3.4   The Disk Operating System

3.4.1   MS-DOS

The PX-16 uses for its operating system the most popular such system currently on the market, MS-DOS version 3.20. This OS is compatible with the EPSON PCe and is composed of:

      ① Device drivers

      ② EPSONDOS.COM

      ③ A command processor (COMMAND.COM)

However, unlike most desk top computers, the PX-16 internalizes MS-DOS into its base unit system ROM (ROM0) as a standard feature. When the system is booted up, the program is loaded into RAM from this system ROM for execution.

The basic functions of the OS are no different than MS-DOS version 3.20 for desk top computers, but there are some expansions that have been made for special PX-16 functions. The following are some examples:

      ① Improved I/O support by the device driver

      ② Boot drive can be changed by the CONFIG.SYS

      ③ Supporting 11 national character sets

However, it must be noted that these expanded/changed functions are available from system ROM only when the system is booted as the HC boot. When the system is booted from a floppy disk as the PC boot, these expanded functions may not be accessed.

This chapter will deal with MS-DOS characteristics internalized into the PX-16 based on its support devices. For more information on MS-DOS in general, its commands, etc., please refer to the PX-16 MS-DOS Reference Manual.

3.4.2 Device Drivers

The PX-16's standard device drivers are located in system ROM (ROM0) at the head of the ROM disk in a file called EPSONBIO.COM. This file is loaded into RAM by the system ROM's IPL program and may be executed from there.

Lap top computers and desk top computers are normally booted from a floppy or hard disk, so their device drivers are also loaded from the floppy or hard disk. The PX-16, however, when booted using the HC boot, boots from its internalized system ROM, and its PX-16 original device drivers (MS-DOS expanded version) are thus also loaded from this same ROM in which they are stored. On the other hand, the PC boot is used to boot the system from a user floppy disk, and as the system loads its device drivers from there, the PX-16 original expanded device drivers may not be utilized. Please refer to the "A-1 HC boot and PC boot" for details regarding device driver loading sequences for the HC and PC boots. The following will explain device drivers supported by system ROM.

(1) Character devices

① CON
Supports console input and output.
   Input- standard keyboard/touch keyboard
   Output- display devices connected to the cartridge2 interface/touch keyboard

Determines the console devices by the installation status and supprts them. When a cartridge2 display device and a touch keyboard are connected at the same time, console output gives priority to cartridge2. Please refer to "the PX-16 MS-DOS Reference Manual" for utilization of CONSOLE commands. Console output devices may be switched by changing the system variable CON_SELECT (A800:601) direct.

② SCRN1
Assigned to the display device screen directly connected to the cartridge2 interface.

③ SCRN2
Assigned to the touch keyboard LCD screen.

④ PRN
Supports printer output. It is capable of supporting three Centronics (parallel) printers and one cartridge printer. The initial settings will support a standardly equipped Centronics printer I/F, while support devices may be switched with XMODE commands. Please refer to "the PX-16 MS-DOS Reference Manual" for more information about XMODE commands. PRN output may also be changed by changing the system variable PRINTER SELECTED (A800:0BH) direct.

⑤ LPT1, LPT2, LPT3
Each is assigned to one of the Centronics printers.

⑥ LPT4
Assigned to the cartridge printer.

⑦ AUX
Assigns a standard equipment RS-232C as an auxiliary input/output device.

⑧ COM1, COM2, COM3
Assigns the RS-232C ports as transmission devices.

⑨ NUL
A dummy input/output device. Returns an EOF when input is assigned to NUL; when output is assigned, the output data is absorbed and no output occurs at all.

⑩ CLOCK$
Clock is assigned to CLOCK$.

(2) Block devices

The PX-16 supports the following devices as block devices:

① Floppy disk drive

② Hard disk drive

③ RAM disk

④ ROM disk

⑤ Cartridge1 (ROM, RAM cartridge)

The drive name differs according to the boot type by which MS-DOS is started. The boot type is set with bits 9 and 10 of DIP switch SW5.

RAM preference (DIP SW5 bit9: ON, bit10: OFF)

Drive names	Block device
A	RAM disk (main + expansion RAM disk)
B	ROM disk (ROM0)
C	ROM disk (ROM1)
D	ROM disk (ROM2)
E	ROM disk (ROM3)
F	Cartridge 1 (option disks)
G	Disk unit or TF-16 FDD
H	Number of drives set by DIP SW 5 bit 7
I	Disk unit HDD
J – Z	Reserved for expansion device utilization

Table 3-4-1   Drive names with RAM preference

If HDD is not connected, drive J advances to drive I.

FDD preference (DIP SW5 bit 9:OFF, bit 10:ON)

Drive designation	Block device
A	Disk unit or TF-16 FDD
B	Number of drives set by DIP SW 5 bit 7
C	Disk unit HDD
D	RAM disk (main + expansion RAM disk)
E	ROM disk (ROM0)
F	ROM disk (ROM1)
G	ROM disk (ROM2)
H	ROM disk (ROM3)
I	Cartridge 1 (option disks)
J - Z	Reserved for expansion device utilization

Table 3-4-2   Drive names with FDD preference

If HDD is not connected, drive D advances to drive C.

Without FDD/HDD (DIP SW5 bit9: OFF, bit10: OFF)

Drive names	Block device
A	RAM disk (main + expansion RAM disk)
B	ROM disk (ROM0)
C	ROM disk (ROM1)
D	ROM disk (ROM2)
E	ROM disk (ROM3)
F	Cartridge 1 (option disks)
G - Z	Reserved for expansion device utilization

Table 3-4-3   Drive names without FDD/HDD

Note: The four ROM sockets, ROM0-3 of the PX-16 may all be utilized, but in order to use any of them as a ROM disk, the format must comply with that given in "3.2.3 ROM." When using 2 ROMs as a single drive (twin ROM), the second ROM disk name will become inaccessible. When using 3 ROMs as a single drive (triple ROM), the second and the third ROM disk names will become inaccessible.

(3) Expansion device driver

The expansion device driver referred to here is one which is supplied by ROM disk or a floppy disk and utilized by registering it into the CONFIG.SYS file. The expansion device drivers supplied by Epson include the following:

-ANSI console device driver

The following will concern expansion device drivers.

① ANSI.SYS
The ANSI escape sequence is supported as an external expansion device driver. It is stored in system ROM and enabled through specifying it in the CONFIG.SYS file as DEVICE = ANSI.SYS.

The ANSI escape sequence is supported as follows.

Escape sequence	Function	CRT/LCD80	LCD40
CUV	Cursor position setting	Supported	Supported
HVP	Vertical, horizontal setting	Supported	Supported
CUU	Cursor upward movement	Supported	Supported
CUD	Cursor downward movement	Supported	Supported
CUF	Cursor forward movement	Supported	Supported
CUB	Cursor rearward movement	Supported	Supported
DSR	Cursor position information request	Supported	Supported
CPR	Cursor position information format	Supported	Supported
SCP	Cursor position evasion	Supported	Supported
RCP	Cursor position return	Supported	Supported
ED	Clear entire screen	Supported	Supported
EL	Clear cursor line	Supported	Supported
SGR	Screen attribute setting	Supported	Partially supported
SM(0-6)	Screen mode setting	Supported	No effect
RM(0-6)	Screen mode cancel	Supported	No effect
SM(7)	Line feed enable	Supported	Supported
RM(7)	Line feed disable	Supported	Supported
Reassigning the keyboard	Key board reassignment RAM disk	Supported	Supported

Table 3-4-4 ANSI escape sequence

Please refer to "PX-16 MS-DOS Reference Manual" for details regarding ESC sequences.

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3.4.3 CONFIG.SYS

(1) CONFIG.SYS search

The function of the CONFIG.SYS file is to change the MS-DOS environment, and in the PX-16 as well each of the normal MS-DOS functions is supported. However, the method by which the PX-16 searches for the CONFIG.SYS file is different.

Normally, the CONFIG.SYS file in MS-DOS is read from the boot drive and the directed environment will be set. The PX-16, however, regardless of the boot drive, first searches for CONFIG.SYS in the lead FD, then the lead HD, cartridge1, the RAM disk and the ROM disk, sequentially, reading it when the PX-16 finds it.

CONFIG.SYS search sequence

1	2	3	4	5	6	7	8
Lead FDD	Lead HD	Cartridge 1	RAM disk	ROM0	ROM1	ROM2	ROM3
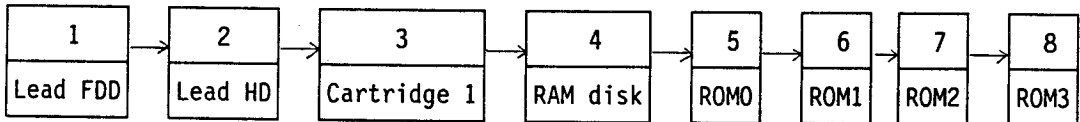
The search for the CONFIG.SYS file is made in the above sequence, and the drive in which it is found becomes the current drive. In the event that CONFIG.SYS is not found the current drive becomes the A drive.

(2) System configuration

The PX-16 can, like an ordinary MS-DOS system, search for the CONFIG.SYS file when booted and perform the configuration of the system as directed. Like an ordinary MS-DOS system, the following command settings can be used in the CONFIG.SYS file.

Commands	Format	Function
BREAK	BREAK= [ON|OFF]	A CTRL-C check. Has the same effect as the "COMMAND.COM" BREAK command. Default is OFF.
BUFFERS	BUFFERS= <x>	Designates number of disk buffers. Default is 2. Can direct up to a maximum of 99. When the optimal number of disk buffers exist, disk access becomes extremely fast.
COUNTRY	COUNTRY= <x>	Designates country codes as <x>. There are numerous country codes, such as 1 for the United States and 33 for France. Default is 1. 81 (Japan) is not in effect.
DEVICE	DEVICE= [<path name>]<file name>	Combines device and drive together with directed file name.
FCBS	FCBS= <x>, <y>	This command determines the number of file control blocks (FCBs) that can be opened concurrently. <x> is total number of files that can be opened concurrently using FCBs. The default value is 4. <y> specifies the number of opened files that are protected from being closed by MS-DOS if a program attempts to open more than <y> files. The default is 0.
FILES	FILES= <x>	Designates the number of files which may be open at any one time using file handles (function 2FH-60H) Default is 8. Any value from 8-255 may be designated.
LASTDRIVE	LASTDRIVE= <x>	Designates the maximum number of drives that may be accessed, including theoretical drives. Default is the number of drives installed to the system. Any value from a-z may be designated.
SHELL	SHELL= [<path name>]<file name>	Designates the command processor. Default is "d:COMMAND.COM /P" (d: is the drive name for ROMO).

Table 3-4-5 Usable commands in the CONFIG.SYS

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(3) Multiple language support

In the ordinary MS-DOS, multiple languages are supported by changing the COUNTRY command in the CONFIG.SYS or executing the KEYBOARD.COM command in AUTOEXEC.BAT. In the PX-16, however, since the system exists in ROM and the file cannot be changed to specify a different country, a different method has been created in which the device driver reads the DIP switches (SW5) settings to obtain the country setting (refer to 2.1.2 regarding this setting). When the COUNTRY command is read from the CONFIG.SYS file or the KEYBOARD.COM file is executed from the AUTOEXEC.BAT file, these take priority over the DIP switch settings which then have no effect.

