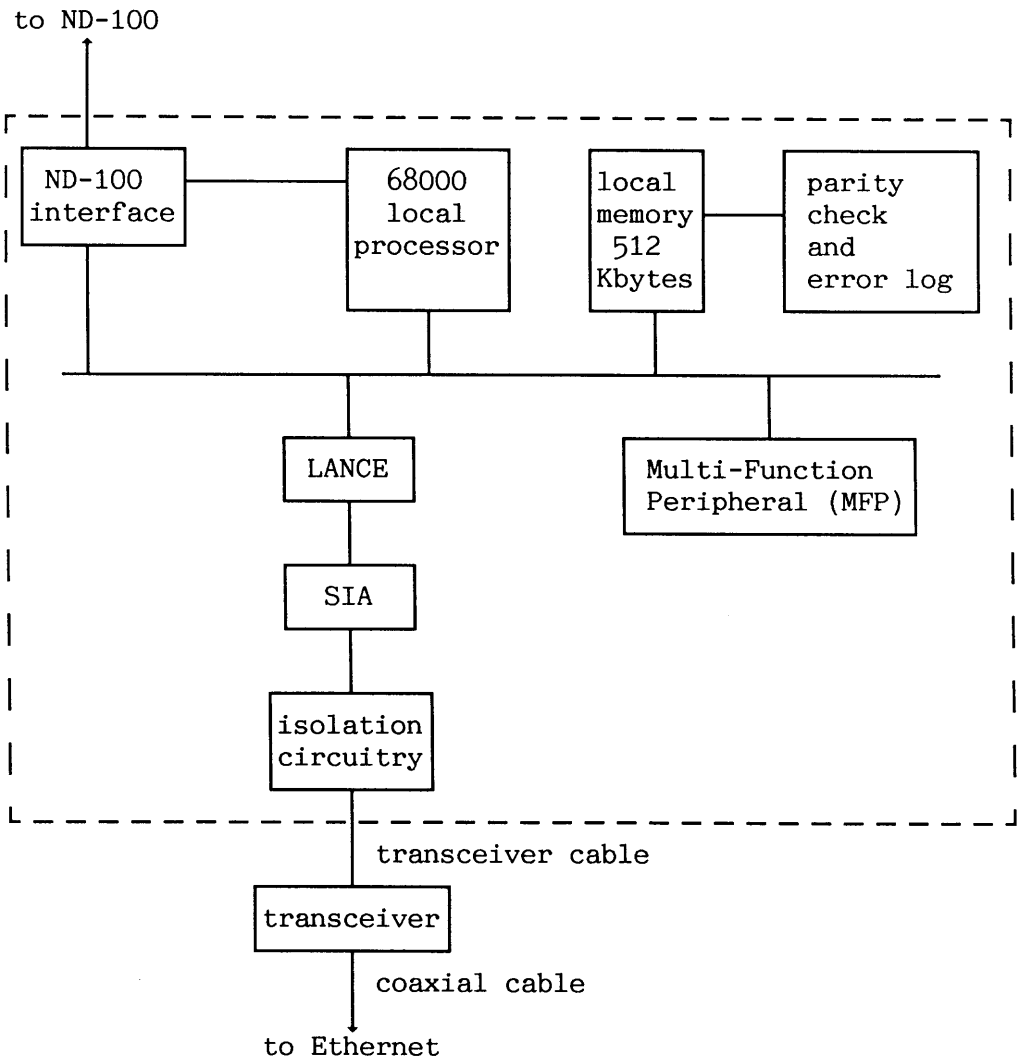


Figure 2. Block diagram of Ethernet II

Ethernet protocol

Ethernet is a protocol designed for baseband local area networks (LANs). The network has a bus topology using an algorithm for bus access known as CSMA/CD (Carrier Sense Multiple Access with Collision Detection).

CSMA/CD

Access to the network is as follows:

All stations on the Ethernet continually listen to network activity.

A controller wishing to transmit waits for a quiet period (i.e. no activity on the network - none of the stations are transmitting) and begins to transmit.

collision

If another station begins to transmit at almost the same time, the transmitted signals will collide and the data on the network becomes garbled.

The transmitting nodes detect this collision and continue to transmit for a predetermined length of time. This ensures that all the nodes on the network recognize that a collision has occurred. The nodes transmit a **jam** pattern of any pattern except that of the CRC. If the collision occured during the preamble, the preamble is still sent followed by the jam pattern.

The action taken by a receiving controller during collision depends upon the time taken to detect the collision.

- If within 4.8µs, an address mismatch has occurred, the packet will be rejected and the Silo pointer reset.
- If within 51.2µs, the packet will be rejected as a **runt packet.**

- After 51.2µs, a **late collision** has occured and the packet written into the Silo (the FIFO on the LANCE - see Section 2.2) but with the CRC error bit set.

The transmitting nodes then **backoff**, each delaying a random period of time before retransmitting. Sixteen attempts, with increasing timeout range, can be made by the controller before an error message is given due to excessive collisions on the network.

The frame formats of packets transmitted and received by the controller are given in Appendix B.

The Ethernet II controller conforms to the following protocol standards:

- IEEE 802.3
- ECMA 80/81/82
- ISO/DIS 8802/3

CHAPTER 2 THE CONTROLLER

CHAPTER 2 THE CONTROLLER

The controller is implemented on a single card featuring:

- a 68000 local processor
- a LANCE (Local Area Network Controller for Ethernet)
- a SIA (Serial Interface Adapter)
- local memory
- Ethernet transceiver power control
- a MFP (Multi-Function Peripheral controller)
- ND-100 bus interface

2.1 68000 local processor

The 68000 is a 10 MHz, 16-bit processor dedicated to the I/O processing required by the Ethernet controller. Its basic control signals - HALT and RESET - are directly set by the ND-100.

68000 interrupt levels

These are assigned as follows:

level	interrupt source
7	ND-100 power low
6	ND-100 OPCOM
5	parity error
4	test console (PTC)
3	MFP (and ND-100) *
2	LANCE interrupt
1	not used
0	indicates no interrupt

* see Section 2.4.5

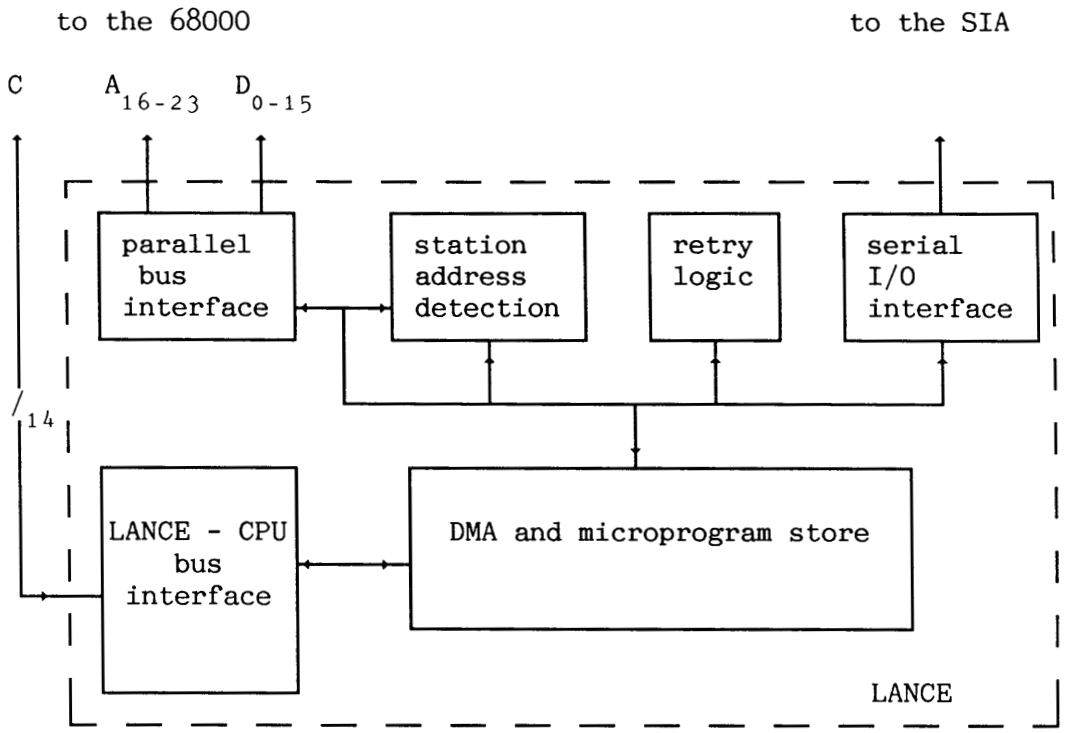
Interrupt priority is assigned such that level 7 has highest priority and level 0 the lowest.

