PHILIPS

CD ROM DRIVE **CDR-X 1000**

CDROM

CDR-X1000 Technical Specification

1. GENERAL:

This document describes the target specification of the Preproduction model called CDR-X1000.
This model will not be released for commercial use.

The consumer CD-ROM drive CDR-X1000 is intended for test and experimental use only for the purpose of field testing a number of CD-ROM system applications. The drive is especially suited for database and program-bank type of stand alone applications such as electronic publishing.

The drive has a standard Small Computer Systems Interface (SASI / SCSI), so it can be linked to most personal- or home-computers.

There is no AUDIO-HiFi output.

2. FUNCTIONAL:

The CD-ROM drive has a built-in intelligent controller to simplify the control-software needed in the host-computer.
The main function of the CD-ROM drive is to read data from the disc and transfer the requested number of bytes starting from a logical byte address on the disc to the host-computer.
CDR-X1000 can read all discs according to the CD-ROM standard, including discs with more Datatracks or discs with mixed Audio and Data tracks.
All Data and Control communication transfer is handled via the SCSI-bus. All data bytes are sent with handshaking, and so automaticaly adapting to the data transfer speed of the host-computer.
Inserting or changing of the disk can only be done, when the disk is stopped.
A diagnostic test, with a check of the drive hardware is done after "Power up" or after "Hard reset".
There is a RS232 port inside the player, to be used for service diagnostics, but can also be used for reading data from the disc.

3. TYPE NUMBER:

Typenumber:	12NC:
CDR-X1000/00 (220volt)	9097 210 00856
CDR-X1000/17 (117volt)	9097 210 00857

4. CABINET:

Usage:	horizontal only.
Loading:	tray, with motor-control.
Dimensions:	W * H * D
with tray closed:	320 * 95 * 305 mm.
with tray opened:	320 * 95 * 454 mm.
Weigth:	7 kg approx.
Material:	Metal/aluminium/polysterene.
Colors:	
front:	black.
cabinet:	brown-gray lacquered.
back:	black.
Front panel:	
switches:	Power on/off.
	Tray open/close.
LED indications:	Power (red) power on.
	Ready (yellow) drive active.
	Busy (green) reading data.
Rear panel/bottom:	SCSI connector (std 50 pin).
Operating temp:	+5 to +40 deg. Celcius (amb.).

5. POWER SUPPLY:

AC power:	powercable type : fixed to drive.
	powercable length: approx. 1.0 m.
	primary fuse : inside drive.
	power consumption: less than 25 watt.
CDR-X1000/00	voltage range : 220 volt (+/- 10%)
	line frequency: 50 herz (+/- 3%)
CDR-X1000/17	voltage range : 117 volt (+/- 10%)
	line frequency: 60 herz (+/- 3%)
Indication	red LED called "power"

6. PERFORMANCE:

Channel bit rate from disc: 4.3218 Mb/s.

Data bit rate after EFM/CIRC: 1.4112 Mb/s.

User data bit rate: 1.2288 Mb/s.

User data byte rate: 153,600 byte/s.

Data transfer rate: Burst 176.4 Kbyte/s.
Average 153.6 Kbyte/s.

If the hostcomputer can't handle the transfer rate of 176 kbyte/s then the transfer rate steps down to 2 kbyte per revolution (16 kbyte/s at inside disc to 7.3 kbyte/s at outside of disc) or less depending on the host.

User data buffer size: 2048 byte.

Delaytimes:			
	power up time :	2.5 sec.	typ.
	spin up time :	3.5 sec.	typ.
	select track :	< 0.5 sec.	
	spin down time:	1.4 sec.	typ.

Access time: average 1.3 sec. over 100M byte of data.
max. 3.0 sec. over 600M byte of data.

7. SCSI INTERFACE:

The SCSI-interface used in the CDR-X1000 CD-ROM drive, is a subset of the ANSI standard X3T9.2/82-2 rev.14.

The subset is specified in the document AR92-0070 and is the minimum set of commands needed to read data from the CD-ROM drive.

