Chapter 1 Introduction

1.1 Purpose of This Manual

This manual describes the functions of the operating system for the EPSON PX-8, HC-8Ø, and HC-88 series (referred to as MAPLE) microcomputer systems. It is intended for system house users who are to develop applications programs which make the best of the MAPLE's capabilities.

The reader is assumed to be familiar with the following:

- Basic knowledge about the CP/M operating system
- General knowledge about machine-language programming
- Z8Ø instructions

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1.2 Before Reading This Manual

This manual uses the following notational conventions:

(1) Data representation

This manual discusses binary, decimal, and hexadecimal numbers. They are represented in the formats:

Binary:	ØØ1ØØØ11B (Numbers are followed by 'B')
Decimal:	35 (only numerals)
Hexadecimal:	23H (Numbers are followed by 'H')

Character constants are enclosed in apostrophes (').

Example:

'ABC'

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(2) Operating system types

The MAPLE runs in three types of operating systems (OS). In this manual, these operating systems are distinguished as follows:

ASCII (OS): ASCII ver. OS (PX-8)

JIS (OS): Japanese-language JIS Keyboard OS (HC-80, -88)

TXT*(OS): Japanese-language TXT Keyboard OS (HC-80, -88T)

* TXT stands for the Touch-16 Japanese language input methods originally developped by EPSON.

Japanese-language (OS): Japanese-language JIS and TXT Keyboard OSs

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Chapter 2 General Description and System Configuration

2.1 MAPLE System Configuration

The MAPLE is a successor of the worldly-accepted EPSON HC-2Ø hand-held computer. It is a new generation hand-held computer which incorporates in its compact body much more functions than ordinary desktop microcomputers. With its battery-driven power supply, the user can user the MAPLE any time, any place, even outside the office.

To further augment this outstanding portability feature, EPSON supplies a wide variety of peripheral devices and options. For example, the MAPLE employs a large (8Ø columns by 8 lines) LCD screen. With the virtual screen support, the MAPLE allows the user to create display images larger than those the conventional CRT devices can provide. The MAPLE is furnished as standard microcassette drives which are completely controlled by the distribution operating system so the user can handle them as easy as floppy disk units. Another standard device is an RS-232C interface which enables the MAPLE to communicate with other computers directly or via a telephone lines. When combined with an optional microfloppy disk drives, P-8Ø printer, or CP-2Ø

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acoustic coupler, all are battery driven!, the MAPLE provides a full computing environment even in locations where no commercial AC source. The main unit proper will meet most of daily business needs.

The MAPLE employs as its operating system the industry standard CP/M version 2.2 operating system implemented in ROM. This allows the user to implement an abundance of commercial CP/M application programs on the MAPLE. In addition to the supports for all MAPLE peripheral devices, the MAPLE CP/M has many extended functions which will help the user develop application programs for the MAPLE.

The MAPLE with the Japanese-language OS and Japanese-language processor unit supports kanji processing so that the user can easily construct application programs using kanji characters.

The ideal combination of the MAPLE with the software that make the best of the MAPLE's portability and capability will explore new computer uses that no one ever imagine.

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2.2 Hardware Configuration

2.2.1 Hardware Configuration (see block diagram)

(1) CPU

The MAPLE uses three processors: Z80, 6301, and 7508. The 6301 and 7508 processors are used mainly to control I/O operations to reduce the burden of the Z80 central processing unit.