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3.4.4 EPSONDOS.COM

With the PX-16, the system file (ordinarily named MSDOS.SYS) is stored in system ROM as EPSONDOS.COM. EPSONDOS.COM in the PX-16 is capable of the same functions as any other MSDOS.SYS, but there a few differences, such as the battery power saving and disk support functions.

① Battery power saving function

As the PX-16 is run on battery power, the halt status is entered when key input is waited in order to conserve battery power. The computer is reactivated whenever a key interrupt is generated.

② Disk support

The PX-16 supports the following disk formats.

Media / Format	Floppy disk									RAM disk	ROM disk	RAM cart-ridge
Number of tracks	80	80	80	80	40	40	40	40	80	—	—	—
Sector /track	9	9	8	8	9	9	8	8	15	16	16	16
Number of sides	1	2	1	2	1	2	1	2	2	1	1	1
Sector size	512	512	512	512	512	512	512	512	512	512	512	128 256 512
Disk capacity in kB	360	720	320	640	180	360	160	320	1.2M	—	—	—
Number of directories	112	112	112	112	64	112	64	112	224	112	—	—
Sectors /cluster	2	2	2	2	1	2	1	2	1	1	1	1
Reserved sector	1	1	1	1	1	1	1	1	1	0	1	0
Number of FAT	2	2	2	2	2	2	2	2	2	1	1	1
Sectors /FAT	2	3	1	2	2	2	1	1	7	—	—	—
FAT ID	0F8H	09FH	0FAH	0FBH	0FCH	0FDH	0FEH	0FFH	0F9H	0FBH	0FCH–0FFH	0F8H

" – " indicates that the applicable value differs with the media capacity or format designation.
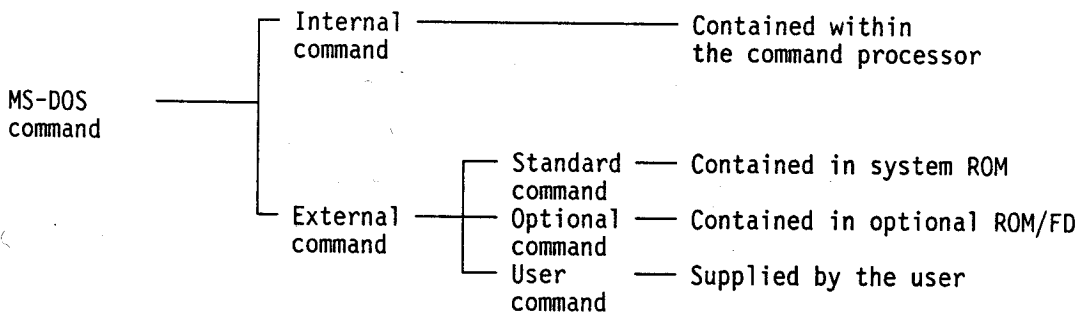
Table 3-4-6 Format specifications

3.4.5 The command processor

The PX-16 command processor (COMMAND.COM) is stored disk in system ROM. It is loaded into RAM by the device driver and executed when the system is booted.

The PX-16 command processor has the same functions as the ordinary MS-DOS command processor COMMAND.COM, but manner in which it searches for the AUTOEXEC.BAT file when the system is booted is different. The PX-16 searches for the AUTOEXEC.BAT in the drives in which the CONFIG.SYS file is found. When the AUTOEXEC.BAT is found not to exist during this search, it next searches for it on the A drive.

The command processor analyses the input MS-DOS command and boots the appropriate program. PX-16 commands may generally be divided as follows:

```
                    ┌─ Internal ──────────────── Contained within
                    │   command                  the command processor
    MS-DOS ─────────┤
    command         │                  ┌─ Standard ── Contained in system ROM
                    │                  │   command
                    └─ External ───────┼─ Optional ── Contained in optional ROM/FD
                        command        │   command
                                       └─ User ────── Supplied by the user
                                           command
```

① Internal commands
Internal commands are contained within the command processor.

Commands	Function
Break	Checks control break ([Ctrl] C press)
CHDIR (CD)	Changes the current directory
CLS	Clears the display screen
CTTY	Changes the standard input and output device to the specified device
COPY	Copies files between devices or directories
DATE	Prompts for the current date
DELETE (DEL)	Deletes files from a disk source
DIR	Lists the filenames in the specified path
ERASE	Deletes files from a disk source
MKDIR (MD)	Creates a sub-directory
PATH	Searches directories for commands or batch files
RENAME	Renames files
RMDIR (RD)	Removes a sub-directory
PROMPT	Changes the MS-DOS command prompt
SET	Sets one string value equal to another in the command processor's environment

Table 3-4-7 Internal commands list

Commands	Function
TIME	Prompts for the current time
TYPE	Displays file contents by ASCII interpretation
VER	Displays the DOS version number
VERIFY	Verifies data for all read/write operations
VOL	Displays the volume identification label

Batch commands	Function
ECHO	Enables or suppresses echoing of message lines
FOR	To repeat a command for several variables
GOTO	Transfer control to the line following the label
IF	Allows conditional execution of commands
PAUSE	Provides a system wait
REM	Allows remark lines to be added to the file
SHIFT	To access more than 10 replaceable parameters in a batch file

Table 3-4-8 Internal commands list

② External commands

External commands are read and executed by the command processor from external devices. While external commands are all stored in floppy disks or a hard disk drive, in the PX-16 they are divided into three different categories as follows:

a) Standard commands

Commands stored in system ROM as standard commands.

Command	Function	Remarks
ANSI.SYS	Receives the ANSI ESC sequence	Enhanced for LCD40
BARCODE.COM	Barcode decoder	Original
CONSOLE.COM	Switches CON devices	Original
CTG1FMT.COM	Formats cartridge 1	Original
FORMAT.COM	Formats hard and floppy disks	S. B options not supported. D option added.
GRAPHICS.COM	Graphic data screen dump	Enhanced for LCD40 and Cartridge printer H
KEYBOARD.COM	Country command driver	Original
MODE.COM	Sets serial, printer, etc., status	
PRINT.COM	Handles simultaneous output to printer	
RAMDISK.COM	RAM disk utility	Original
ROMID.COM	ROM disk utility	Original

Table 3-4-9 Standard commands (1)

Command	Function	Remarks
TERM.EXE	Communications utility	Original
XMODE.COM	PX-16 expansion function support	Original
XKEY.COM	Development utility	Hidden file
O.BAT		
1.BAT		
APPEND.COM	Settings for data file search path	
ASSIGN.COM	Assigns drive name to other drives	
ATTRIB.EXE	Sets/displays file attributes	
BACKUP.EXE	Creates backup disks	
CHKDSK.EXE	Reports status of designated drive	
DEBUG.COM	Debugger	
DISKCOMP.COM	Performs a comparison of designated disks	
DISKCOPY.COM	Creates a backup copy of an entire disk	
EDLIN.COM	Text file line editor	Enhanced for LCD40
FC.COM	Performs a comparison of designated files	
FDISK.COM	Hard disk management utility program	Enhanced for LCD40
FIND.EXE	Searches for a keyword in a designated file	
GWBASIC.EXE	GW-BASIC	Expansion function support
JOIN.EXE	Joins subdirectories in designated disk	
LABEL.COM	Creates/changes/erases disk volume label	
MORE.COM	Performs page by page display output to screen	Enhanced for LCD40
RECOVER.COM	Recovers bad sectors in files	
REPLACE.COM	Replaces files	
RESTORE.EXE	Restores backed up disk	

Table 3-4-10   Standard commands (2)

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Command	Function	Remarks
ROMBIOS.COM	Displays ROM BIOS version ID	
SHARE.EXE	Performs shared and exclusive file control	
SORT.EXE	Sorts data received from standard input and outputs to standard output	
SUBST.EXE	Replaces logical drive name with path name	
TREE.COM	Displays tree structure of designated directory	
XCOPY.EXE	Copies file/directory	

Table 3-4-11 Standard commands (3)

b) Optional commands
Supplied by Epson as optional floppy disk.

Command	Function	Remarks
ROMFORM.EXE	Creates PROM format file	
XTERM.EXE	Communication program	
TERMINST.COM	Installation program of XTERM.EXE	

Table 3-4-12 Optional commands

c) User commands
Commands created, supplied and assembled by the user.

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3.5 BIOS

3.5.1 Features of PX-16 BIOS

PX-16 ROM BIOS is stored in the upper 32KB of the system ROM (ROM0) and resides at F8000H to FFFFFH of memory map.
The PX-16 ROM BIOS supports various I/O devices and I/O access is very easy. There are some differences in the functions supported by BIOS between the HC boot mode and PC boot mode.

(1) HC Boot Mode

All the functions of the PX-16 can be used in the HC boot mode. Those are the EPSON PCe, IBM PC/XT compatible functions, all the expansion device supporting functions unique to the PX-16, and the power supply control (resume function, auto power off function and the wake function).

(2) PC Boot Mode

The Epson PCe, IBM PC/XT compatible functions can be used. As shown below, booting is required under the same environment as for the EPSON PCe or IBM PC/XT. The PX-16 special expansion devices cannot be used.

System Configuration for PC Boot

Display device	LCD80, LCD80/2 or CRT
Keyboard	Standard keyboard
Floppy disk drive	Disk unit (3.5") or TF-16 (5.25")

3.7　Power supply

3.7.1　Power suppply specifications

In the PX-16, all power supply and protective circuitry are internalized and placed on the power supply board (HIN-PS). For its main power source, the system has both a 2000mAH Ni-Cd battery and dedicated AC adapter, providing a 2 way power system, either of which may be utilized to run the PX-16. In other words, in the event of a Ni-Cd battery power failure, the AC adapter may be connected to operate the system.
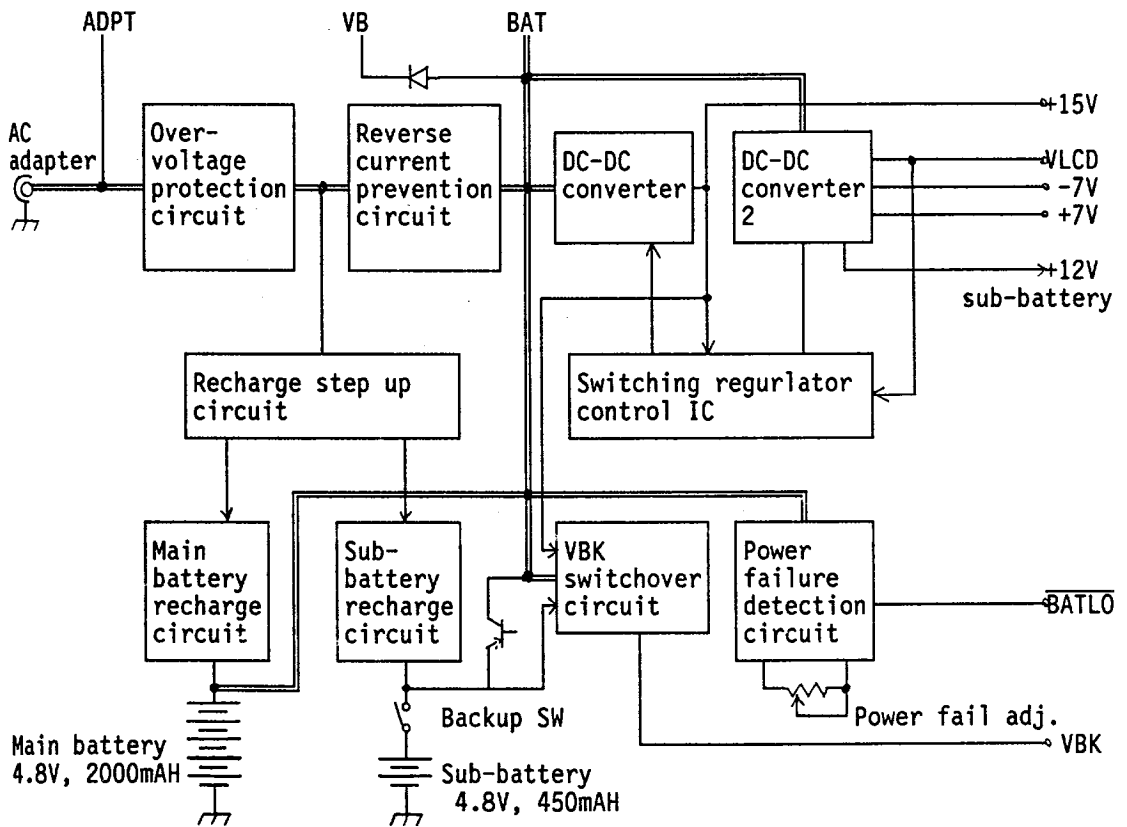
< Power supply board block diagram >