For stand alone applications only one drive will be linked to one hostcomputer, therefore no selection phase is needed. For compatibility reasons is the "BSY" signal tied to ground. This means that no other drives or hostcomputers can use the SCSI-bus as the bus is allways occupied (busy) by the CD-ROM drive. The drive will respond to all Logical Unit Numbers (LUN) from 0 to 7. For futher details see the standard documentation.

The drive has a build in databuffer of 2048 userbytes. In this buffer is the data temporary stored until it is checked that the data is errorfree, before it send to the host. If the host has not read out the data from the buffer in time, before the next block of 2 kbytes comes from the disc, then the reading from the disc is stopped and the pic-up is stepped one revolutiontrack backwards.

8. SCSI-BUS CONNECTOR PIN ASSIGNMENTS:

SIGNAL PIN	GROUND	SIGNAL-NAME	
2	1	'data 0'	(1)
4	3	'data 1'	
6	5	'data 2'	
8	7	'data 3'	
10	9	'data 4'	
12	11	'data 5'	
14	13	'data 6'	
16	15	'data 7'	
34	33	'ATN'	(2)
36	35	'BSY'	allways low
38	37	'ACK'	
40	39	'RST'	(3)
42	41	'MSG'	
44	43	'SEL'	(2)
46	45	'C'/D	
48	47	'REQ'	
50	49	'I'/O	

(1) ' ' means negative logic.
(2) Not implemented yet.
(3) 'RST' min pulslength is 20 microsec.

Data response time from REQ signal to ACK in the host:
for 150 kbyte/s: max. 6 microsec.

Data setup time from ACK to REQ in the drive:
for 150 kbyte/s: min. 0.3 microsec.
max. 6 microsec.
for < 50kbyte/s: typ. 19 microsec.

9. SCSI / SASI COMMANDS: For more information see AR92-0070.

During execution of the SCSI commands in the drive, the green LED "BUSY" lights up.

Start :

Actions:

- Closes the disc loading tray and disables the control of the disc loading motor.
- The disc is started up and the Table Of Contents in the leadin area is read.
- If it is not a CD-ROM disc then this is detected and an error message is given.
- The drive is positioned to the beginning of the first datatrack on the disc, ready for a select data track command.
- The yellow LED "READY" lights up.

Stop:

The STOP command stops the drive immediately and enables the control of the disc loading tray. The yellow LED "READY" is turned off.

Select datatrack:

The SELECT DATA TRACK command can only be executed if the CD-ROM drive unit has been started. One data-track number in the range of 1 to 99 (decimal) may be selected. If the selected data track is not on the CD-ROM disk or out of range then an error message occurs.

Read status:

The READ STATUS command causes the CD-ROM unit to send the present status of the drive. The result of the diagnostic test done after "power up" or after a "Hard reset" is also indicated.

Read data:

The READ DATA command reads userdata from the selected data track on the disc and transfers a specified number of bytes to the host, starting from a specified byte address.

10. ERROR RATES:

The drive has a build in Error Correction additional to the standard CIRC errorcorrection to correct for errors in the userdata from the disc. This is possible due to that for each block of 2 kbyte of user data on the disc there are 288 bytes of parity.

If an error occurs in the user data then data is corrected by the microcomputer in the drive before it is send to the host. No unreliable data will be send to the host.

The delay time for correcting an erroneous block of 2 kbyte is max. 150 ms.

The error rate is messured in MBBE, which stands for Mean Bits Between Error and should be seen more as an indication of what can be expected as they also depend on the disc quality.

10.1 Soft read error rate : MBBE = 10^{11}.

A soft error means a correctable error. The data was recovered after error-correcting (ECC) or a re-read.

10.2 Hard read error rate : MBBE = 10^{13}.

A hard error means an uncorrectable error. The data could not be recovered after a re-read and the ECC failed due to too many errors in the 2kb block. This will force a break of the read data command.

10.3 Undetected read error rate: MBBE= 10^{19}.

An error in the data occurs without being detected.