1) Z80

- Main CPU
- CMOS version
- 2.46 MHz clock

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2) 63Ø1

- 8-bit CPU
- CMOS version
- 614 KHz clock
- Contains 4K-byte program

The 63Ø1 CPU controls the following I/O devices:

- Screen (LCD)
- Serial Interface
- Microcassette
- ROM capsule
- Speaker

3) 75Ø8

- 4-bit CPU
- CMOS version
- 200 KHz clock
- Contains 4k-byte program

The 75Ø8 CPU controls the following I/O devices

- Keyboard
- Power supply to main CPU
- RESET SW
- Battery voltage port

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- Temperature data port
- Calendar ports
- Alarm port
- 1-second software timers

(2) Memory

OS ROM:	32K bytes (CMOS mask ROM)
Main ROM:	64K bytes (CMOS DRAM)
VRAM:	6K bytes (CMOS DRAM)

- The OS ROM and main RAM are bank-switched.
- VRAM is controlled by the 6301 processor.
- The main RAM and VRAM are battery backed up and their data are sustained even when power switch is turned off.

(3) Battery

Two types of rechargeable Ni-Cd batteries are used:

Main battery capacity:	1100 mAH
Subbattery capacity:	90 mAH

Normally, the main battery is held on. When the power voltage falls down to 4.7 volts, power is switched from the main battery to subbattery and the subbattery maintain only power to the RAM. Recharging (tricle

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recharging) is accomplished using the attached AC adapter. Eight hours after tricle recharging is started with the AC adapter, recharging is stopped to prevent overcharging from damaging the battery. The main battery charges the subbattery while it is in operation.

(4) Interrupt handling

Z80 mode 2 interrupts are used for interrupt to Z80. Six interrupt levels are available. They are listed below in the descending order of priority:

1) Interrupts from the 7508
2) RS-232C receive interrupt from 8251
3) CD (Carrier Detect) interrupt from RS-232C interface
4) FRC (Free Running Converter) overflow interrupt
5) ICF (Interrupt Catch Flag) interrupt from the bar code reader.
6) External interrupt

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2.2.2 Built-in I/O devices

(1) Keyboard

- The keyboard consists of 66 keys and six switches (66 keys and seven switches for Japanese-language version).
- The keyboard supports N-key rollover feature.
- The keyboard also supports auto repeat feature.

(2) LCD

- 48Ø dots (wide) x 64 dots (long)

  Dot size: Ø.41 mm (wide) x Ø.45 mm (long)

  Dot spacing: Ø.46 mm (wide) x Ø.5Ø mm (long)
- 8Ø characters by 8 lines (3Ø characters by 3 lines for kanji characters)
- The LCD panel swivels in the range of 18Ø° in 13 intervals.
- The LCD view angle can be controlled by a slide switch.
- 1/64 duty

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(3) Microcassette drive

- The microcassette drive is controlled by software.
- Allows Dame recording and playback. Only playback is possible with voice information.
- The sound from the microcassette drive can be monitored using the internal or external speaker.
- The tape speed is 2.4 cm/second.

(4) ROM capsule

- 28-pin 2764/27128, 27256, or equivalent.
- NMOS or CMOS mask ROM or PROM is possible.
- A ROM capsule can contain up to two ROM chips. They may be used single or in combination.
- Power to the ROM is supplied only when it is accessed, which is controlled by software.
- The ROM capsule allows easy installation or removal by the user.

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(5) Built-in dynamic speaker

- Compact dynamic speaker
- The frequency and duration can be controlled by software.
- The volume can be adjusted with a volume control.
- The output can be connected to an external speaker interface.

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2.2.3 External Interfaces

(1) RS-232C

- The RS-232C interface uses a CMOS 8251 controller chip (compatible with Intel 8251A).
- The output level is ± 8 volts.
- The power to the driver is controlled by software.
- 8-pin mini-DIN connector is used.
- Bit rates (bps)

  TX: 110, 150, 200, 300, 600, 1200

  RX: 110, 150, 200, 300, 600, 1200

  TX: 240, 4800, 8600, 19200

  RX: 240, 4800, 8600, 19200

  TX: 1200, 75

  RX: 75, 1200
- Number of start bits: 1
- Number of stop bits: 1, 2
- Data length: 7, 8
- Parity: Even, odd, none
- Full duplex/half duplex

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(2) Serial interface

- The output level is ± 8 volts.
- The power to the driver is controlled by software.
- The driver is shared with the RS-232C interface.
- 8-pin mini-DIN connector is used.
- Bit rates (bps)

  TX: 110, 600, 4800, 38400

  RX: 110, 600, 4800, 38400
- Number of start bits: 1
- Number of stop bits: 1
- Data length: 8
- Parity: None
- Full duplex/half duplex

(3) Bar code reader

- 3-pole connector
- Power is controlled by software.