Detailed and introductory descriptions of the 68000 can be found in the vendors' manuals.

2.2 LANCE

The LANCE (Local Area Network Controller for Ethernet - Am7990) is a single integrated circuit featuring:

- on-board DMA and buffer management (48 byte FIFO known as a Silo)
- network and packet error reporting
- back-to-back packet reception
- network diagnostics (see page 46):
  - internal/external loopback
  - CRC logic check
  - time domain reflectometer



C: control signals

Figure 3. Block diagram of the LANCE

The LANCE operates in two modes:

- transmit
- receive

In transmit mode, the LANCE directly accesses data in memory and formats it into a **packet** for transmission (see Appendix B). The packet consists of:

- preamble
- sync pattern
- data
- 32-bit CRC

The LANCE transmits the packet to the SIA. It loads the first byte of data into its Silo. Then, as the LANCE transmits the preamble to the SIA, it simultaneously loads the Silo with the remaining data.

In receive mode, packets are loaded into the Silo via the SIA. The CRC of the received data is calculated and compared and appended to CRC field given by the packet. If the CRCs do not match, an error bit is set.

Error reporting

System errors reported by the LANCE include:

- babbling transmitter (the transmitter is attempting to send more than 1518 data bytes)
- collision (collision detection malfunctions)

- missed packet (insufficient buffer space)
- memory timeout (25.6µs)

Packet errors include:

- CRC (data invalid)
- framing (the end of the packet was not on a byte boundary). This is also known as octet or alignment error.
- overflow/underflow (slow response to a DMA request)
- buffer (insufficient buffer space)

Detailed information on LANCE operation can be found in the vendors' manuals.

2.3 SIA

The SIA (Serial Interface Adapter - Am7992B) is a single integrated circuit featuring:

- a Manchester encoder/decoder
- collision detection

For transmission the SIA encodes the separate clock and NRZ data packet into a standard Manchester II serial bit stream (see Appendix B for a description of Manchester encoding).

For reception the SIA indicates to the LANCE that data is being received and separates the incoming Manchester-encoded data stream into clock and NRZ data.

Any collisions on the network are detected and signalled to the LANCE.

2.4 Local memory

The local memory consists of:

- 512 Kbyte DRAM (dynamic RAM)
- 1 Kbit SRAM (static RAM)
- 128 Kbyte EPROM (future option)

2.4.1 Local DRAM

The local DRAM is accessible from the ND-100 as if it were any other ND-100 memory bank. The location of the DRAM in the ND-100 address space can be set by two thumbwheels located on the card edge (see section 3.2). The bank number of the card can be read back to the ND-100 using the IOXT instruction.

Messages between the controller and ND-100 can be transferred via special mailbox areas in the DRAM.

To pass messages, the Ethernet controller can interrupt the ND-100 and vice versa. The controller's control and status registers are under the direct control of the ND-100 (see section 2.4.6 for their description).

DRAM access priority

The priority of access to the DRAM is:

- ND-100 (highest)
- LANCE
- 68000 (lowest)

Byte parity on memory

The DRAM includes a byte parity DRAM of 256K by 18 bits.

Parity errors

The Ethernet II has two parity error tests:

- external
- internal

external parity test

Here, the ND-100 generates an error which is reported.

> Note
> This test should only be used by ND-100 stand-alone programs. Tests under SINTRAN should only run after the memory has been tested.

The ND-100 executes the test as follows:

- it disables the parity write by using an IOXT instruction to set the **disable check bit** in the Ethernet control register (bit 8). (See page 29.)
- it then looks for the parity error signal on the bus when the error is detected
- and sets the LED marked 'PERR' on (see Section 3.2). The LED is turned off by a RESET.

internal parity test

Here the 68000 generates parity errors and initiates an interrupt.

- the 68000 writes a one to PARITYDIS, the parity disable register (address: EF0022) to disable parity write

- any parity error is reported by a level 5 interrupt to the 68000
- the contents of PARITYDIS are read

If PARITYDIS is set together with BREAKMODE (address: EF0024), forced parity errors are used to set the breakpoint without changing the code. The parity error routine should read the BREAKMODE address to determine whether the parity error was a breakpoint or not.

Power failure

The DRAM and its refresh system are connected to the stand-by power supply so that the memory contents are preserved.

The ND-100 activates its **Master Clear**, a power failure sequence, on detecting the failure of its main power supply. This includes a **power-low interrupt** to the controller which resets the controller within approximately 50µs. The interrupt service routine for power-low saves all registers in the 68000 and drives the HALT and RESET signals low.

At the end of the Master Clear pulse, bus arbitration is reset and the 68000 becomes bus master. The SCIP (Status Change in PIOC) register on the Ethernet controller (see Section 2.4.3) is reset 200µs after power low by the **Delayed Clear** pulse.

The ND-100 restarts the controller by using an IOXT instruction, which results in the 68000 fetching the system stack pointer and restart address (held in the first eight bytes of DRAM). SINTRAN (the operating system) and PIOCOS cannot restart the controller in this manner.

Local SRAM - DRAM protection

The SRAM protects the DRAM from being written to:

- by input DMA.
- by the 68000 user

The SRAM is a **protect table** for the controller's DRAM.

The DRAM is divided into memory segments of 512 bytes. Each segment has a corresponding bit in the SRAM which is either set or cleared to select memory protection or not.

Read and write access to a memory segment is gained by writing a one to the address of the segment concerned plus an offset address of 15360K. A zero protects the segment from access.

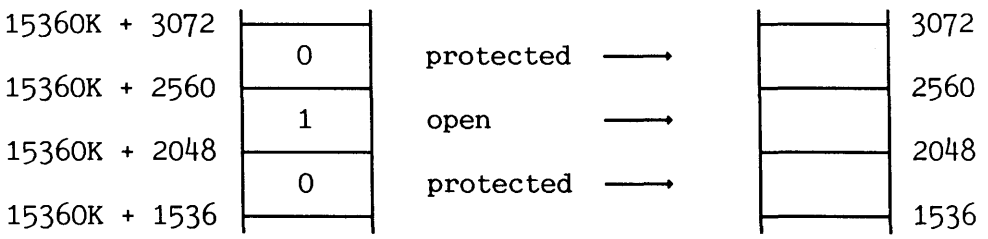


Figure 4. Memory protection

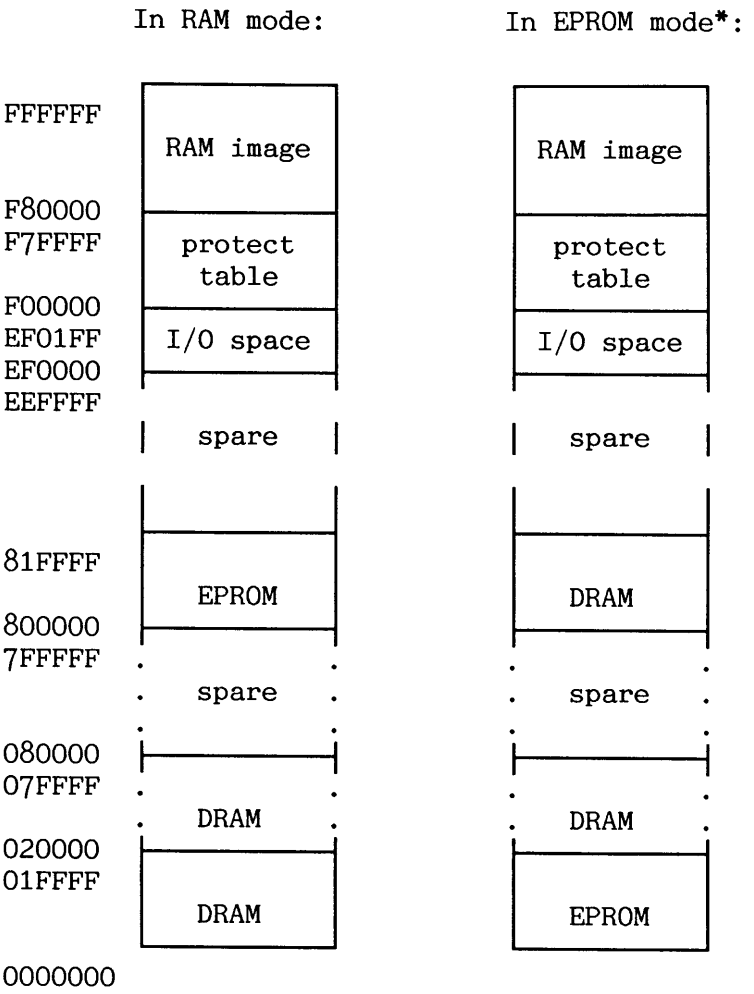
Attempting to access a protected area results in a bus error which will interrupt the 68000 with a write protect violation.