11. RS 232 MONITOR PORT:

The monitor is meant as a diagnostic tool for service but can also be used for reading data from the disc.

The communication with the MONITOR is through the RS-232 port with 1200 baud, 7 bits, even parity, 1 stopbit and full duplex with no handshaking.

For more information see document AR92-0081.

12. CDR-X1000 MICRO COMPUTER SOFTWARE:

The software is structured in a modular form.

There are four main-modules:

- Initialisation with selftest of SW and HW.
- RS-232 Monitor.
- Servo and Data control.
- SASI/SCSI interface.

13. CD-ROM DISC SPECIFICATION:

User data capacity:	1 block = 2048 bytes 1 second = 75 blocks 1 minute = 60 seconds --- 600 Mbyte = 65 minutes on the disc.
Bit density:	24000 bits per inch.
Disc diameter:	outer 120 mm. inner 15 mm.
Rotational speed :	max. 480 rpm. (inside). min. 220 rpm. (outside).
Linear velocity:	1.2 - 1.4 m/s.

CDR-X1000 SASI/SCSI Command Specification

1. GENERAL:

This document specifies the subset of SCSI, X3T9.2/82-2 used in the Philips consumer CD-ROM drive CDR-X1000 built in intellegent controller, as the minimum set of commands needed for CD-ROM applications.

The drive executes only the INFORMATION TRANSFER phases: Command, Data, Status and Message. The SCSI-bus can never be in more than one phase at the time and should be executed in above mentioned order.

No selection phase is needed as the "BSY" signal is tied to ground.

Inserting or changing of the disc can only be done when the disc is stopped.

2. COMMAND SET:

Group: 0

03H	:	Request sense (read status)
0BH	:	Seek (select data track)
1BH	:	Start/stop unit

Group: 1

28H	:	Read data (bytes)

All other commands will not be accepted by the target CD-ROM drive unit and an "illegal request" error will be returnd exept for a write command where a "data protect" error will be returnd instead.

The "read data" command can only be executed if the disc is started and a data track is selected, otherwise an "illegal request" error occurs.

3.0 STATUS BYTE:

At the end of each command one status byte is sent during the STATUS phase to the Initiator, unless the command is not cleared by a "Hard Reset".

Status Byte Format:	bit	7	6	5	4	3	2	1	0
		0	0	0	0	0	0	S	0

Bit 1:

S = 0 Good Status, no error occured during execution of the command.

S = 1 Check Condition, an error occured during execution of the command.

The Target preserves the Sense Data, until it is retrieved by the Initiator with a Request Sense Command or until the receipt of any subsequent command.

3.1 MESSAGE BYTE:

After the STATUS byte, then is a MESSAGE byte sent during the MESSAGE phase to the Initiator, unless the command is not cleared by a "Hard Reset".

Message Byte Format:	bit	7	6	5	4	3	2	1	0
		0	0	0	0	0	0	0	0

The MESSAGE byte is allways zero to indicate the termination of the command.

4.0 Command: Request sense / Read status

Bit	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	hex
Byte 0	Group Opcode	0 0 0 0 0 0 1 1	03
Byte 1	LUN Reserve	x x x x x x x x	X
Byte 2	R e s e r v e d	x x x x x x x x	X
Byte 3	R e s e r v e d	x x x x x x x x	X
Byte 4	Alloc. length	0 0 0 0 1 0 0 0	08
Byte 5	R e s e r v e d	x x x x x x x x	X

Group (Hex): 00 x = don't care.
Opcode (Hex): 03
LUN (Hex): Not used.
Alloc.length: 08 = the number of bytes allocated for returned sense data. (Extended format).

The Initiator sends this command immediately after it receives CHECK CONDITION Status on the prior command.
The command causes the Target to send eight bytes of Sense Data to the Initiator.
The Sense Data is reserved by the target until it is retrieved by the Request Sense command or any other command.