Fig.3－7－1　Power supply board block diagram

< The power supply system >

The output power of each of the power supply circuits is shown below. As the power supply system utilizes a DC-DC converter, it remains stable even in the event that battery voltage drops as low as 4V. However, too great a drain on output voltage created by user-designed-circuit can result in power voltage variations, caution must be paid to ensure that demand current does not exceed total power capacity.

Circuit	Output voltage	Variance	Total capacity	Power capacity for options	Remark
+ 5 V	+ 5.1 V	± 0.4 V	500 mA	350 mA	
+ 7 V	+ 7.0 V	± 2.0 V	10 mA	6 mA	
– 7 V	– 7.0 V	± 2.0 V	10 mA	6 mA	
VLCD	–20.5 V	± 2.0 V	10 mA	10 mA	
VBK	+ 5.0 V	± 0.5 V	100 mA	60 mA	During power on
	+ 5.0 V	+ 0.25V – 0.5 V	1mA	0.5 mA	During power off
VB	ADPT-0.6 V	———	4 A (peak)	———	AC adapter connected
	BAT-0.4	———	4 A (peak)	———	AC adapter not connected
BAT	Main battery output	—	———		
ADPT	+4.5 6 V	———	5 A	———	Load connected
	+5.3 6 V	———	5 A	———	No load

Power supply specifications

Circuit	Base unit [mA]		K/B 6 [mA]	Touch K/B [mA]	LCD80 4 [mA]	LCD40 3 [mA]	CRT/ FDD [mA]	Cartridge printer [mA]	Asynchronous RS [mA]
+ 5 V	130 | 65	100 | 60	5/LED	15	130	10	150	25	5
+ 7 V	4		—	—	—	—	—	—	3.5
- 7 V	4		—	—	—	—	—	—	3.5
VLCD	—		—	2 4	8	5	2.5	—	—
VBK	1 | 1	1 | 1	—	5	30	5	30	—	—
VB	—		—	—	—	—	—	1 A printing 'H'	—
BAT	—		—	—	—	—	—	—	—
ADPT	—		—	—	—	—	—	—	—

10 MHz Run | 10 MHz Stand-by

4.77MHz Run | 4.77MHz Stand-by

Demand current by circuit

3.7.2 Power ON/OFF

< Power ON/OFF control >

Power ON/OFF control of the PX-16 is performed by the slave CPU. When any of the following conditions occur while the main power is off, the slave CPU will turn the main power on and light the power indicator LED, unless the system is in power failure status, in which case the power will not come on regardless which of the following conditions occur.

- The power switch is pushed

- An external switch signal (EXSW) goes ON (high)

- The arrival of the activation time of an ALARM which has been previously enabled

- The activation of a RING signal (high) which has been previously enabled

When any of the following conditions occur while the main power is on, the slave CPU will turn the power indicator LED and the PX-16 power off.

- The slave CPU receives a power off command from the main CPU

- The power switch is pushed with the mode not in expansion power OFF mode

- An external switch has been turned OFF with the mode not in expansion power OFF mode

- A specified length of time has passed after the detection of a power failure (default= 2 minutes after an HC boot, 4 minutes after a PC boot) but power has not gone off due to any of the above conditions

- The system reset switch has been pushed

When any of the following conditions occur while the main power is on, the slave CPU will generate an interrupt to the main CPU. The main CPU will recognize this interrupt as a switch OFF and send a power off command to the slave CPU.

- The power switch has been pushed with the mode in expansion power OFF mode

- An external switch has gone to OFF with the mode in expansion power OFF mode

- A power failure (battery low) has been detected

- A disk unit power failure (battery low) has been detected

Please refer to "3.3.5 Slave CPU" for more details regarding power ON/OFF status.

< The Power Indicator LED >

The PX-16 power indicator LED is controlled by the slave CPU and shows the current system power status. The power indicator LED comes on when power is at normal levels and power status is ON. It blinks when electrical voltage drops to +4.75V or less and goes off when the power is turned off.

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3.7.3 The Battery

The PX-16 is equipped with two internalized rechargeable Ni-Cd batteries: a main battery (2000mAH) and a sub- battery (450mAH).

(1)   The Main Battery

The PX-16 utilizes an Ni-Cd (4.8V, 2000mAH) RB701 battery for its main battery. Fully charged for this Ni- Cd battery is considered to be a charge of at least 150% of its nominal capacity. As recharge current for the main battery is about 200mA, recharge time is as follows:

$$(2000mAH \times 1.5)/200mA = \text{approx. } 15H$$

(1/3 of the recharge current is consumed as heat energy.)

The life of an Ni-Cd battery, taking one discharge and recharge as a single cycle, is equivalent to 500 cycles, after which it should still retain at least 60% of its original capacity. It should also retain at least 60% of its original capacity when recharged continuously for a period of one year between temperatures of 5 to 30°C.

(2)   The sub-battery

The PX-16 utilizes an Ni-Cd battery (4,8V, 450mAH) RB104 for its sub-battery.
The sub-battery is charged using one of the following methods.

(a) When the AC adapter is connected:

Power ON - Charged with about 1/100C (about 5 mA) from the main battery and with about 1/30C (about 15 mA) from the AC adapter; that is, with a total of 20 mA charging current. It takes about 34 hours to fully charge the sub-battery.

Power OFF - Charged with about 1/30 C (about 15 mA) from the AC adapter. It takes about 45 hours to fully charge the sub-battery.

(b) When the AC adapter is not connected:

Power ON -   Charged with about 1/100C (about 5 mA) from the main battery.

Power OFF - Not charged.

(c) When the system reset switch is pressed (only when AC adapter is connected):
When the system reset switch is pressed while the AC adapter is connected, the sub-battery is charged with about 1/8C (about 60 mA) for the first 8 hours after system reset, then with about 1/30C (about 15 mA). It takes about 16 hours to fully charge the sub-battery.

(d) When the AC adapter is connected after detecting power failure:
When the AC adapter is connected after detection of power failure, the sub-battery is charged with about 1/8C (about 60 mA) for about 1 hour, then the charge current drops to about 1/30C (about 15 mA). It takes about 25 hours to fully charge the sub-battery.

As the sub-battery is recharged by trickle recharging, it has a longer life extending up to as much as 6 years of normal use.

3.7.4 Recharging and continuous use

(1) Recharging

Type	Capacity [mAH]	Conditions	Recharge current (TYP.) [mA]	Recharge time [H]
Main battery	2000		250	12
Sub-battery	450	Power off	15	45
		power on	25	27
		in 8 hours after system reset	60	16
		in 1 hour after power failure	60	25

(2) Current consumption

Unit	Battery capacity [mAH]	Conditions	Current demand (TYP) approx. [mA]
Base unit (With no expantion RAM board 384 kB)	2000 (RB701)	With memory backup	0.5
		Awaiting key input	160 /4.77 MHz 170 /10 MHz
		Program execution and no I/O processing	220 /4.77 MHz 270 /10 MHz
		During RS-232C operation	+ 20
RAM board (384kB)	———	With memory backup	0.15
		Awaiting key input	1.7
		In accessing RAM	15
Standard keyboard		In operation (1 LED is on)	5
Touch keyboard	———	In operation (EL is off)	40
		In operation (EL is on)	190
		At stand by	0.05

Unit	Battery capacity [mAH]	Conditions	Current demand (TYP) approx. [mA]
LCD80	———	In operation	150
		Power off	0.05
LCD80/2	———	In operation (with CRT)	210
		In operation (with LCD)	160
		In accessing (with FDD)	+ 30
		Power off	0.05
CRT/FDD	———	In operation (with CRT)	230
		In operation (with FDD)	+ 30
		Power off	0.05
LCD40	———	In operation	45
		Power off	0.05
Cartridge printer H	———	In operation	1000 – 3000
		At stand by	5
Disk unit	2000 (RB701)	In operation (with 1 FDD)	
		In operation (with 2 FDD)	
		In operation (with 1FDD $ HD)	
		At stand by	
Asynchronous RS board	———	In operation	20
		At stand by	0
Barcode reader	———	In operation	40
		At stand by	10

< Memory backup time >
Example
   Base unit + standard K/B + LCD80
   – Full charged   : approx. 2.5 months
   – After power failure : approx. 20 days

Chapter 4 - Interfaces

4.1 Overview

4.1.1 Overview

The PX-16 base unit is equipped with the following interfaces as standard equipment:

- Cartridge 1 interface
- Cartridge 2 interface
- Printer interface
- System bus
- RS-232C interface
- Barcode reader interface
- Keyboard interface
- Touchkey board interface
- Expansion interface
- RAM board interface

The cartridge 2 interface can be connected to a CRT/FDD cartridge or the CD80/2 display to utilize the following interfaces:

- CRT interface
- FDD interface

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4.1.2 I/O addresses

The I/O addresses related to interface operation are listed below. Addresses P0H~P3FFH are EPSON PCe and IBM PC-XT compatible, and addresses P11D0H~P11EFH are the expansion I/O addresses for the PX-16.