The protect table is established at system start-up. Programs running in 68000 Supervisor mode can access protected DRAM areas.

2.4.2 EPROM

The 128K by 16 bit EPROM can only be accessed by the 68000. The EPROM is currently not used by the controller, so the boards are delivered with empty EPROM sockets. Future developments may implement EPROM.

2.4.3 Address decoding



* see previous section

RAM image This area is always used by the ND-100. The LANCE and 68000 do have access.

Addresses of other devices in the I/O address space

The I/O addresses within this region are decoded twice i.e. EF00XX = EF01XX, so that PIOC and Ethernet I software can be used.

address range	used by/as:	R/W
EF00C0 - EF00FF	MFP	R/W
EF00B8 - EF00BF	ETHSTAT	R
EF00B0 - EF00B7	LANRESET	W
EF00A8 - EF00AF	XCVPW	W
EF00A0 - EF00A7	LANCE	R/W
EF0080 - EF009F	SCIP	W
EF0060 - EF007F	EAREN	R
EF0040 - EF005F	MERRSTAT	R
EF0020 - EF003F	MODCR	R/W
EF0010 - EF001F	PROFF	W
EF0000 - EF000F	not used	-

R: read
W: write

Table 1. Addresses used in the I/O address space

MFP

Multi-Function Peripheral
The MFP uses the base address of EF00C0 plus a displacement of 1-55 (1-37 hex) to address all the registers within the MFP. ONLY ODD addresses are used to access the MFP.

ETHSTAT

Ethernet hardware status
These addresses read the current hardware status of the controller. Only two of the bits read are significant when ZERO:

bit	meaning
2	power enable
0	LAN interrupt

LANRESET

LANCE hardware reset
Using an address in this range will initiate a hardware reset.

XCVPW

Transceiver 12 Volt power switch
Writing a one to this single-bit register will enable the 12 Volt power switch on the transceiver. Writing a zero, turns the power off.

LANCE

LANCE address space
Only two addresses are needed to address the LANCE. They are:

address	name
EF00A0	Register Data Port (RDP)
EF00A2	Register Address Port (RAP)

All accesses to the LANCE are 16-bit using even-byte addresses.

SCIP

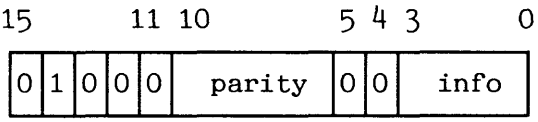
Status Change In PIOC
Using this address range results in an interrupt on level 12 to the ND-100.

EAREN

Error Address Enable
Using this address range returns the address (A_{1-16}) of a memory error on the 68000 data bus.

MERRSTAT

Parity Error Enable
The information returned by these addresses has the format:



bit	description
10	write to parity
9	address bit 18
8	address bit 17
7	NGACK) error detected in *
6	BGACK) read access *
3	parity error in high byte
2	parity error in low byte
1	parity bit read with high byte
0	parity bit read with low byte

Write to parity is enabled when the bit is zero; disabled when set.

* The logic state of the following bits/signals determine which device detected an error in read access:

NGACK bit 7	BGACK bit 6	device
0	0	ND-100
0	1	none
1	0	LANCE
1	1	68000

MODCR

Mode control register
This is addressed by:

address	description
EF0020	EPROMMODE
EF0022	PARITYDIS
EF0024	BREAKMODE
EF0026	SPARE

All four single-bit registers are cleared after RESET. Each register can be cleared by writing a zero or set by writing a one to its address.

PROFF

Protection Off
Writing a one into this address by a 68000 routine means the protect table contents are ignored.

2.4.4 Ethernet transceiver power control

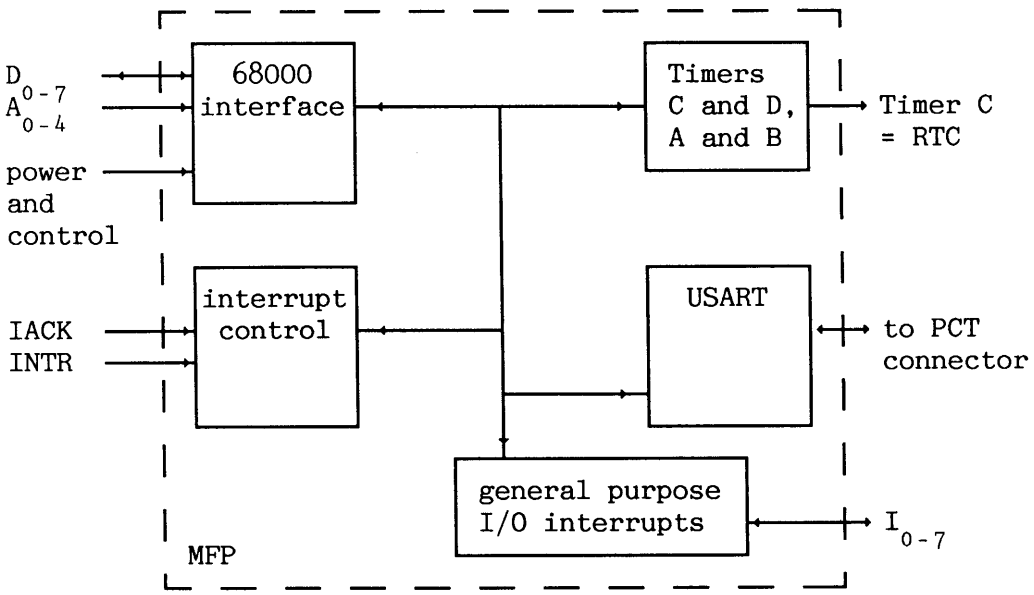
A current switch monitors the D.C. current supplied to the transceiver from the ND-100 via the controller card. The current switch will disconnect the supply on controller command or when the current level could harm hardware or data integrity.

2.4.5 Multifunction Peripheral (MFP)

The 68901 Multifunction Peripheral (MFP) combines many of the peripheral functions into one integrated circuit:

- eight parallel I/O lines
- interrupt controller for 16 sources
- four timers
- one full-duplex serial port for Asynchronous or Synchronous communication channel (USART)

A functional block diagram of the MFP is given below:



PCT: PIOC console terminal
RTC: real time clock

Figure 5. The Multifunction Peripheral (MFP) block diagram

The MFP is used as follows:

USART The USART is connected to a 10-pin PCT (PIOC console terminal) connector. When activated, the PCT interrupts the 68000 on interrupt level 5 via the MFP.

Timers A-D Timer C is used as a real time clock (RTC). Timers A,B and D are not used.

Interrupts The interrupts (I_0-I_7) are assigned as follows:

interrupt	use
7	write violation
6	ND-100 interrupt
5	LANCE error *
4-0	not used

* A LANCE error is generated when a memory cycle is stopped by any of the following:

- protect violation
- bus error
- address out of range

MFP after RESET and initialization

After RESET, all the MFP's registers except for timer registers are cleared. Software then re-initializes the registers. The interrupt vectors from the MFP to the 68000 are:

vector address	indicates:
117	write violation by 68000 *
116	ND-100 requesting interrupt *
114	receive buffer full
113	receive error
112	transmit buffer empty
111	transmit error
107	LANCE memory access error
105	RTC (real time clock)

* the ND-100 is the source

2.4.6 ND-100 interface

Messages between the controller and ND-100 can be transferred via mailbox areas in the DRAM.

To pass messages, the Ethernet controller can interrupt the ND-100 on interrupt level 12 and the ND-100 can interrupt the controller by setting the **ND interrupt** bit (Ethernet control register$_2$ - see following description).