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(4) Analog input ports

- 2 channels
- Input level: Ø to 2 volts
- Resolution: 6 bits (2 v / 2^6 ≒ Ø.Ø3 v)

(5) External speaker

- The output to the built-in speaker can be switched to the external speaker by plugging in a plug into the speaker jack.

(6) System bus

- A total of 5Ø lines including the 16 address bus lines and 8 data bus lines are available.

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Peripheral Devices Connectable to the External Interface

External Interface	Peripheral	Cable	Options
RS-232C	Printer	#723	P40 P80 Series
		#725	EPSON printers with serial I/F MP(X) series FP(X) series RP(X) series
	Acoustic coupler	#724	CP-20 CX-20 CX-21
	Computer	#726	MAPLE PINE
		#725	QC(X)-20 QC(X)-10
		#738	HC(X)-20

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External Interface	Peripheral	Cable	Options
Serial I/F	Minifloppy disk drive	#723	TF-10 TF-15 TF-20
	Microfloppy disk drive	#726	PF-10
	Printer	#723	P40 P80 series
		#725	EPSON printers with serial I/F MP(X) series FP(X) series RP(X) series
Bar code reader I/F	Bar code reader (Wand)		HØØBR code JA (low resolution) HØØBR code HA (high resolution)

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External Interface	Peripheral	Cable	Options
System bus	Expansion unit	#727	RAM disk unit Japanese-language unit Modem unit Multi-unit 64 Universal unit

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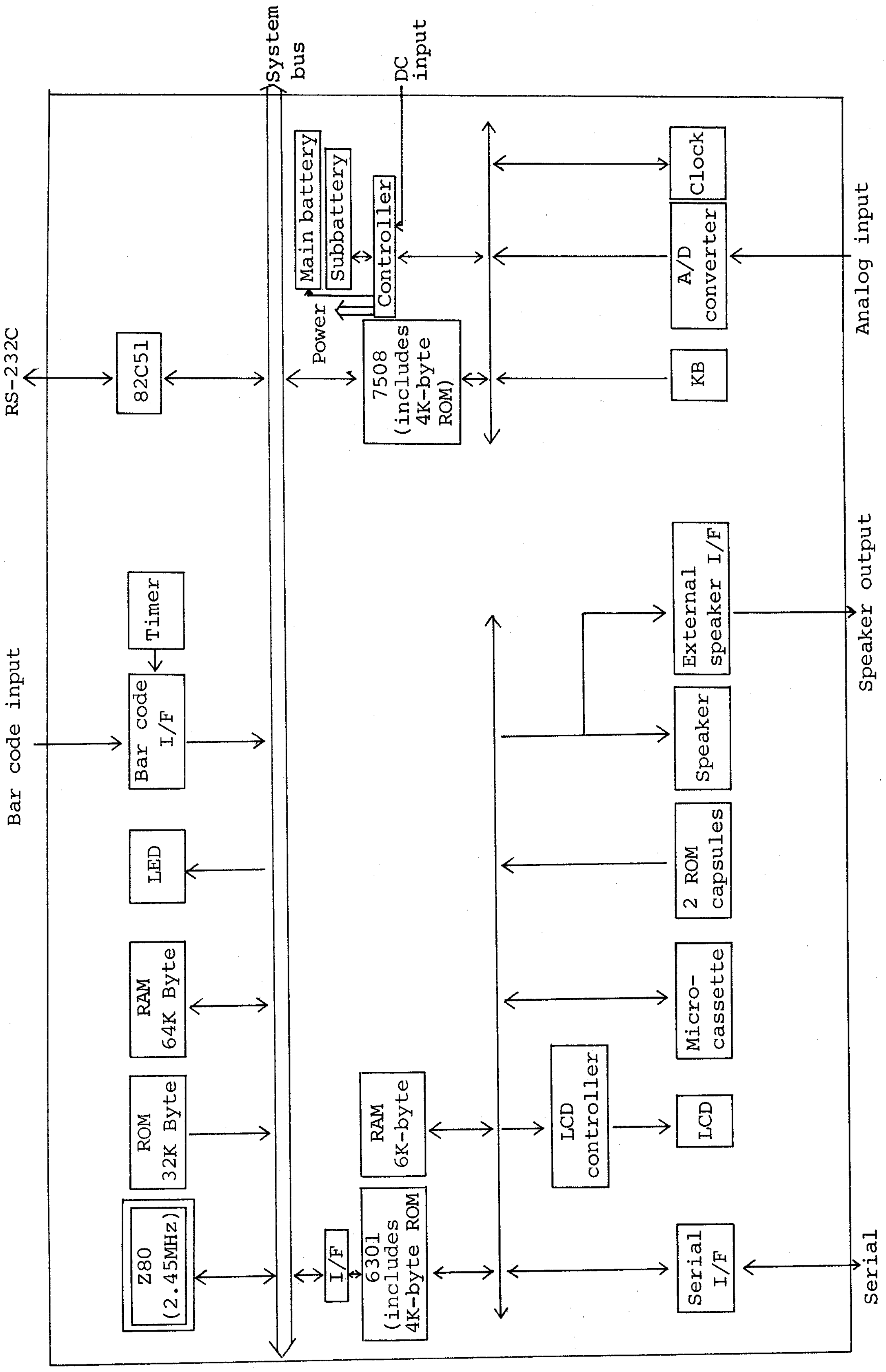
Block Diagram