Address	Interface	Remarks
P60H ~ P63H	Keyboard, Speaker	IBM PC/XT EPSON PCe Compatible
P2F0H ~ P2F7H	Asynchrounus RS board (Development interface)	
P2F8H ~ P2FFH	Asynchrounus RS board (Secondary RS-232C interface)	
P320H ~ P32FH	Hard disk	
P378H ~ P37FH	Printer interface	
P3B0H ~ P3BFH	MDA control (monochrome display)	
P3D0H ~ P3DFH	CGA control (color display, LCD80, LCD80/2)	
P3F0H ~ P3F7H	Floppy disk	
P3F8H ~ P3FFH	Primary RS-232C interface	
P258H ~ P259H	RAM disk	
P4258H ~ P4259H P8258H ~ P8259H PC258H ~ PC529H	RAM disk	PX-16 original
P11D0H ~ P11D3H	Barcode reader, LCD40	
P11D4H ~ P11D8H	Cartridge 1	
P11D9H ~ P11DBH	UART (Barcode reader interface, cartridge 1 interface)	
P11DCH	LCD80, LCD80/2, CRT/FDD Cartridge	
P11E0H ~ P11E3H	Touch keyborad	
P11ECH ~ P11EFH	Disk unit	

Table 4-1-1 I/O Address related to Interface

4.2 Cartridge 1 interface

4.2.1 Overview

The cartridge 1 interface is functionally compatible with the cartridge interface of the HX-40/PX-4, and can use HX-40/PX-4 cartridges without adjustment. However, the only HX-40/PX-4 cartridge options the PX-16 OS supports are the ROM cartridge and the RAM cartridge. If cartridges other than these are used, the device driver must be installed in the system. The PX-16 can also use the cartridge printer H, and user-designed cartridges.

The cartridge 1 interface can respond to a variety of options through the following four modes:

① **Handshake mode (HS mode)**

This mode is used to link the PX-16 CPU with the CPU in the option device, and is similar to the 8255 handshake mode. Data is handled through input and output buffers. Data handling control is implemented through flags.

② **Input output mode (IO mode)**

This interface consists of a 4-bit input port and a 4-bit output port.

③ **Data bus mode (DB mode)**

In this mode the option is treated by the PX-16 as a normal IO device. The cartridge interface data bus is directly connected to the base unit data bus.

④ **Output port mode (OT mode)**

The interface is an 8-bit output port.

The cartridge 1 interface also has a 1-channel UART for use as an expansion I/O. This UART is accessed through P11D9H~P11DBH.
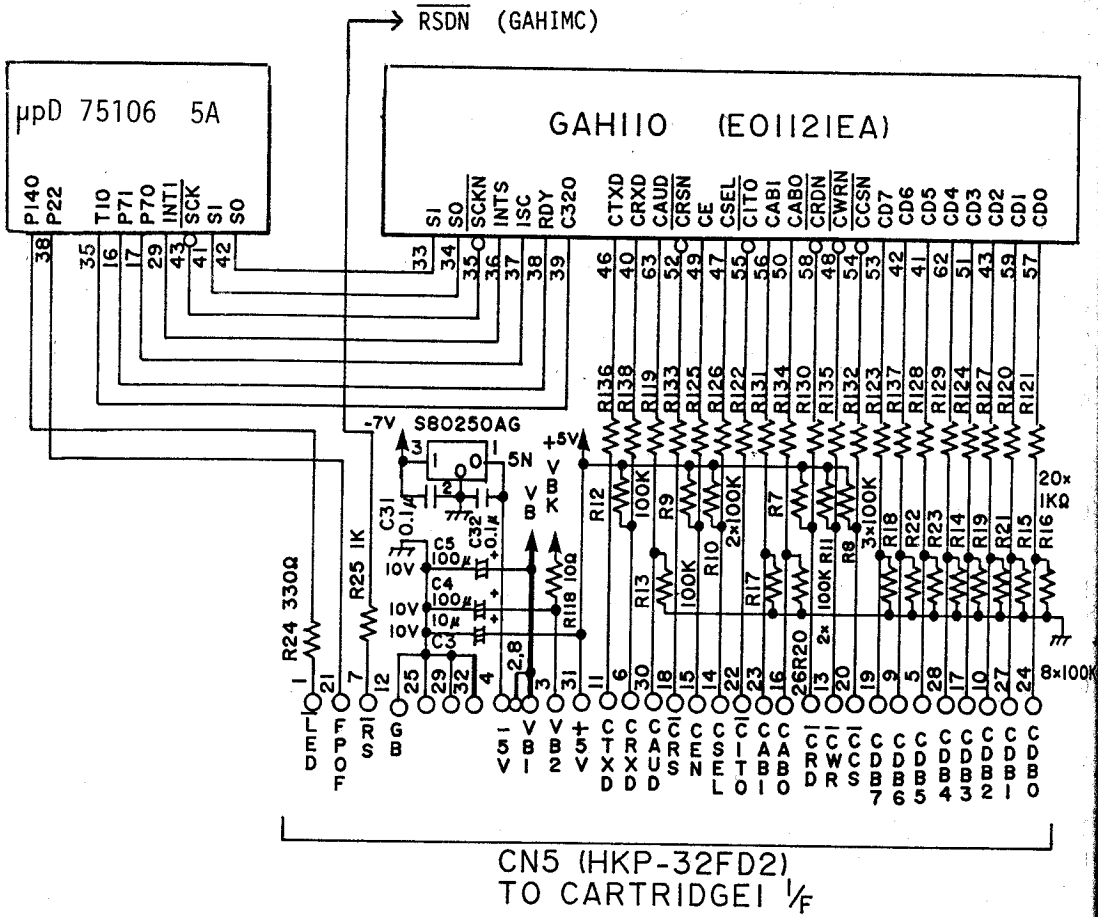
4.2.2 Circuit diagrams

Fig. 4-2-1 Cartridge interface

4.2.3 Signal lines

(1) Pin assignment

Pin number	Sinbol	I/O	signal line
1	GB	–	Logic ground
2	CAUD	I	Digital audio input
3	CDB4	I/O	Data bus
4	$\overline{CRD}$	I/O	Read signal
5	CDB0	I/O	Data bus
6	$\overline{CITO}$	O	Cartridge interrupt output
7	$\overline{CCS}$	I/O	Chip select
8	$\overline{CRS}$	O	Reset
9	CAB0	I/O	Address bus
10	CSEL	I	Option select
11	GB	–	Logic ground
12	CDB2	I/O	Data bus
13	VB1	–	Battery output voltage
14	CRXD	I	Serial receive data
15	–5V	–	–5V voltage
16	+5V	–	+5V voltage
17	GB	–	Logic ground
18	CDB1	I/O	Data bus
19	GB	–	Logic ground
20	CAB1	I/O	Address bus
21	FPOF	O	Power fail signal
22	CDB7	I/O	Data bus
23	CDB3	I/O	Data bus
24	CEN	I	Enable from 6301
25	$\overline{CWR}$	I/O	Write signal
26	CTXD	O	Serial transmit data
27	CDB6	I/O	Data bus
28	$\overline{RS}$	O	Reset signal
29	CDB5	I/O	Data bus
30	VB2	–	Backup output voltage

Signal direction is as viewed from the base unit.

Table 4-2-1 Cartridge 1 interface pin assignment
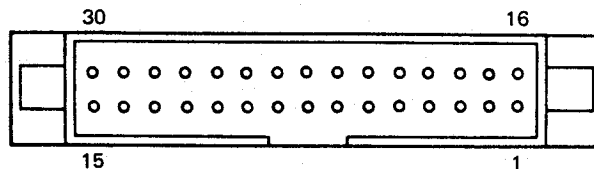
(2) Connector

PICL-30P-LT (JAE)

Fig. 4-2-2   Cartridge 1 Interface connector

③ Reset processing

The PX-16 automatically sets the international character set when the printer is reset.

The default values are as follow:

When DIP switches are other than Scandinavia
(which is Denmark, Sweden, Norway and Finland):   do nothing.

When DIP switches are set to Scandinavia: Output Scandinavian character
                                                   set code (ESC+R+1).

This output data is determined by the pointer specified in CPRN_CTRL_ADDR1
(A800:0014), CPRN_CTRL_ADDR2 (A800:0018). To alter output data immediately after
reset rewrite this pointer so that it points to the first address of the output data.

④ Power supply

The power for the cartridge printer H is supplied from the PX-16 base unit through a con-
nector. Voltage fluctuates considerably during printing, and to protect the PX-16 base unit
the supply of power to the printer will be interrupted when the voltage drops below about
4.0V (even instantaneously), and restarted when the voltage rises above about 4.2V
again. During the power is off, the printer is in the busy state.

(16) Cartridge printer 2 for PX-4/HX-40

Cartridge printer 2 is a high-speed, 24-column cartridge printer for the PX-4/HX-40, and it
is not supported as standard. However, except for difference in number of columns, it can
be treated as cartridge printer H by rewriting the following area.

Address	Current data	New data
A800:14	7CH	7FH
A800:18	80H	7FH

After patching these addresses, turn the power off and on.

4.3   Cartridge 2 Interface

4.3.1   Overview

The space on the left rear side of cartridge 2 left open for options consists of 80 signal conductors. These 80 signal conductors are added to the characteristic PX-16 signals on the EPSON PCe or IBM PC/XT option slot signals.
There are a number of devices that may be connected to the cartridge 2 interface, most of these through the LCD40 and LCD80 display cartridge options, including:

- LCD40 (320x80 dot, 40x10 lines)
- LCD80 (640x200 dot, 80x25 lines)
- LCD80/2 (LCD80 with floppy disk drive interface and CRT interface)
- CRT/FDD cartridge (CRT interface and floppy disk drive interface)
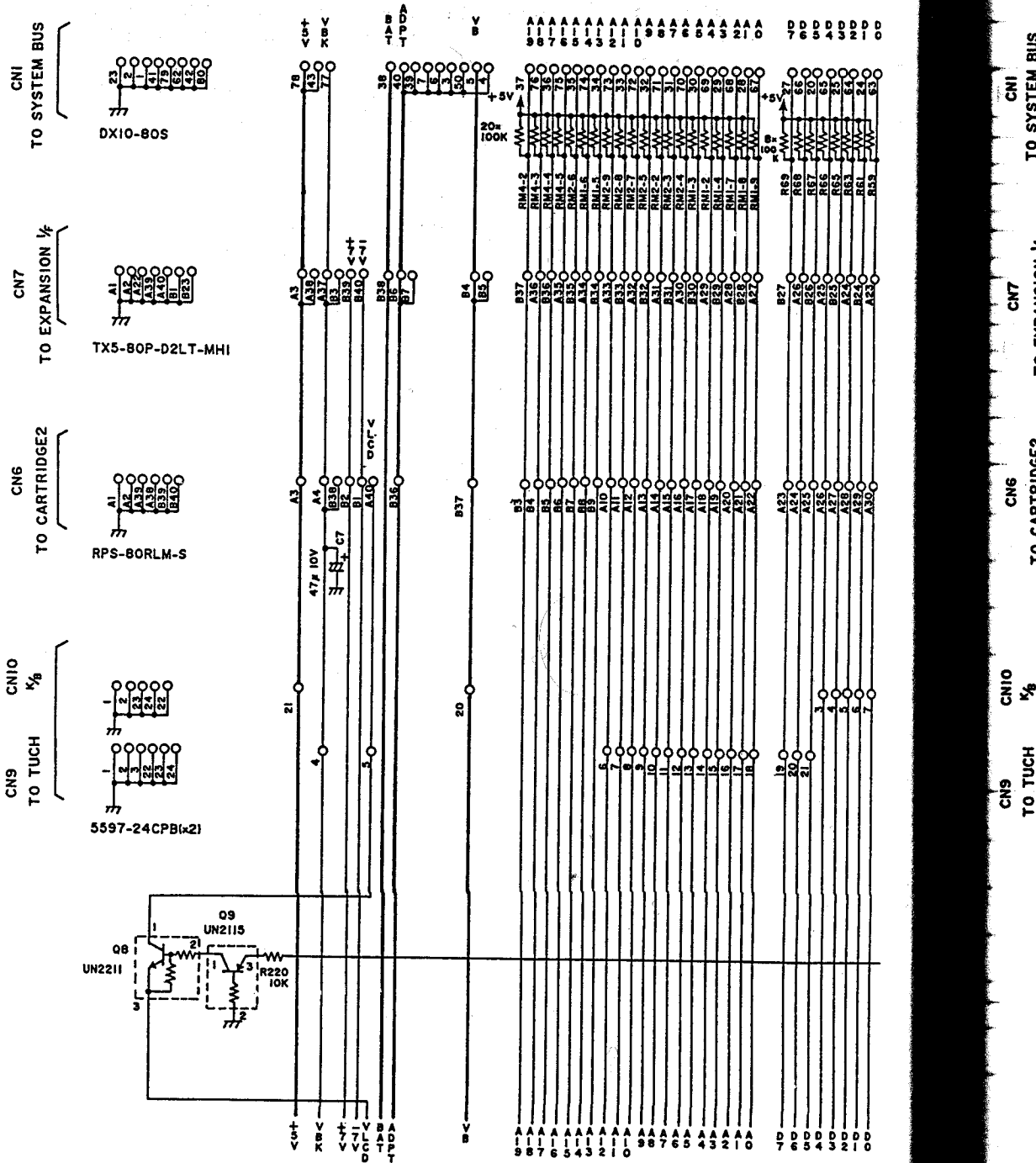- Universal cartridge 2
- Blank cartridge 2