Sense / Status Data Format :

Bit	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	Hex
Byte 0	V Class Err code	0 1 1 1 0 0 0 0	70
Byte 1	Segment nr	0 0 0 0 0 0 0 0	00
Byte 2	Reserve Sense ky	0 0 0 0 S S S S	S
Byte 3	Info byte (msb)	0 0 0 0 0 0 0 0	00
Byte 4	Info byte	0 0 0 0 0 0 0 0	00
Byte 5	Info byte	0 0 0 0 0 0 0 0	00
Byte 6	Info byte (lsb)	0 0 0 0 0 0 0 0	00
Byte 7	Add. Sense len	0 0 0 0 0 0 0 0	00

V : Address valid (bit 7) = 0
Class : Error Class (bit 4-6) = 07H
Err code : Error code (bit 0-3) = 00H
Sense ky : Sense key (bit 0-3) = see table below
Info byte : Information bytes (byte 3-6) = 00H
Add. Sense len : Additional Sense Length = 00H

SENSE KEYS:
- 0000 = No Sense or No error.
- 0001 = Recovered error. Soft error.
- 0010 = Unit Not Ready or Still busy.
- 0011 = Disc Error or no CD-Rom disc.
- 0100 = Hardware Error.
- 0101 = Illegal Request.
- 0110 = Unit Attention.Disc may have been changed.
- 0111 = Data protect. Write protected disc.
- 1011 = Aborted command. The initiator may try the command again.

5.0 Command: Start/Stop Unit

Bit	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	hex
Byte 0	Group Opcode	0 0 0 1 1 0 1 1	1B
Byte 1	LUN	x x x x x x x x	X
Byte 2		x x x x x x x x	X
Byte 3		x x x x x x x x	X
Byte 4	Reserved sta	0 0 0 0 0 0 0 S	S
Byte 5		x x x x x x x x	X

Group (Hex): 00 x = don't care.
Opcode (Hex): 1B
LUN (Hex): not used
Sta (bit 0): 0 = Stop.
Stops the disc and enables the disc loading motor.
1 = Start.
Closes the disc loading tray, disables the disc loading motor and starts the disc.

5.1 ERRORS:

SENSE KEY: 0000 = No Sense.
If no error occured during execution of a start command and allways after a stop command.
0011 = Disc Error.
No disc loaded or no CD-ROM disc.
For start command only.
0100 = Hardware error from selftest.
This sense key is NOT cleared after read status.

6.0 Command: Seek or Select CD-ROM Data Track

Bit	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	hex
Byte 0	Group Opcode	0 0 0 0 1 1 0 1	0B
Byte 1	LUN	x x x x x x x x	X
Byte 2		x x x x x x x x	X
Byte 3		x x x x x x x x	X
Byte 4	Track address	0 T T T T T T T	T
Byte 5		x x x x x x x x	X

Group (Hex): 00 x = don't care.
Opcode (Hex): 0B
LUN (Hex): not used
T (byte 5): Data Track Address
Selected CD-ROM Data Track number in the range of 1 to 99 in binary format.

6.1 ERROR:

The SELECT TRACK command will only be executed if the target unit is started.

SENSE KEY:
- 0000 = No Sense or No error.
- 0011 = Medium error.
  Selected track is no CD-ROM data track.
- 0100 = Hardware Error or Bad Disc.
  Target unit can not read subcode after 5 retrys.
- 0101 = Illegal Request.
  If not the selected data track can be found on the CD-ROM disc or the target unit is not started.

7.0 Command: Read Data

Bit	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	hex
Byte 0	Group Opcode	0 0 1 0 1 0 0 0	28
Byte 1	LUN	x x x x x x x x	X
Byte 2	LBA (msb)	A A A A A A A A	A
Byte 3	LBA	A A A A A A A A	A
Byte 4	LBA	A A A A A A A A	A
Byte 5	LBA (lsb)	A A A A A A A A	A
Byte 6	TL (msb)	L L L L L L L L	L
Byte 7	TL	L L L L L L L L	L
Byte 8	TL (lsb)	L L L L L L L L	L
Byte 9		x x x x x x x x	X

Group (Hex): 01 x = don't care.
Opcode (Hex): 08
LUN (Hex): not used
LBA (byte 2-4): 4 bytes with the Logical Byte Address of the first byte to transfer.
TL (byte 6-8): 3 bytes with the data Transfer Length.