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2.3 Software Features and Organization

2.3.1 Software Features

This subsection lists the features of the MAPLE software.

(1) Industry-standard CP/M 2.2

This allows the user to transport an abundance of commercial CP/M application programs to the MAPLE with relatively little effort.

(2) A variety of peripheral devices supported by OS.

The peripheral devices that MAPLE CP/M 2.2 supports are:

RAM disk
ROM capsule
Mini- and micro-FD
Microcassette
Speaker
Analog input
RS-232C
Power
Clock (calendar)

To support these devices, 25 BIOS entries have been included into the standard CP/M BIOS. Consequently, the user can develop application programs handling these devices with great ease.

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The OS, however, supports no bar code equipment. It must be handled by application programs. These programs are also supplied from EPSON.

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(3) Many CP/M drives

The table below lists the peripheral devices that are supported as CP/M drivers.

Drive	Peripheral	Capacity		Directories	Maximum tracks/sector
		Total	Data area		
A:	RAM disk	When main RAM is used:	Ø - 23K bytes	16	3 TRK/7 SCT
		When RAM disk is used:			
		6ØK bytes	59K bytes	32	7 TRK/31 SCT
		64K bytes	63K bytes	32	7 TRK/63 SCT
		12ØK bytes	119K bytes	32	14 TRK/63 SCT
		128K bytes	127K bytes	32	15 TRK/63 SCT
B: C:	ROM capsule	Depends on ROM type			
		8K bytes	8K bytes	31	Ø TRK/63 SCT
		16K bytes	16K bytes	31	1 TRK/63 SCT
		32K bytes	32K bytes	31	3 TRK/63 SCT
		Sum of the above capacities when drives B: and C: are used as a contiguous drive.	←		
D: E: F: G:	FD	320K bytes	278K bytes	64	39 TRK/64 SCT