The ND-100 will interrupt the controller on level 6 when the normal Ethernet/ND-100 communication path cannot be used.

The control and status registers are under the direct control of the ND-100.

Ethernet control register

This is a 16-bit register controlling the following functions:

bit	function
15-9	not used
8	disable check bit
7	not used
6	power low
5	halt
4	reset
3	start OPCOM
2	ND interrupt
1	not used
0	enable SCIP interrupt

A **Master Clear** pulse from the ND-100 (or power-on) will set the controller's RESET and HALT signals and reset any local I/O activity.

The ND-100 starts controller activity by writing to the control register with the halt and reset bits cleared (zero).

The ND-100 writes to this register using an IOXT instruction. The Ethernet address of the controller plus 1 or 3 must be loaded into the T register before an IOXT is executed (see Section 3 - Thumbwheel selection of Ethernet address).

Ethernet status register

This has the format:

bit	function
15-8	bank number
6	memory is 512 Kbytes *
5	halt
4	reset active
2	interrupt set for ND-100 on level 12
0	interrupt enabled onto ND-100 bus

* always zero

bank number

Bits 8 and 9 are ALWAYS zero as the controller must start on a half-megabyte boundary i.e. the bank number is **always** a multiple of four.

The ND-100 reads this register using an IOXT instruction. The Ethernet address of the controller plus 0 or 2 must be loaded into the T register before an IOXT is executed (see Section 3 - Thumbwheel selection of Ethernet address).

CHAPTER 3 INSTALLATION

CHAPTER 3 INSTALLATION

This section outlines how to install your Ethernet II card. It also offers some guidelines on network configuration and equipment requirements.

> Note
> All equipment using the Ethernet II controller must be to IEEE 802.3, ISO/DIS 8802/3 standards.

3.1 What you need

Controller to ND-100:

- Ethernet II Controller
- Ethernet/GPIB plug panel
- internal cable between controller and plug panel

To establish an Ethernet network:

- Ethernet transceiver(s)
- fan-out unit(s)*
- transceiver cable(s)
- coaxial cable(s)
- coaxial accessories
- repeater(s)*
- point-to-point cable(s)*

* depends upon network size

Ethernet transceiver

The transceiver is powered by the ND-100's 12 Volt D.C. supply via the Ethernet controller. A current switch will disconnect the power to the transceiver in the case of:

- short circuit or excessive transceiver current consumption
- low 5 Volt supply
- a power off command from the controller

A **power-off command** is issued:

- after jabber (data transmitted to jam the network)
- as a result of a hanging transmitter
- if the heartbeat is missing

Fan-out unit

A fan-out unit acts as a transceiver multiplexer, providing eight transceiver-type connections for DTEs (Data Terminal Equipment).

Transceiver cable

This cable links the transceiver to the Ethernet controller card via the ND-100's plug panel. The maximum cable length, i.e. distance between transceiver and controller, is 50m. It is a four-pair shielded cable, 75Ω impedance.

> Note
> The transceiver cable is called an AUI (Attachment Unit Interface) cable in IEEE 802.3 terminology.

connectors

cable to transceiver:

- 15 pin D-type sub-miniature female with slide lock assembly
- Cinch type DA 51220-1 or equivalent

The transceiver must have a mating male connector with locking posts.

cable to controller:

- male with locking posts
- Cinch type DA 53018 or equivalent

This connector must mate with the female connector in the ND-100 plug panel.

Coaxial cable

The maximum segment length of coaxial cable is 500m. The cable is marked every 2.5m for correct transceiver installation. It has the following characteristics:

- 4 shields
- foamed dielectric
- 50Ω impedance
- 10.3mm thick
- propogation velocity: 0.77c
- supplied by one vendor only

Cable recommendations:

The following lists, in order of preference, steps that can be taken to reduce signal reflections caused by cable discontinuities.

- The cable segment should be made from one continuous cable.
- If segments are built up from smaller sections, cable from the same manufacturer and preferably the same batch should be used.
- If cable sections from different manufacturers are used, then standard lengths (23.4m, 70.2m, 117m) should be used.
- An arbitary configuration of the cable should only be used if the worst-case signal reflection at any point on the cable is less than 7% of the initial signal.

Coaxial accessories

The following accessories are required:

- male n-type coaxial connector at the end of every cable segment
- female jack with a 50Ω terminator at each end of the (composite) segment
- a cable splice - female-female coaxial barrel connector - to join segments

All of these connectors must be electrically isolated from the building ground (rubber isolators are available for the Ethernet terminator and cable splice accessories).

Repeaters

A repeater must be used when more than one 500m cable segment is used. Two types of repeaters are available:

- local repeater
- remote repeater

A repeater ensures that valid data is transferred over a long distance on the Ethernet. It does this by:

- regenerating preamble
- extending collision fragments
- carrying out automatic partitioning and reconnection in the event of a segment failure
- allowing manual partitioning for segment servicing or reconfiguration

A **local repeater** is used for point-to-point links between cable segments within the same building.

A **remote repeater** is used for connections between buildings.

A maximum of two repeaters can be used in the path between any two stations connected to the Ethernet. However, more than two repeaters can be used providing the **round-trip delay** (51µs) is not exceeded.

Point-to-point cable

Coaxial segments in the same building can be joined by using a link segment of up to 1 km.

The link can be greater than 1 km providing the **round-trip delay** (51µs) is not exceeded.

The point-to-point cable consists of a double fibre optic cable terminated by 9mm SMA connectors at each end.

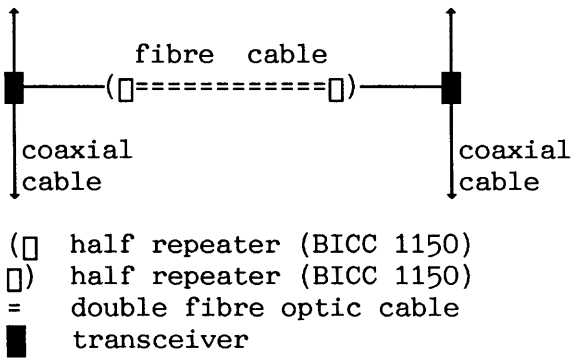
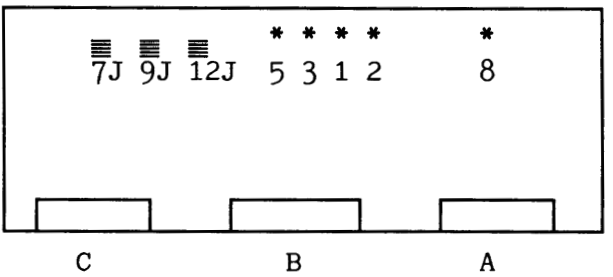


Figure 6. A point-to-point link

3.2 What to set



Ethernet II card

(component side)

key:

*

LED	colour	denotes
8	yellow	external 12V transceiver
5	red	memory parity error
3	yellow	active memory cycle
2	red	68000 halt
1	red	68000 reset

≣

thumbwheel	selects	page ref:
7J,9J	memory bank number	40
12J	Ethernet number	41

A,B,C edge connectors

Figure 7. LED activity and thumbwheel selection on an Ethernet II card

Thumbwheel selection of memory bank

The thumbwheels numbered 7J and 9J select the memory bank accessible to the controller. The thumbwheel numbers correspond to the memory segments as follows:

thumbwheel 7J	thumbwheel 9J	bank number	PIOC address space (Kbytes)	Physical page (hex)
0	0-3	0	0 - 512	0 - FF
0	4-7	4	512 - 1024	100 - 1FF
0	8-11	8	1024 - 1536	200 - 2FF
0	12-15	12	1536 - 2048	300 - 3FF
1	0	16	2048 - 2560	400 - 4FF
.	.	.	.	. .
.	.	.	.	. .
↓ etc.	↓ etc.	↓ etc.	↓ etc.	↓ ↓ etc. etc.