4.3.2 Circuit diagram
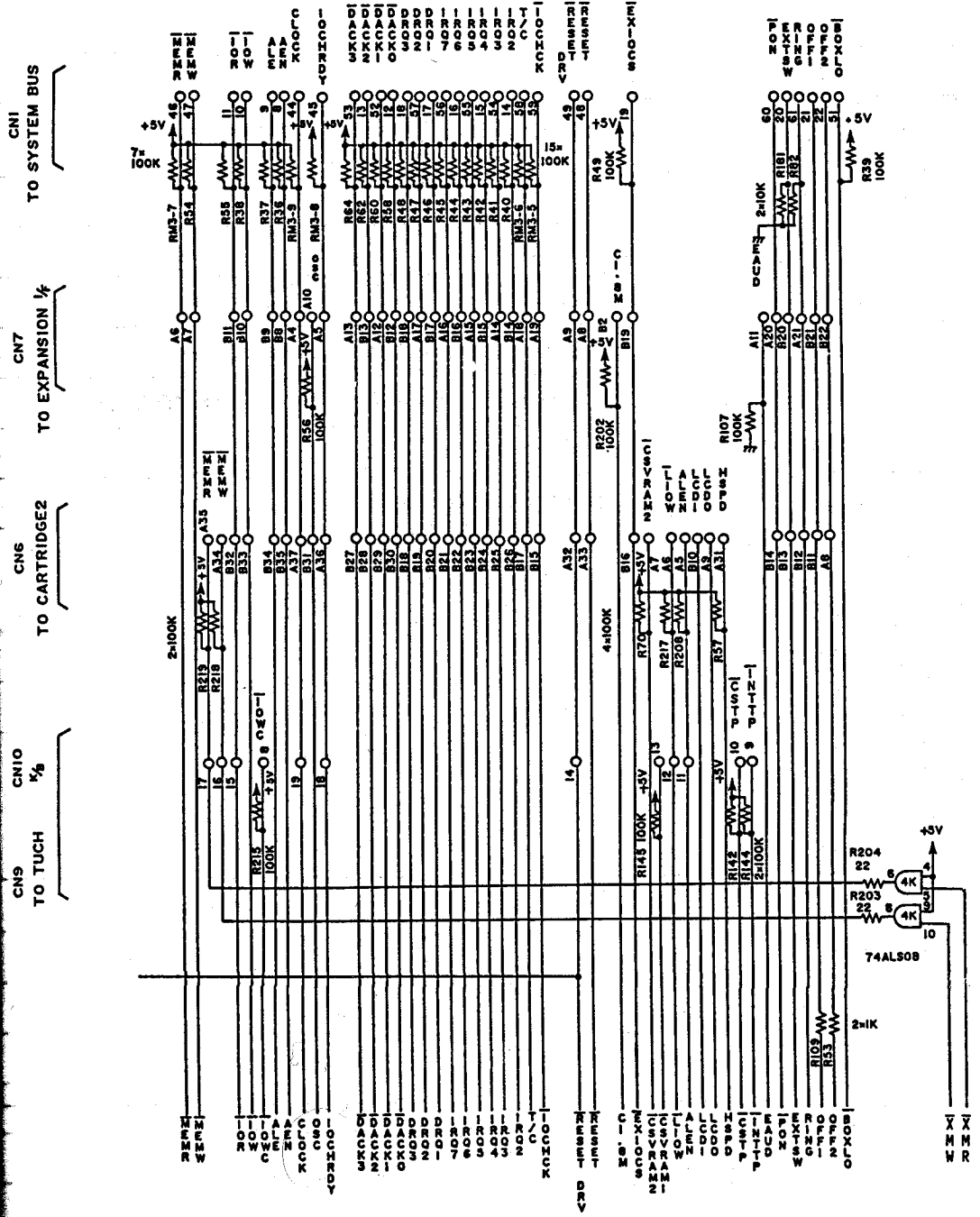

Fig. 4-3-1 Circuit diagram (1)

Fig. 4-3-2 Circuit diagram (2)

4.3.3 Signal lines

(1) Pin assignment

Pin no.	Signal	I/O	Meaning
A1 A2	GND GND	– –	Logic ground
A3	+5V	–	+5V power
A4	VBK	–	Back up voltage
A5	ALEN	O	LCD40 control signal
A6	$\overline{\text{LIOW}}$	O	LCD40 control resistor line signal
A7	$\overline{\text{CSVRAM2}}$	O	LCD40 VRAM select signal (activates with A6000H- A7FFFH)
A8	OFF2	O	OFF2 signal
A9	LCD0	I	LCD discrimination signal
A10 A11 A12 A13 A14 A15 A16 A17 A18 A19 A20 A21 A22	A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1 A0	O	Address bus
A23 A24 A25 A26 A27 A28 A29 A30	D7 D6 D5 D4 D3 D2 D1 D0	I/O	Data bus

Signal direction is as viewed from the base unit.

Table 4-3-1 Cartridge 2 Interface signal lines (1)

Pin no.	Signal	I/O	Meaning
A31	HSPD	O	System clock switch signal. 1=10MHz
A32	$\overline{\text{RESETDRV}}$	O	Reset drive signal (positive logic on the IBM XT)
A33	$\overline{\text{RESET}}$	O	Reset signal
A34	$\overline{\text{MEMW}}$	O	Memory write command (equivalent to $\overline{\text{XMW}}$ signal)
A35	$\overline{\text{MEMR}}$	O	Memory read signal (equivalent to $\overline{\text{XMR}}$ signal)
A36	IOCHRDY	I	Option READY signal
A37	CLOCK	O	System clock (4.77MHz or 10MHz)
A38 A39	GND GND	–	Logic ground
A40	VLCD	–	LCD drive power. –20V
B1	–7V	–	–7V power
B2	+7V	–	+7V power
B3 B4 B5 B6 B7 B8 B9	A19 A18 A17 A16 A15 A14 A13	O	Address bus
B10	LCD1	I	LCD discrimination signal
B11	OFF1	O	OFF1 signal
B12	RING	I	RING input. Expansion interrupt factor.
B13	EXTSW	I	ON/OFF signal for external power source. 1=ON
B14	$\overline{\text{PON}}$	O	POWER ON signal

Signal direction is as viewed from the base unit.
Table 4-3-2 Cartridge 2 Interface signal lines (2)

Pin no.	Signal	I/O	Meaning
B15	IOCHCK	I	IO channel check signal
B16	EXIOCS	0	Expansion IO chip select. Activates from P11D0H- P11EFH
B17	T/C	0	Reverse of DMA controller EOP.
B18 B19 B20	DRQ3 DRQ2 DRQ1	I	DMA request input signal
B21 B22 B23 B24 B25 B26	IRQ7 IRQ6 IRQ5 IRQ4 IRQ3 IRQ2	I	Interrupt request input signal
B27 B28 B29 B30	DACK3 DACK2 DACK1 DACK0	0	DMA acknowledge output signal
B31	OSC	0	14.31818 MHz
B32	IOR	0	IO read command
B33	IOW	0	IO write command
B34	ALE	0	Address latch enable command
B35	AEN	0	AEN signal. HIGH in DMA
B36	ADPT	–	AC adaptor output voltage
B37	VB	–	Battery output voltage
B38	VBK	–	Backup voltage
B39 B40	GND GND	– –	Logic ground

Signal direction is as viewed from the side of the base unit.
Table 4-3-3 Cartridge 2 Interface signal lines (3)
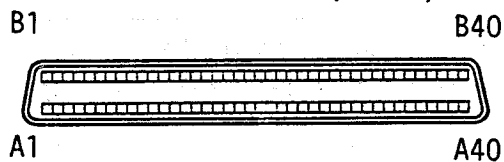
(2)   Connector

Connector : RPS-80RLM-S (HONDA)

B1   B40

A1   A40

Fig. 4-3-3 Cartridge 2 interface connector

4.4   RS-232C interface

4.4.1   Overview

The PX-16 serial interface uses an 8250A-equivalent UART.

The transmit and receive circuits are independent of each other, and the clock from the baud rate generator is input Separately. The Baud rate generator clock is 1.8432MHz.

Interrupts from the UART are connected to IR4 through the tristate buffer. IR4 can be controlled through this tristate buffer.
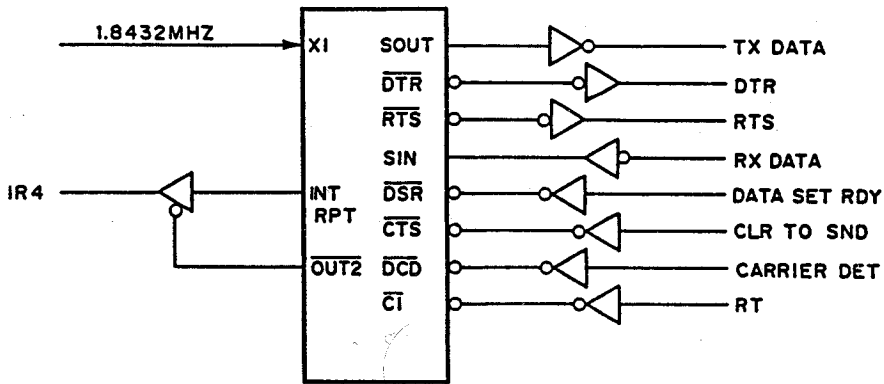
Fig. 4-4-1   RS-232C Interface Diagram

4.4.2 Circuit diagram

Fig. 4.4.2 Circuit Diagram

4.4.3 Signal lines

(1) Pin asignment

Pin No.	Signal line	I/O	Function	When power is OFF
1	RXD	I	Receive data	
2	CTS	I	Transmit enable	
3	DSR	I	Data set ready	
4	DCD	I	Receive carrier detect	
5	CI	I	Ring indicator	OFF
6	TXD	0	Transmit data	
7	RTS	0	Transmit request	
8	DTR	0	Data terminal ready	
9	SG	–	Signal ground	