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Drive	Peripheral	Capacity		Directories	Maximum tracks/sector
		Total	Data area		
H:	Microcassette	Approx. 3ØK bytes with 3Ø-minute tape	Approx. 3ØK bytes with 3Ø-minute tape	12	Only sequential access in file units is allowed.
I:	ROM capsule in extension unit Supported by a combination of OS ASCII version B or later and a Multi-unit 64.	128K bytes	128K bytes	31	15 TRK/63 SCT
	ROM capsule in extension unit Supported by a combination of Japanese-language OS and a Japanese-language unit.	32K bytes	32K bytes	31	3 TRK/63 SCT

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(4) RAM disk features

- Allows both reads and writes.
- High-speed access.
- Provides a storage capacity of 23K bytes maximum when main memory is submitted as RAM disk and a capacity of 128K bytes when an extension unit is installed.
- Data is maintained even when power is turned off.
- The main memory RAM disk is disabled when the extension unit RAM disk is used.

(5) ROM capsule features

- Allows only reads.
- High-speed access
- Provides a storage capacity of 8K bytes (one 2764 chip) to 64K bytes (two 27256 chips).
- Easily installed and removed.

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(6) FD features

- Allows both reads and writes.
- High-speed access.
- Provides a large capacity of removable storage.
- Can handle both mini- and micro-floppy disk drives.
- The micro-FD drives (PF-1Ø) is battery driven.

(7) Microcassette

- Allows both reads and writes.
- High-speed access.
- Customized OS allows the user to handle microcassette in the same easy way as FD files.
- Only sequential access is supported.
- Only one file can be open at a time.

(8) Extended unit ROM capsule

- Allows only reads.
- High-speed access
- ASCII OS supports larger capacity than internal ROM capsules.

(9) Devices for software exchange

The user can select any of the following devices for exchanging storage media of different sizes and

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formats:

- ROM capsule
- FD
- Microcassette

(1Ø) Screen

The MAPLE is provided with a large (80 columns by 8 lines) LCD. Its OS also supports virtual screens as large as 80 columns by 48 lines. The user can switch between four screens, namely, i.e., three text only screens (the 80-column text screen, the 39-column Split screen, and the Dual screen) and one graphics screen, all under software control. In addition to these screens, the Japanese-language OS supports two types of kanji screens. It also permits switching of virtual screens and control of screen scrolling with function keys.

(11) Clock

The MAPLE has a clock which indicates the year (lowest two digits, month, day, minutes, and second). The clock is battery backed up and performs automatic leap year adjustment.

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(12) Password function

The password function protects the MAPLE programs and data from unauthorized accesses. Once a password is defined, this function defers any attempt for a power-on sequence until the operator enters the defined parameter.

(13) Alarm function

The alarm function sounds an alarm at the preset time, whether the MAPLE is in use or not, and displays the predefined messages on the screen. This function can be used for schedule management.

(14) Wake function

The wake function automatically powers on the MAPLE and executes programs in the preprogrammed sequence when the preset time (month, day, and hour) has reached. If the MAPLE is already in on state when the preset time is reached, this function sounds an alarm and displays messages indicating the operating procedure for the programs (alarm function). This function can be used for automatically starting the MAPLE in instrumentation and data gathering applications.

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(15) Auto start function

The auto start function performs the steps or programs predefined by the user automatically at power on time. This function will be useful when the MAPLE is used as a dedicated machine.

(16) Menu function

The menu function displays a directory of executable programs on the screen in a menu format at power on or warm boot time. The user can select the program with cursor movement keys and start the selected program by pressing the RETURN key. This function is highly convenient for users who are unfamiliar with operator operations. When a program is already in the TPA, this function causes the program in memory to be immediately executed, thus eliminating the time-consuming program load step.

(17) System display function

The system display function is started by pressing the CTRL and HELP keys simultaneously and displays the system status on the screen. The user can define the parameters for the password, alarm wake, auto start, and menu functions from the screen. The function also allows the user to manually control the microcassette drive.

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(18) Hard copy function

The user can take a hardcopy of the current contents of the LCD screen on the printer in one of the following methods:

(1) Pressing the CTRL/PF5 key.