Table 2. Thumbwheel selection of memory banks

Thumbwheel selection of Ethernet number

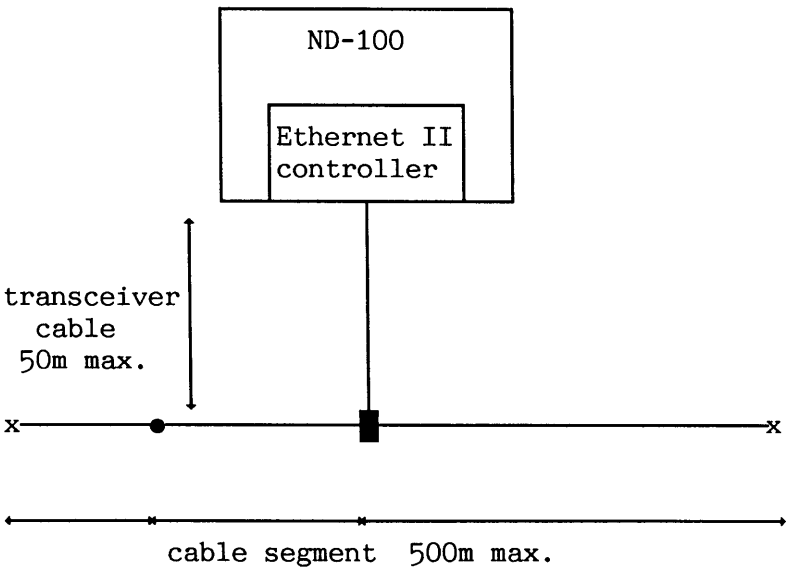
An ND-100 can control four Ethernet controllers. The Ethernet address of a controller in the system must be set by thumbwheel 12J.

thumbwheel 12J	Ethernet number	Ethernet address (device number)	Ident Code
0	1	140360_8	140034_8
1	2	140364_8	140035_8
2	3	140370_8	140036_8
3	4	140374_8	140037_8

Table 3. Thumbwheel selection of Ethernet address

The Ethernet address (device number) given above is the base address, each controller is assigned four addresses, two for reading from and two for writing to the ND-100 (see Section 2.4.6).

3.3 How to connect to the network



x : 50Ω terminator with insulator

▮ : transceiver

● : cable splice with insulator

⟷: standard lengths of coaxial cable (to a maximum of 500m)

Figure 8. Connecting to the Ethernet

Configuration:

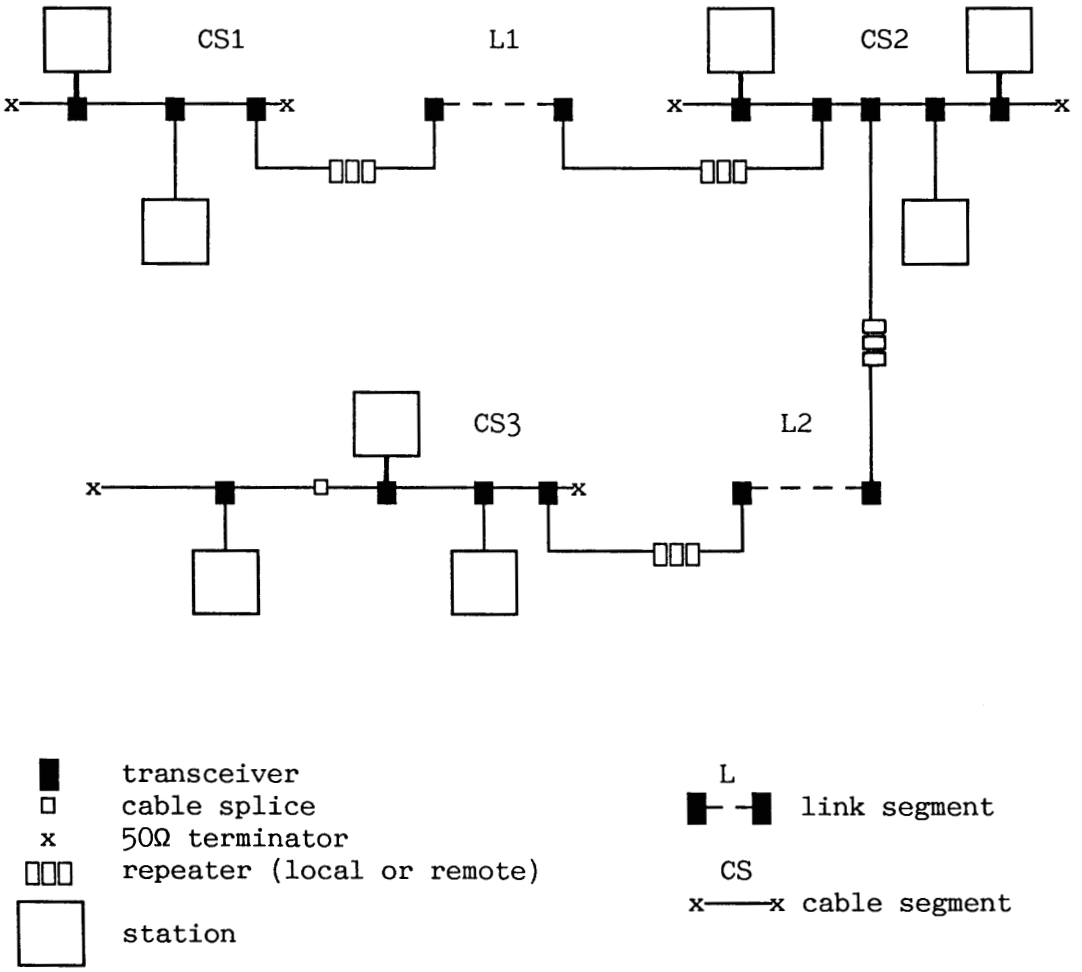


Figure 9. A typical multi-station, multi-segment Ethernet

3.4 How to upgrade to an Ethernet II

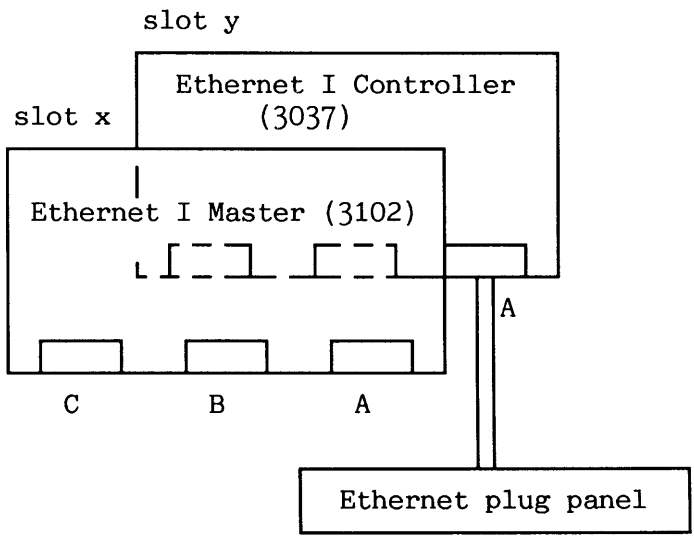


Figure 10. Upgrading from an Ethernet I

1. Remove the Ethernet I Master and Controller cards.

2. Remove the cable linking the B-connectors.

3. Insert the Ethernet II card in the slot that was occupied by the Ethernet I Controller card (slot y).

4. Reset the thumbwheel settings of any I/O cards above the Ethernet memory space.

5. **IF** any DMA request sources are installed at slot numbers greater than the Ethernet controller, insert a dummy plug linking the following connector signals in the slot once occupied by the Ethernet I Master (slot x):