Signal direction is a seen from the base unit.
Table 4-4-1 RS-232C interface pin assignment
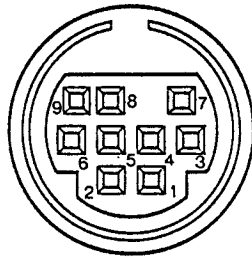
(2) Connector

TSC7928-01-201 (Hoshiden)

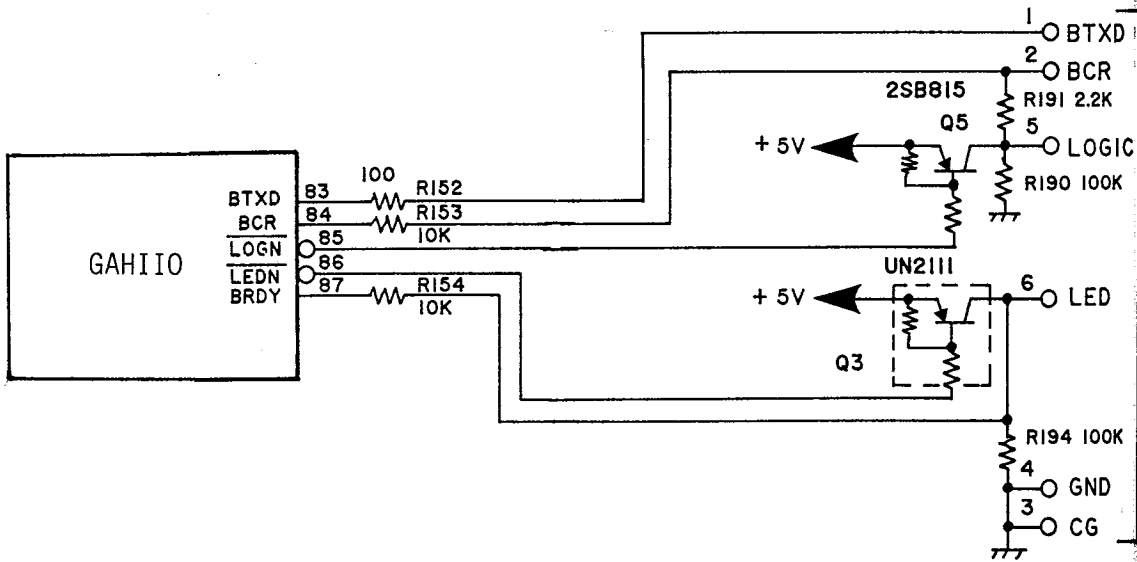Fig. 4-4-3 RS-232C interface connector

4.5.2 Circuit diagram

Fig. 4-5-3   Barcode Interface circuit

4.5.3 Signal lines

(1) Pin assignment

Pin no.	Signal	I/O	Meaning
1	BTXD	O	UART transmit data
2	BCR	I	BCR read signal
3	CG	–	Case ground
4	GND	–	Logic ground
5	LOGIC	–	BCR +5V power supply
6	LED	I/–	BCR LED control power supply, or BCR status signal

Signal direction is as viewed from the base unit.
Table 4-5-1   Barcode reader interface pin assignment

(2) Connector

TCS7567-01-201 (Hoshiden)
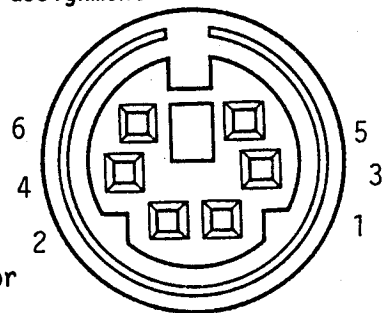
Fig. 4-5-4   Barcode reader interface connector

(3) Description

Pin No.	Signal line	I/O	Function	When power is OFF
1	BTXD	O	Data transmitted from UART. Used for BCR with decoders	High impedance
2	BCR	I	Read signal from BCR	
3	CG	–	Case ground	
4	GND	–	Logic ground	
5	LOGIC	–	BCR +5V power supply high = power on low = power off	OFF
6	LED	I/–	For BCR without internal decoder this is LED control power supply. high = power on low = power off. For BCR with internal decoder this is status read from the BCR. Refer to BCR specifications for signal significance and polarity	

Signal direction is as viewed from the base unit.

CN12 (TCS7567-01-101)

4.5.4 Electrical characteristics

(1) DC characteristics

		min	typ	max
Input voltage (BCR)	V_{IH}	1.4	1.9	2.5V
	V_{IL}	0.8	1.3	1.8V
	V_{IH}-V_{IL}	0.4	0.6	0.7V

Input voltage (LED) V_{IH} 2.4V min
 V_{IL} 0.8V max

Output voltage (BTXD) V_{OH} 3.9V min (I_{OH} = 0.4mA)
 V_{OL} 0.5V max (I_{OL} = 1.0mA)

Output voltage (LOGIC) 4.5V to 5.5V (When Output current 0-50mA)

Output voltage 4.5V to 5.5V (When Output current 0-30mA)

(2) I/O circuits

Input
BCR
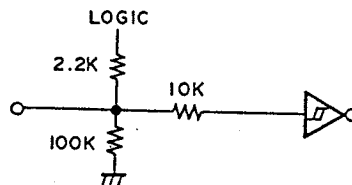
Output
BTXD
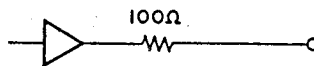
LOGIC, LED
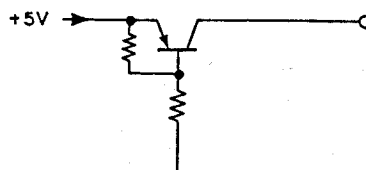
LED
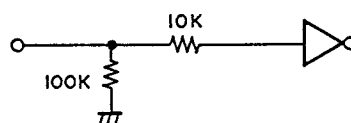
4.5.5 BARCODE.COM

(1) Overviw

The barcode decoder program must be loaded when an application program uses a barcode reader that does not have its own decoder. Executing BARCODE.COM, a standard utility stored in the system ROM, extends BIOS and loads the barcode decoder.
When BARCODE.COM is executed, the barcode decoder program occupies about 8KB of memory and stays resident. The BCR can be used under GW-BASIC or by using extended BIOS call INT 18H.

(2) Features of BARCODE.COM

Features of the PX-16 barcode decoder are as follows:
- Supports the four types of barcode.
  - JAN/EAN/UPC-A/UPC-E
  - 3 of 9
  - Codabar
  - Interleaved 2 of 5

- Automatically identifies the type of barcode
 The program has two functions for reading barcode: one that reads only a specified type of barcode; and one that automatically indentifies and reads any supported type of barcode.

- Pulse-driven LED
  The LED in the barcode reader can be driven by a pulse signal to save current consumption.

(3) Software support

(a) GW-BASIC
Executing BARCODE.COM makes it possible to use the following GW- BASIC command. For details, refer to the PX-16 GW-BASIC Reference Manual.
- BCR(n) ON/OFF/STOP
- ON BCR(n) GOSUB
- OPEN "BCR2:"

(b) INT 18H
Executing BARCODE.COM extends BIOS call INT 18H so that functions 30H to 33H can be used as barcode functions. For details, see "3.5 BIOS."
- Function 30H Initialize BCR
- Function 31H Disable read
- Function 32H Read one character
- Function 33H Read status

4.6 System bus

4.6.1 Overview

The system bus is the interface located to the rear of the base unit, and has 80 signal lines. The system bus includes signal lines unique to the PX-16 as well as those for the option slot of the EPSON PCe or IBM PC/XT.

The system bus signal lines are common with those used with the touch keyboard interface, cartridge 2 interface and expansion interface, so caution is required in I/O characteristics.

4.6.2　Circuit diagram

Fig. 4-6-1　System bus circuit diagram (1)
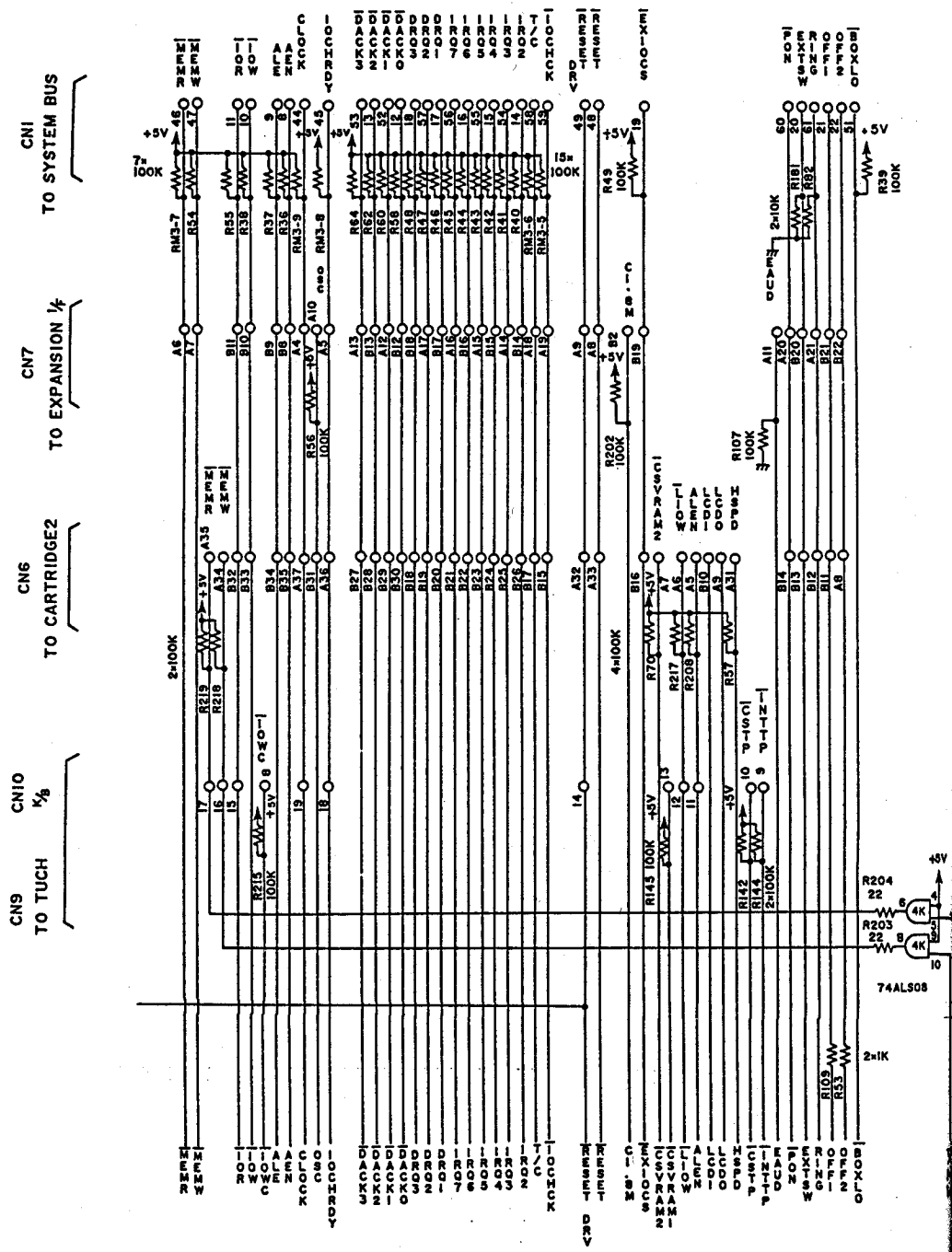
Fig. 4-6-2 System bus circuit diagram (2)