The "Read" command reads data from the selected data track on the disc and transfers the specified number of bytes, starting with the byte address specified in LBA.

7.1 ERROR:

If a data track is not selected then an illegal request error will be returned.

SENSE KEY:
- 0000 = No Sense or No error.
- 0011 = Medium Hard error (Bad Disc). Target unit can not read disc data after 10 retrys.
- 0100 = Hard error or Bad Disc. Target unit can not read subcode after 5 retrys.
- 0101 = Illegal Request. No data track selected or a logical byte address outside the selected data track area.

CDR-X1000 Monitor Specification

1. GENERAL:

The monitor is primary meant as a Service debug-tool for the drive but can also be used for reading data from the disc with the restriction of 1200 baud datarate.

The communication to the monitor is through a RS-232 port, which should be linked to a terminal.

2. FUNCTION:

After POWER ON or after a HARD RESET from the SASI/SCSI port the microcomputer in the CD-ROM drive CDR-X1000 will first do a SELFTEST of the hardware. The result of this test is messaged via the RS-232 port.

The monitor will output a promt ">" to show that it is waiting for an input of a command. Commands are terminated with a "Return".

If a SASI/SCSI command is executed, then the monitor is switched off until the SASI/SCSI command is ready. To indicate that the monitor is active again a new promt is sent out.

If a command can not be correctly executed or an error occurs then an error-message is sent to the terminal.

3. RS-232 PORT:

Baudrate	:	1200
Parity	:	even
Stopbit	:	1
Duplex	:	full
Handshake	:	not used

3.1 RS-232 CONNECTOR:

The 4 pin connector is placed on the data-pcb inside the drive. To connect the terminal the bottomplate has to be removed.

pin	signal
1	Rx input
2	ground
3	Tx output
4	ground

3.2 CONNECTOR LOCATION:

```
                Data-pcb                .                          .
                Componentside           .                          .
                                        !                          !
                ----------------------                             !
                !                                                  !
                !                                                  !
                !                                                  !
                !                                                  !
                !                                                  !
                !                                                  !
                !                                                  !
                !                                                  !
                !                                                  !
        Rx  --->! o  1                                             !
        Gnd ----! o  2                                             !
        Tx  <---! o  3        ---------------------                !
        Gnd ----! o  4        !SCSI/SASI connector!                !
                ------------------------------------------------------
                              !        cable       !
```

4. SELFTEST OF DATA-PCB:

After a Reset or Power On a selftest is done. Before the selftest is the following text sent, " Test data-pcb version C.1 date 10/05/85 ".

If during testing an error occurs, then this is sent to the terminal with the text: "Error" plus an error-code. (see 6.)

When the selftest is ready is the following text sent, "Selftest is ready".

4.1 PROM test with a checksum over all bytes. The checksum is also diplayed as: " Checksum = C08D ".

4.2 RAM test.

4.3 Test port 2.

5. DEBUG COMMANDS:

Commands can only be entered via the RS-232 port after the promt " > ". Each monitor Command is two letters long, followed by 0 to 3 parameters. Any invalid Command-charachter will cause an error and a a beep (ASCII 7) + "??" + CRLF to be sent out.

If any parameters are expected then a "Blank" (ASCII 32) is sent out. Parameters should be separated by a comma.

The command should be terminated by a "Return" (ASCII 13).

5.1 Definitions:

Allowed chrs:	a....z	A....Z	lower case are treeted as upper case.
promt	>	ASCII 62	Monitor waiting for a new command.
comma	,	ASCII 44	Parameter separator.
Return	CR	ASCII 13	Command termination.
BIN	Binary output		ex. 1 0 0 1 1 1 1 0 Msb first.
byte	8 bit HEX number		ex. AA,1F,CD,FF,55
Address	16 bit HEX number		ex. 10FF
port	byte		00 to 03.
from	address		1000 to 1FFF.
to	address		1000 to 1FFF. The "to" address must be higher then the "from" address.