   INGRANT to OUTGRANT
   INIDENT to OUTIDENT

6. Run configuration test.

7. Reinstall COSMOS Ethernet option.

3.5 Ethernet statistics

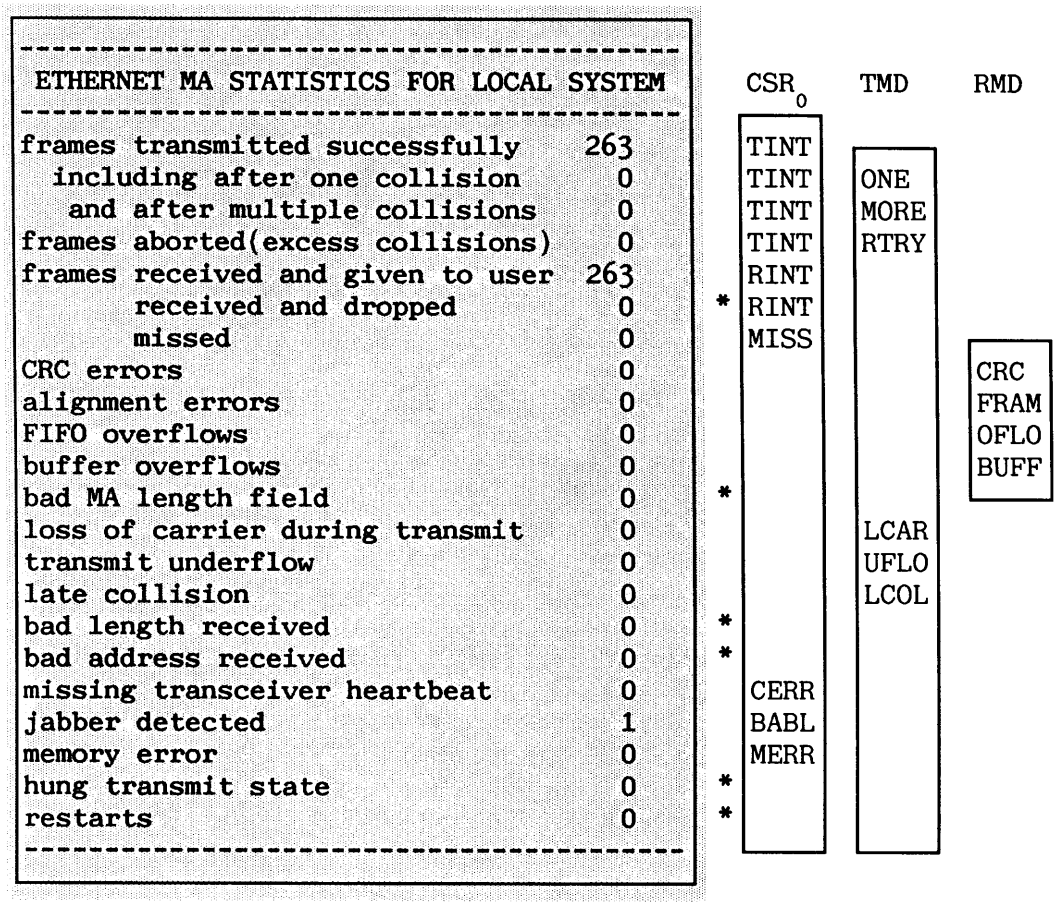
A monitor program can be run as follows:

```
@(UTI)ENCOS-MON↵

------------------------------------------------------------
                COSMOS ETHERNET MONITOR
                      VERSION xxx
                FOR ND-110063 ETHERNET II
          (type HELP for list of available commands)

------------------------------------------------------------
ENTER COMMAND:STAT↵
  get statistics
 server number (0/1/2/3):0
 system name:name of system
 source of statistics is specified by integer code as follows:
 0  => MA Logical Address statistics
 N  => Network Server Statistics for connection to system N
 specify statistics source (0/N):0
MA stats
 via physical copy (Y/N):N
```

Figure 11. Calling Ethernet statistics from the COSMOS Monitor

where xxx represents the current version number of the COSMOS Monitor

This will return the statistics for Ethernet server 0. The following is an example of statistics reported to the terminal. The text which is not highlighted is a cross-reference to the relevant registers in the LANCE (it is NOT reported to the terminal).



CSR: Control and Status Register
RMD: Receive Message Descriptor
TMD: Transmit Message Descriptor
*: statistic determined by the 68000

Figure 12. Typical Ethernet statistics returned by the COSMOS Monitor

Description of COSMOS Monitor statistics

frames transmitted successfully
This is the number of successfully transmitted frames.

frames transmitted successfully after one collision
This the number of frames that required one retry to transmit the packet.

frames transmitted successfully after multiple collisions
This the number of frames that required more than one retry to transmit the packet.

frames aborted
This is the number of frames aborted. The transmitter has failed after sixteen retries to transmit the frame.

frames received and given to the user
This is the number of successfully received frames.

frames received and dropped
The number of frames dropped after reception if the ENNS buffer space is full.

frames missed
This is the number of times the receiver lost a packet.

CRC errors
This is the number of CRC errors detected by the receiver.

alignment errors
This is the number of alignment or framing errors received. The error is flagged when a received packet contains a non-integer multiple of eight bits and a CRC error.

FIFO overflows
This is the number of times the Silo overflowed

resulting in all or part of the incoming packet being lost.

Buffer overflows
A buffer overflow is detected when either the Silo overflow occurred before the LANCE received the next status information or the LANCE does not own the next buffer whilst data-chaining a received packet.

bad MA length field
This is the number of received frames with a field length inconsistent to that in the DMA command byte.

loss of carrier during transmit
This is the number of times the carrier input signal to the LANCE (RENA) has been lost whilst the LANCE was transmitting. The LANCE continues to transmit the packet but will not retry if transmission fails.

transmit underflows
This is the number of times the transmitter has truncated a message due to late data being received from memory. In this case, the Silo is emptied before the end of the packet was reached.

late collision
The number of collisions that occurred after the slot time.

bad length received
The number of incorrect length fields received.

bad address received
The number of incorrect addresses received.

missing transceiver heartbeat
This is the number of times a collision occuring after LANCE transmission fails to activate the LANCE within 2µs.

jabber detected
This is the number of times a transmitter timeout error has occurred. This timeout occurs

when the transmitter has been on the channel longer that the time required to send the maximum packet length.

memory error
This error is set when the LANCE, as a Bus Master, has not received a READY signal in response to an address. This error turns the LANCE transmitter and receiver off.

hung transmit state
The number of one second software timeouts on awaiting transmit commands.

restarts
The number of restarts given by the ND-100 to the 68000.

APPENDIX A GLOSSARY

APPENDIX A GLOSSARY

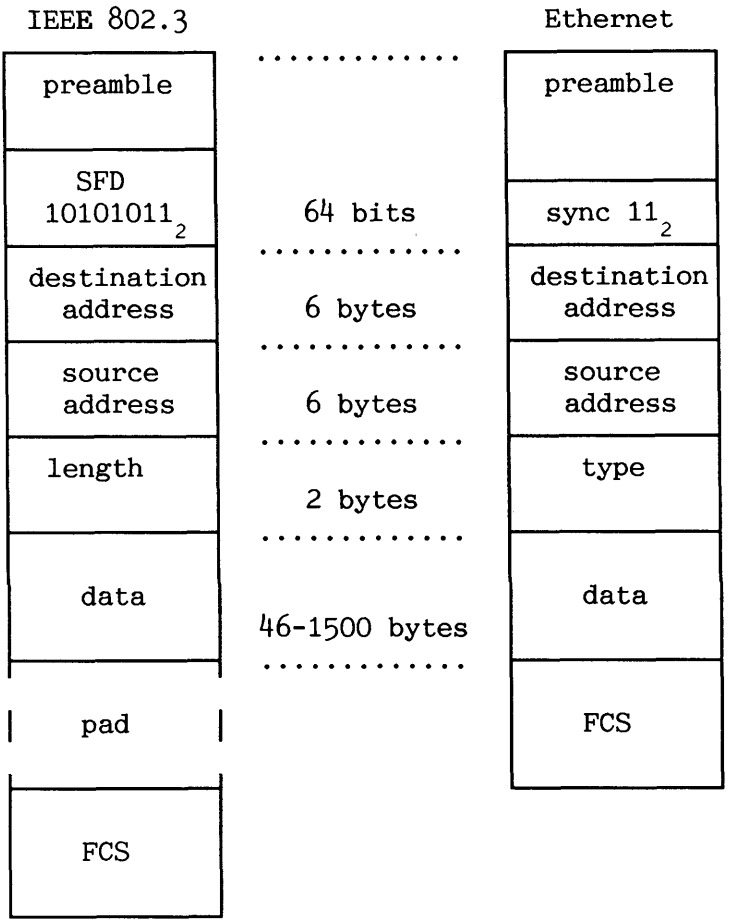
backoff	The time a transmitting node waits before retransmitting after a collision.
68000	16-bit microprocessor
c	speed of light in a vacuum (3×10^8 ms^{-1})
CPU	Central Processing Unit
CRC	Cyclic Redundancy Checksum
CSMA/CD	Carrier Sense Multiple Access/Collision Detect
DMA	Direct Memory Access
Ethernet	A protocol for communicating between devices on a Local Area Network.
Ethernet I	An Ethernet controller for ND-100 systems based on a two card solution (Ethernet master and a controller).
frame	packet + preamble
FIFO	First-In, First-Out (called Silo as implemented within the LANCE).
heartbeat	A signal generated by a transceiver to indicate it is operative. This is also known as SQE.
IEEE	Institute of Electrical and Electronic Engineers (U.S.A.)
ISO	International Standards Organisation
jam	Nodes jam the network by transmitting simultaneously to ensure all nodes know a collision has occured on the network.
LAN	Local Area Network