4.6.3 Signal lines

(1) Pin assignment

Pin no.	Signal	I/O	Meaning
1 2	ADPT	–	AC adapter output voltage
3	BAT	–	Battery terminal voltage
4 5 6 7 8 9 10 11 12 13	A19 A17 A15 A13 A11 A9 A7 A5 A3 A1	O	Address bus
14 15 16 17	D7 D5 D3 D1	I/O	Data bus
18	GND	–	Logic ground
19	OFF2	O	Gate array OFF2 signal
20	OFF1	O	Gate array OFF1 signal
21	EXTSW	I	ON/OFF signal for external power source. 1=ON
22	EXIOCS	O	Expansion IO chip select. Activates from P11D0H– P11EFH
23 24	DRQ3 DRQ1	I	DMA request input signal
25 26 27	IRQ6 IRQ4 IRQ2	I	Interrupt request input signal
28 29	DACK2 DACK0	O	DMA acknowledge output signal
30	IOR	O	IO read command
31	IOW	O	IO write command
32	ALE	O	Address latch enable command
33	AEN	O	AEN signal. HIGH in DMA

Signal direction is as viewed from the side of the base unit.
Table 4-6-1 System bus pin assignment (1)

Pin no.	Signal	I/O	Meaning
34 35 38	ADPT	–	AC adaptor output voltage
36 37	VB	–	Battery output voltage
39 40 41 42	GND	–	Logic ground
43	+5V	–	+5V power supply
44	VBK	–	Backup voltage (also output at power off)
45 46 47 48 49 50 51 52 53 54	A18 A16 A14 A12 A10 A8 A6 A4 A2 A0	O	Address bus
55 56 57 58	D6 D4 D2 D0	I/O	Data bus
59	GND	–	Logic ground
60	RING	I	RING input. Expansion interrupt factor.
61	PON	O	POWER ON signal
62	IOCHCK	I	IO channel check signal
63	T/C	O	Reverse of DMA controller EOP.
64	DRQ2	I	DMA request input signal
65 66 67	IRQ7 IRQ5 IRQ3	I	Interrupt request input signal
68 69	DACK3 DACK1	O	DMA acknowledge output signal
70	BOXLO	I	Battery low signal from disk unit

Signal direction is as viewed from the side of the base unit.
Table 4-6-2 System bus pin assignment (2)

Pin no.	Signal	I/O	Meaning
71	ADPT	–	AC adaptor output voltage
72	RESETDRV	O	Reset drive signal (positive logic on the IBM XT)
73	RESET	O	Reset signal
74	MEMW	O	Memory write command (equivalent to XMW signal)
75	MEMR	O	Memory read signal (equivalent to XMR signal)
76	IOCHRDY	I	Option READY signal
77	CLOCK	O	System clock (4.77MHz or 10MHz)
78	+5V	–	+5V power
79 80	GND	–	Logic ground

Signal direction is as viewed from the side of the base unit.
Table 4-6-3 System bus pin assignment (3)

(2) **Connector**

DX10-80S (Hirose)
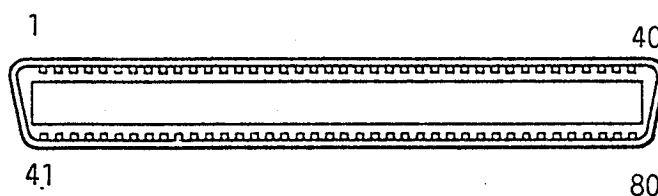
Fig. 4-6-3 System bus connector

4.7 Printer Interface

4.7.1 Overview

The printer interface is a standard 8-bit parallel Centronics-compatible interface which supports connection of standard printers. The data strobe signal $\overline{STRB}$ is supplied from the base unit, for the handshake with the BUSY printer busy signal. In addition to $\overline{STRB}$ and BUSY there are also $\overline{ERR}$ indicating printer errors, and $\overline{INIT}$ for printer initialization, for a total of 20 signals in the interface.

When the printer interface is not connected to an external printer, it is possible to use this interface for other applications.
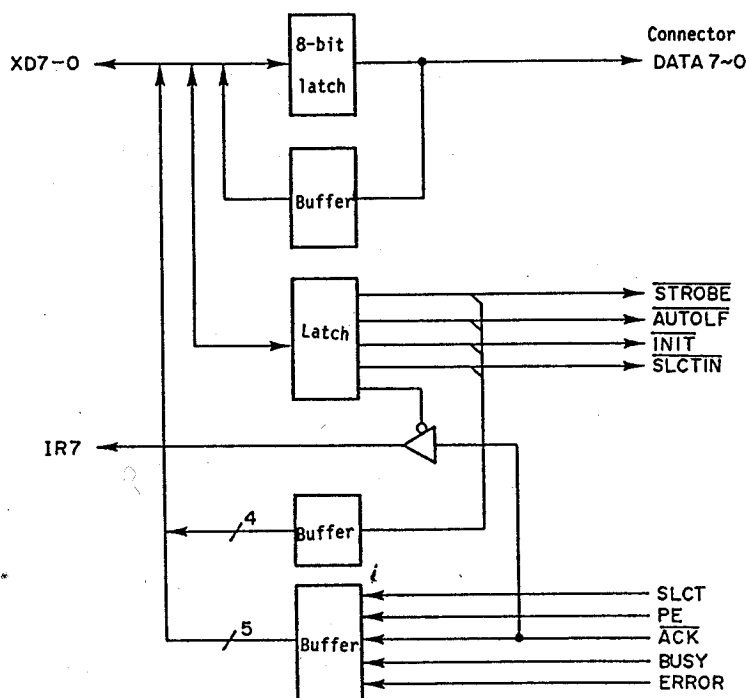
Fig. 4-7-1 Printer interface block diagram

The data and the control signal for the printer are written to the output buffer. All the output signal status can be read. Also, the status of the printer can be read. $\overline{ACK}$ is a level 7 interrupt, but the output port setting determines whether or not $\overline{ACK}$ produces the interrupt.

4.7.2 Circuit diagram
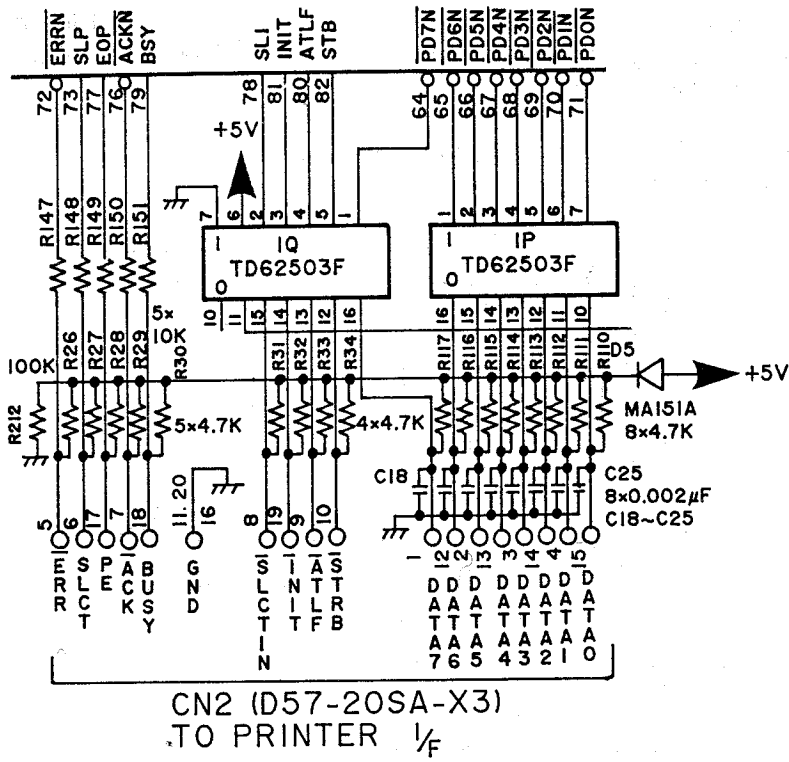
Fig. 4-7-2 Printer interface circuit diagram

4.7.3 Signal lines

Pin no.	Signal	I/O	Meaning
1 2 3 4	DATA7 DATA5 DATA3 DATA1	O	Data bus
5	ERR	I	Error signal from printer
6	SLCT	I	Printer select signal
7	ACK	I	ACK signal
8	SLCTIN	O	Select in
9	ATLF	O	Auto line feed signal
10	STRB	O	Strobe signal
11	GND	–	Ground
12 13 14 15	DATA6 DATA4 DATA2 DATA0	O	Data bus
16	GND	–	Ground
17	PE	I	Paper empty detect signal
18	BUSY	I	Printer busy signal
19	INIT	O	reset signal
20	GND	–	Ground

Signal direction is as viewed from the side of the base unit.
Table 4-7-1 Printer interface pin assignment

(2) Connector

D57-20SA-X3 (DDK)

Fig. 4-7-3

Rev. B
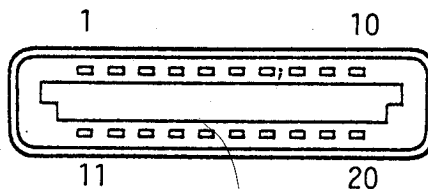
4.8   Expansion interface

4.8.1   Overview

The expansion interface is located on the left side of the main CPU.

The expansion interface signals include the IBM PC/XT, EPSON PCe compatible signals and the special PX-16 signals.