5.2 Port Commands:

rp <port> — Read I/O-port (0..3).
Display of In-port (0..3) in bin. format with MSB first.

sp <port>,<byte> — Set I/O-port (0..3).
Set Out-port (0..3) to byte.

5.3 RAM-memory Commands:

sm <address>,<byte> — Set content of RAM-memory address to byte.

rm <from>,<to> — Read bytes from RAM-memory and display in HEX and ASCII with 16 bytes per line.
Memory dump <from> until <to> address.
"ADDRESS" "16 HEX bytes" "16 ASCII chrs"

fm <from>,<to>,<byte> — Fill RAM-memory with byte.
Warning !! The drive may hang up if the addressrange is used higher then 1E00.

ra — Read Header in RAM (Min,Sec,Block).

5.4 Register Commands:

rr <register> — Read Internal registers in the range of (00 ... 7F).

sr <register>,<byte> — Set content of Internal registers in the range of (00...7F) to byte.

5.5 SCSI/SASI Commands:

ss <byte> — Set SCSI status byte.

rc — Read 10 bytes from the SCSI command-buffer (RAM address 1F01-1F0A) and 1 byte (RAM-address 1F00) with the number of command bytes in the buffer and display in HEX format. The byte-counter is reset to 00.

om <from>,<to> — Output to SCSI-bus the specified data-bytes from RAM memory.
Warning !! All bytes must be read by the host controller before the command is terminated.

5.6 Disc Commands:

rt	Read Table Of Content (TOC) for all tracks on the disc and display as: Tracknumber, Abs.time, Mode(Data/Audio).
rs	Read SUBCODE Q-channel. - Rel.time (Min,Sec,Frame). - Abs.time (Min,Sec,Frame). - Track number. - X.
rh	Read HEADER registers on the data-pcb. (Min , Sec , Block)

6. MONITOR ERROR CODES:

ERROR CODE	NAME
01	Invalid port address
02	Out of memory address
70	PROM error
71	RAM error
72	D-FF error
76	Read TOC error

7. DATA-PCB HARDWARE:

7.1 PROM size 16 kbytes (27128).

7.2 RAM size is 4 kbytes. Address 1000 to 1FFF.

7.3 The I/O ports are memory-mapped.

7.3.1 OUTPORT 0:

bit	name
0	DAC0
1	DAC1
2	DAC2
3	RC12
4	RDIR
5	RC0
6	Not connected
7	Not connected

7.3.2 OUTPORT 1:

Not used.

7.3.3 OUTPORT 2:

bit	name	description
0	SEN	Master reset of sync. HW.
1	REN	Ready Enable of data block DMA from disc.
2	DMA	Selects RAM to 8051 or DMA.
3	DEN	Block-data output enable for direct read in SSI-mode.
4	SSI	Direct blockdata output selector
4	SSI	Direct blockdata output selector
5	I/O	SCSI-signal, selects bus-direction in/out.
6	C/D	SCSI-signal, selects Command/Data mode.
7	MSG	SCSI-signal, selects Message mode.

7.3.4 OUTPORT 3:

bits	description
0....7	SCSI-databyte output.

7.3.5 INPORT 0:

Not used.

7.3.6 INPORT 1:

byte	name	description
BCD	MIN	Blockheader address byte.

7.3.7 INPORT 2:

bit	name	description
0	LCK	Sync. lock flag clocked by HDR.
1	RDY	Ready Enable flag clocked by HDR. (DMA transfer Ready flag).
2	HDR	Header access flag.
3	DAV	Data Enable flag clocked by HDR.
4	ERR	Blockerror flag clocked by HDR and stops DMA by setting RDY=1.
5	ATN	SCSI-signal Attention.
6	REQ	SCSI-signal at data-transfer.
7	ACK	SCSI-signal at data-transfer.

7.3.8 INPORT 3:

bits	description
0....7	SCSI-databyte input.