LANCE	Local Area Network Controller for Ethernet
LED	Light Emitting Diode
ND-100 series	The family of 16-bit general purpose computers from Norsk Data consisting of the following: ND-100 ND-100/CE ND-100/CX ND-100 Compact ND-100 Satellite ND-110/CE ND-110/CX
node	An access point to (or a device on) the Ethernet.
NRZ	Non-Return-to-Zero...a type of data encoding.
OPCOM	OPerator COMmunication...direct communication with the ND-100 CPU.
OSI	Open Systems Interconnection
packet	Significant information within the Ethernet frame (destination address to FCS fields).
PIOC	Programmable Input/Output Controller
preamble	preamble + sync (or SFD)
segment	in memory...512K of contiguous memory of a cable...fixed length of cable.
SIA	Serial Interface Adapter
SQE	Signal Quality Error (see heartbeat)

APPENDIX B ETHERNET PROTOCOL DETAILS

APPENDIX B ETHERNET PROTOCOL DETAILS

Frame format



IEEE 802.3 - Ethernet differences

Frame terminology

An IEEE 802.3 and Ethernet frame should be identical. Each protocol divides the frame into fields with different names. A short description of the field terminology is given below.

Each octet (byte) in the frame is transmitted/received low-order bit first (see FCS). Transmission/reception begins with the preamble field.

preamble A sequence of bits transmitted to synchronize clocks and other devices on the network. The bit pattern is alternate ones and zeros (1010...10). An Ethernet frame transmits a further six bits as preamble compared to the IEEE 802.3 (equivalent to the first six bits of the SFD).

SFD - IEEE 802.3 **Start Frame Delimiter.** This is a byte of data indicating the start of a frame (information) after the preamble. The byte is always 10101011_2 (IEEE 802.3 only).

sync - Ethernet An Ethernet sync field consists of two bits both set to one.

> Note
> The actual bit pattern of the preamble and SFD (IEEE 802.3) will be the same as the preamble and sync (Ethernet).

source address

This six byte field specifies the station sending the frame. It has the format:

byte	1	2	3	4	5	6
hex value	08	00	26	LB	HB	00

The first three bytes are the **global ND address.** A number unique to ND Ethernet equipment and registered with the IEEE and ISO.

The next two bytes are the high and low bytes (HB and LB) of an ND system.

The last byte is zero.

destination address

This six byte field specifies the station(s) for which the frame is intended.

The first two bits have the following significance:

bit	value	type of address
0	0	individual
	1	group *
1	0	global
	1	local/broadcast

* a group address can select none, one, more than one or all stations.

length - IEEE 802.3

This two byte field gives the number of data bytes in the frame. If the number of data bytes is less than 64 bytes a pad field is added to allow the shorter data field to be received.

type - Ethernet

This two byte field specifies the type of packet. Packet length is supplied by the LANCE during reception.

data This is Manchester-encoded data (see next section).

FCS **Frame Check Sequence** A cyclic redundancy check (CRC) is used by the transmit and receive algorithms to monitor any corruption of information received/transmitted on the Ethernet. The FCS (Frame Check Sequence) field of the frame will contain the frame's CRC value.

The CRC is calculated from the following frame fields:

- source address
- destination address
- length (type)
- data
- pad

Note: The low-order bit transmitted/received first of the FCS is the most significant term of the CRC polynomial and the high-order bit the least significant.

Manchester encoding

The separate data and clock signals are encoded by making, at the centre of a bit cell:

- a positive-going transition for a logical ONE
- a negative-going transition for a logical ZERO

and

- a transition at each cell boundary between consecutive bit cells of the same value.

Three examples of a Manchester-encoded bit stream are given below:

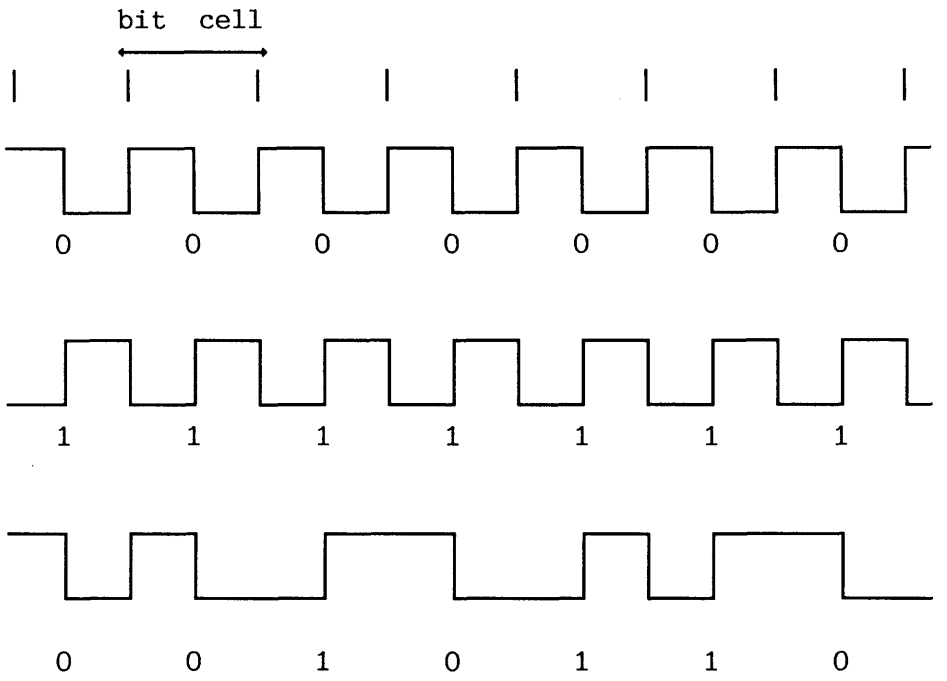


Figure 13. Examples of Manchester-encoded signals

APPENDIX C ND ETHERNET PRODUCT GUIDE

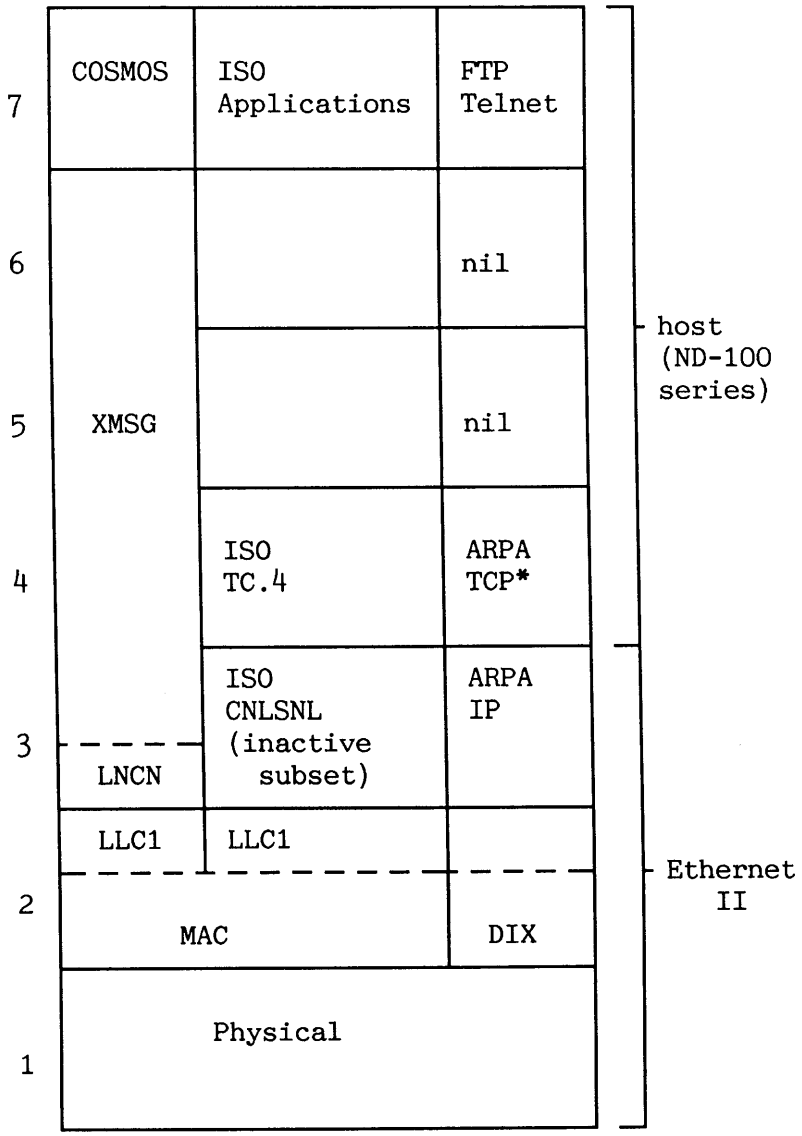
APPENDIX C ND ETHERNET PRODUCT GUIDE

Ethernet accessories

ND Number	Product Name	
107700	Transceiver cable, 5m	
107710	Transceiver cable, 15m	
107720	Ethernet 50Ω terminator	
107730	Ethernet cable splice	
107740	Ethernet transceiver	
107750	Local repeater package	A
107760	Ethernet coaxial cable, 23.4m	
107770	Ethernet coaxial cable, 70.2m	
107780	Ethernet coaxial cable, 117m	
107790	Remote repeater package	B
107830	Fan out unit package	

A includes 1 repeater, 2 transceivers and two transceiver cables
B includes 2 repeaters, 2 transceivers and two 15m transceiver cables

OSI model and ND's implementation



* to be implemented late 1987 by Ethernet II

DIX : Digital-Intel-Xerox specified protocol
ARPA : Advanced Research Projects Agency
LLC : Logical Link Control
CNLSNL: Connectionless Network Layer
LNCN : Local Network COSMOS Network Layer
MAC : Media Access Control

Index

68000 . . . . . 11, 17, 18, 20, 53
interrupt levels 12
68901
see Multifunction Peripheral (MFP) 26

access
read 19
write 19
address
decoding 21
destination 59
error 48
Ethernet 29, 30, 41
global ND 59
I/O space 22
offset 19
source 59
alignment error 15, 47

babbling transmitter 14
backoff 7, 53
bank number 16, 30
BREAKMODE 18
breakpoint 18
buffer space 15
bus error 19

c 53
cable
recommendations 36
cable segment 36, 54
cable splice 36
cable type
coaxial 33, 35
point-to-point 38
point-to-point 33
transceiver 33, 34
coaxial cable 33, 35

collision 6, 14
late 7, 48
COSMOS 4
COSMOS Ethernet Monitor
how to run it 45
statistics 46
CPU 53
CRC 6, 13-15, 53, 60
error 47
CSMA/CD 6, 53
current switch 34

disable check bit 17
DMA 53
DRAM 16
access priority 16
address 16
byte parity 17
protection 19

EAREN 22
ECMA 80/81/82 7
EPROM 16, 20
EPROM mode 21
errors
alignment 15
CRC 47
frame 47
octet 15
packet 15
system 14
Ethernet 53
protocol 6
Ethernet address 41
Ethernet control register 17, 29
Ethernet I 53
Ethernet II
block diagram 5
communication architecture 4
hardware 5
implementation 11
installation 33
statistics 45
Ethernet protocol 57
Ethernet status register 30

Ethernet transceiver 33
power control 11
Ethernet/GPIB plug panel 33
ETHSTAT 22

fan-out unit 33
FCS 60
fibre optic cable 38
FIFO . . . . . 7, 13, 47, see Silo, 53
frame 53
format 57
statistics 47
terminology 58
frame errors 47
framing 15
future option 16

half-repeater 37
HALT 11, 18, 29
heartbeat 34, 53
missing 48

I/O address space 22
IEEE 53
IEEE 802.3 . . . . . 3, 7, 33
internal cable 33
interrupts 16
IOXT instruction 16, 18
ISO 53
ISO model
Ethernet II layers 4
ISO/DIS 8802/3 . . . . . 3, 7, 33
isolators 36

jabber 34, 48
jam 6, 34, 53

LAN 53

LANCE 11, 13, 22, 46, 54
error reporting 14
features 13
operation 14
LANCE error 27
LANRESET 22
LED 17, 54
length
error 48
length field 59, 60
LLC 4
local memory 11
local processor
68000 11
local repeater 37

MAC 4
mailbox 16, 28
Manchester encoder/decoder 15
master clear 18, 29
memory
error 49
segment 19, 54
timeout 15
MERRSTAT 22
messages 16
MFP 11, 22
missed packet 15
MODCR 22
Multifunction Peripheral (MFP) 26

ND-100
bus interface 11
series 54
node 54
NRZ 15, 54

octet error 15
offset address 19
OPCOM 54
OSI 54
OSI reference model 4, 66
overflow/underflow 15, 48

packet 14, 54
    errors 15
    missed 15
    runt 7
packet errors 47
pad field 60
parity error
    forced 18
    tests 17
PARITYDIS 17
PCT 26, 27
PIOC 54
point-to-point cable 33, 38
power failure 18
power off command 34
power-low interrupt 18
preamble 6, 54, 58
PROFF 22
protect table 19

RAM mode 21
receive mode 14
remote repeater 37
repeater 33, 37
    half 37
    local 37
    maximum number 37
    remote 37
RESET 11, 17, 18, 29
    power failure 18

SCIP 18, 22
segment
    cable 36, 54
    memory 19, 54
SFD
    Start Frame Delimiter 58
SIA 11, 14, 15, 54
Silo 6, 13, 14, 47, 48, 53
slot time 48
SQE 54
sync field 58

system
errors 14

terminator 36
thumbwheel 16
12J 41
7J 40
9J 40
timeout
software 49
transceiver 34
disconnection 34
transceiver cable 33, 34
transmit mode 14
type field 59, 60

USART 27

write protect violation 19
interrupt 27

XCVPW 22

UPDATING

Manuals can be updated in two ways, new versions and revisions. New versions consist of a completely new manual which replaces the old one, and incorporate all revisions since the previous version. Revisions consist of one or more single pages to be merged into the manual by the user, each revised page being listed on the new printing record sent out with the revision. The old printing record should be replaced by the new one.

New versions and revisions are announced in the ND Customer Support Information and can be ordered from the address below.

The reader's comments form at the back of this manual can be used both to report errors in the manual and give an evaluation of the manual. Both detailed and general comments are welcome.

PRINTING RECORD	
PRINTING	NOTES
7/87	Version 1

ND-12.055.1 EN
Ethernet II Controller

RING BINDER OR PLASTIC COVER

The manual can be placed in a ring binder for greater protection and convenience of use. Ring binders may be ordered at a price of NKr. 45.- per binder.

The manual may also be placed in a plastic cover. This cover is more suitable for manuals of less than 100 pages than for larger manuals.

Please send your order, as well as all types of inquiries and requests for documentation to the local ND office, or (in Norway) to:

Graphic Center
Norsk Data A.S
P.O.Box 25 BOGERUD
N-0621 OSLO 6 - Norway

I would like to order

..... Ring Binders, B5, at NOK 35,- per binder

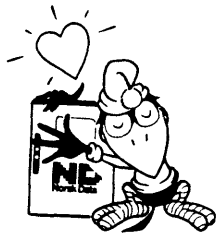
..... Ring Binders, A4, at NOK 45.- per binder

..... Plastic Covers, A4, at NOK 10.- per cover

Name: .....

Company: .....

Address: .....



SEND US YOUR COMMENTS!

Are you frustrated because of unclear information in our manuals? Do you have trouble finding things?

Please let us know if you:
- find errors
- cannot understand information
- cannot find information
- find needless information.

Do you think we could improve our manuals by rearranging the contents? You could also tell us if you like the manual.

Send to:
Norsk Data A.S
Documentation Department
P.O. Box 25 BOGERUD
N - 0621 OSLO 6 - Norway

NOTE!

This form is primarily for documentation errors. Software and system errors should be reported on Customer System Reports.

Manual Name: _____ Manual number: _____

Which version of the product are you using? _____

What problems do you have? (use extra pages if needed) _____

_____

_____

_____

_____

_____

Do you have suggestions for improving this manual? _____

_____

_____

_____

_____

_____

_____

Your name: _____ Date: _____

Company: _____ Position: _____

Address: _____

_____

What are you using this manual for? _____

_____