As the expansion interface is positioned beneath the keyboard, it is not visible when the keyboard is connected to the base unit. When an external expansion board is to be connected to the expansion interface, first remove the expansion interface connector cover from the left side of the base unit then insert the external expansion board to the base unit and connect it to the expansion interface. The following external expansion boards may be connected to the expansion interface:

- Asynchronous RS board
- Development tool

4.8.2 Circuit diagram

Fig. 4-8-1 Expansion interface circuit diagram (1)

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Fig. 4-8-2 Expansion interface circuit diagram (2)

4.8.3 Signal lines

(1) Pin assignment

Pin no.	Signal	I/O	Meaning
A1 A2	GND GND	– –	Logic ground
A3	+5V	–	+5V power
A4	CLOCK	O	System clock
A5	IOCHRDY	I	Option READY signal
A6	$\overline{\text{MEMR}}$	O	Memory read signal
A7	$\overline{\text{MEMW}}$	O	Memory write command
A8	$\overline{\text{RESET}}$	O	Reset signal
A9	$\overline{\text{RESETDRV}}$	O	Reset drive signal (positive logic on the IBM XT)
A10	OSC	O	14.31818 MHz
A11	EAUD	O	Digital audio signal from the expansion I/F
A12 A13	$\overline{\text{DACK1}}$ $\overline{\text{DACK3}}$	O	DMA acknowledge output signal
A14 A15 A16	IRQ3 IRQ5 IRQ7	I	Interrupt request input signal
A17	DRQ2	I	DMA request input signal
A18	T/C	O	Reverse of DMA controller EOP.
A19	$\overline{\text{IOCHCK}}$	I	IO channel check signal
A20	$\overline{\text{PON}}$	O	POWER ON signal
A21	RING	I	RING input. Expansion interrupt factor.
A22	GND	–	Logic ground
A23 A24 A25 A26	D0 D2 D4 D6	I/O	Data bus

Signal direction is as viewed from the base unit.
Table 4-8-1 Expansion interface pin assignment (1)

A27
A28
A29
A30
A31
A32
A33
A34
A35
A36

A37

A38

A39
A40
B1

B2

B3

B4
B5

B6
B7

B8

B9

B10

B11

B12
B13

B14
B15
B16

B17
B18

B19

B20

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Pin no.	Signal	I/O	Meaning
A27 A28 A29 A30 A31 A32 A33 A34 A35 A36	A0 A2 A4 A6 A8 A10 A12 A14 A16 A18	O	Address bus
A37	VBK	–	Backup voltage
A38	+5V	–	+5V power
A39 A40 B1	GND GND GND	– – –	Logic ground
B2	C1.8M	O	Baud rate generation clock
B3	VBK	–	Back up voltage
B4 B5	VB VB	– –	Battery output voltage
B6 B7	ADPT ADPT	– –	AC adaptor output voltage
B8	AEN	O	AEN signal. HIGH in DMA
B9	ALE	O	Address latch enable command
B10	IOW	O	IO write command
B11	IOR	O	IO read command
B12 B13	DACK0 DACK2	O	DMA acknowledge output signal
B14 B15 B16	IRQ2 IRQ4 IRQ6	I	Interrupt request input signal
B17 B18	DRQ1 DRQ3	I	DMA request input signal
B19	EXIOCS	O	Expansion IO chip select. Activates from P11D0H- P11EFH
B20	EXTSW	I	ON/OFF signal for external power source. 1=ON

Signal direction is as viewed from the base unit.
Table 4-8-2 Expansion interface pin assignment (2)

Pin no.	Signal	I/O	Meaning
B21	OFF1	O	OFF1 signal
B22	OFF2	O	OFF2 signal
B23	GND	–	Logic ground
B24 B25 B26 B27	D1 D3 D5 D7	I/O	Data bus
B28 B29 B30 B31 B32 B33 B34 B35 B36 B37	A1 A3 A5 A7 A9 A11 A13 A15 A17 A19	O	Address bus
B38	BAT	–	Battery terminal voltage
B39	+7V	–	+7V power, RS-232C output voltage, buzzer voltage
B40	-7V	–	-7V power, RS-232C output voltage, buzzer voltage

Signal direction is as viewed from the base unit.
Table 4-8-3 Expansion interface pin assignment (3)

(2) Connector

TX5-80P-D2LT-MH1 (JAE)

A1   A40

B1   B40
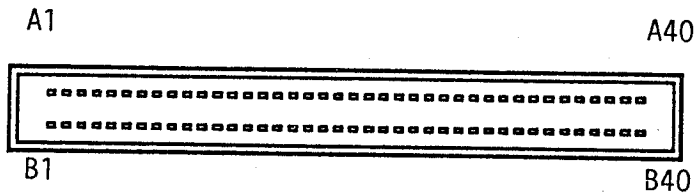
Fig. 4-8-3 Expansion interface connector

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4.11 RAM board interface

4.11.1 Overview

The RAM board interface is used to connect a 384KB RAM board, and consists of a pair of connectors. The PX-16 is equipped with three RAM board interfaces.

CN14 is linked to CN15, CN16 to CN17, and CN18 to CN19. Connecting these connector pairs to RAM boards provides enhanced RAM capabilities.

Connector	RAM expansion
CN 14,15	Main RAM (256kB to 640kB)
CN 16,17	Expansion RAM (0kB to 384kB)
CN 18,19	Expansion RAM (384kB to 768kB)

Table 4-11-1   Connectors and RAM Expansion

4.11.2 Circuit diagram
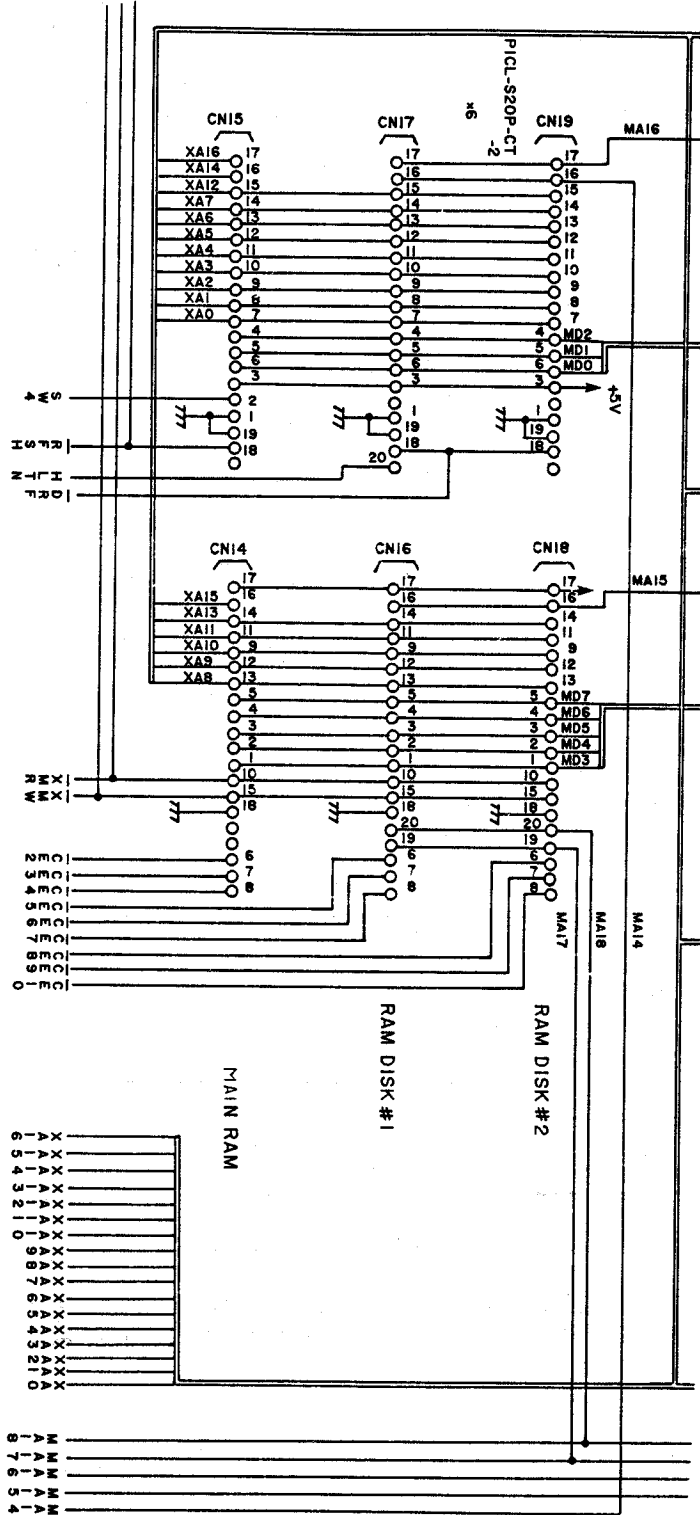
Fig. 4-11-1 RAM Board Interface

4.11.3 Signal lines

(1) Pin assignment

Pin number	I/O	CN14 (Main RAM)	CN16 (Disk #1)	CN18 (Disk #2)
1	I/O	MD3		
2	I/O	MD4		
3	I/O	MD5		
4	I/O	MD6		
5	I/O	MD7		
6	O	$\overline{CE2}$	$\overline{CE5}$	$\overline{CE8}$
7	O	$\overline{CE3}$	$\overline{CE6}$	$\overline{CE9}$
8	O	$\overline{CE4}$	$\overline{CE7}$	$\overline{CE10}$
9	O	XA10		
10	O	$\overline{XMR}$		
11	O	XA11		
12	O	XA9		
13	O	XA8		
14	O	XA13		
15	O	$\overline{XMW}$		
16	O	XA15		
17	–	VBK		
18	–	GND		
19	O	----------	MA17	
20	O	----------	MA18	

Signal direction is as viewed from the base unit.
Table 4-11-2 RAM board interface signals (1)

(2)

Pin number	I/O	CN14 (Main RAM)	CN16 (Disk #1)	CN18 (Disk #2)
1	–	GND		
2	I	SW4		
3	–	+5V		
4	I/O	MD2		
5	I/O	MD1		
6	I/O	MD0		
7	O	XA0		
8	O	XA1		
9	O	XA2		
10	O	XA3		
11	O	XA4		
12	O	XA5		
13	O	XA6		
14	O	XA7		
15	O	XA12		
16	O	XA14		
17	O	XA16		
18	O	$\overline{\text{RFSH}}$	$\overline{\text{DRF}}$	
19	–	GND		
20	–	----------		

Signal direction is as viewed from the base unit.
Table 4-11-3 RAM board interface signals (2)

(2) Connector

PICL-S20-CT-2 (JAE)

```
20                    1
┌──────────────────────┐
│ ■■■■■■■■■■■■■■■■■■■■ │
└──────┘        └──────┘
```

Fig. 4-11-2 RAM board interface connector

(3) Description

CN14, CN16, CN18

Pin No.	Connector name CN14	CN16	CN18	I/O	Meaning	When the main power is OFF.
1 2 3 4 5		MD3 MD4 MD5 MD6 MD7		I/O	Memory data bus	Off
6 7 8	CE2 CE3 CE4	CE5 CE6 CE7	CE8 CE9 CE10	O	RAM chip enable signal. CE2-CE4 = main RAM, CE5-CE10 = expansion RAM disk	H level
9 11 12 13 14 16		XA10 XA11 XA9 XA8 XA13 XA15		O	Internal address bus	Off
10		XMR		O	Internal memory read signal	Off
15		XMW		O	Internal memory write signal	Off
17		VBK		–	Backup voltage	Always output
18		GND		–	Logic ground	
19 20	---- ----	MA17 MA18		O	Expansion RAM disk address bus	Off

Signal direction is as viewed from the base unit.

Right-side partial table:

Pin No.
1 19
2
3
4 5 6
7 8 9 10
11 12
13 14 15
16 17
18
20

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Pin No.	Connector name			I/O	Meaning	When the main power is OFF.
	CN15	CN17	CN19			
1 19	GND			−	Logic ground	

2	SW4	--	--	I	Main RAM installation determination.
					  1=Main RAM expansion RAM disk installed
					  0=No main RAM expansion RAM disk
					     installed.
					Not used in CN17 and CN19
						Off

3	+5V			−	+5V power supply	Off
4 5 6	MD2 MD1 MD0			I/O	Memory data bus	Off
7 8 9 10 11 12 13 14 15 16 17	XA0 XA1 XA2 XA3 XA4 XA5 XA6 XA7 XA12 XA14 XA17			0	Internal address bus	Off
18	RFSH	DRF		0	CN15: memory refresh signal CN17, CN19: expansion RAM disk memory refresh signal	Low level
20	NC			−	Not connected	

Signal direction is as viewed from the base unit.