(2) Calling the BIOS hardcopy routine.

Some OS versions do support the hard copy function.

(19) Power off state in restart and continue modes

The MAPLE can be in one of the two power off modes, i.e., restart and continue modes, depending on how the MAPLE is powered off.

- Restart mode: Execution starts at CCP or a menu is displayed when the MAPLE is powered on.
- Continue mode: The processing that were being executed when the MAPLE was powered off is resumed when the MAPLE is powered on again.

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(2Ø) Power on/off

The MAPLE can be powered on and off not only through the POWER switch but under program control. The MAPLE can be turned on by the wake function and turned off by a BIOS routine. The user can also set the restart or continue mode. The contents of MAPLE memory are maintained when MAPLE power is turned off.

(21) Auto power off function

The auto power off function automatically turns MAPLE power off in the continue mode when no key entry is made for a predetermined time, thus saving battery power. When the MAPLE is powered on again, executions resumes at the point when the auto power off function is executed.

(22) Voltage drop warning

When the battery voltage drops below approximately 4.7 volts, the OS displays a message "CHARGE BATTERY" on the screen and, in approximately 2Ø seconds later, automatically turns MAPLE power off. This precludes the contents of the RAM from being completely destroyed or the CPU from hanging up due to the reduced battery voltage level. When this occurs, the active battery is automatically switched to the subbattery which only maintains the power to RAM.

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2.3.2 Software Organization

The MAPLE OS resides in the 32K-byte ROM. The OS runs while switching between the RAM and ROM banks. The OS contains the modules listed below.

Module	Function
STARTER	Resides in ROM and performs the following: - System initialize - RESET switch processing - POWER switch processing - Processing of alarm interrupts in power off state.
INTROM	Resides in ROM and processes interrupts from the 75Ø8 and 8251.
MENU	Resides in ROM and controls menu processing.
SYSCRN	Resides in ROM and controls system display processing.
RELOC	Resides in ROM and relocates RAM resident modules from ROM.

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Module	Function
BDOS	Resides in ROM and processes CP/M BDOS calls.
PREBIOS	Resides in ROM and perform preprocessing for CP/M BIOS calls.
PSTBIOS	Resides in ROM and perform postprocessing for CP/M BIOS calls.
BIOS1 BIOS2 BIOS3	Resides in ROM and processes CP/M BIOS calls. The BIOS module is divided into three submodules.
SCREEN	Resides in ROM and controls CONOUT BIOS call processing.
MCT	Resides in ROM and controls the microcassette drive.

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Module	Function
CCPD	The CCP portion of CP/M in a relocatable format and is relocated into RAM at the beginning of execution.
RBDOSB	The BDOS entry portion of CP/M (main BDOS body resides in ROM) in a relocatable format and is relocated into RAM at the beginning of execution.
RSYSPR	The part of the CP/M BIOS entry portion (main BIOS body resides in ROM) in a relocatable format and is relocated into RAM at the beginning of execution. Includes interrupt handling routines and other system routines.
SYSAR1 SYSAR2 SYSAR3	Copied into RAM and initialize the system work area. There are three modules which are invoked at different timings depending on when the work area is to be initialized.
ROMID	Contains the OS ROM identification.

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2.4 MAPLE State Transition

The MAPLE can be in eight states when viewed from the software standpoint. The interrelationship between these eight states is illustrated in the figure on the next page.

MAPLE states

(1) Restart mode power off state

(2) Continue mode power off state

(3) Password entry screen display state

(4) Menu screen display state

(5) System display screen display state

(6) Alarm/wake screen display state

The MAPLE performs no special wake function except it displays messages (strings) indicating operating procedures in the same way as the alarm function when a wake time is reached in the power on state.

(7) Charge battery screen display state

(8) CCP or application program running state

States 1 through 7 are unique to the MAPLE and only supported by the MAPLE OS.

Note: Power failure refers to a drop in the battery voltage below a specified level.

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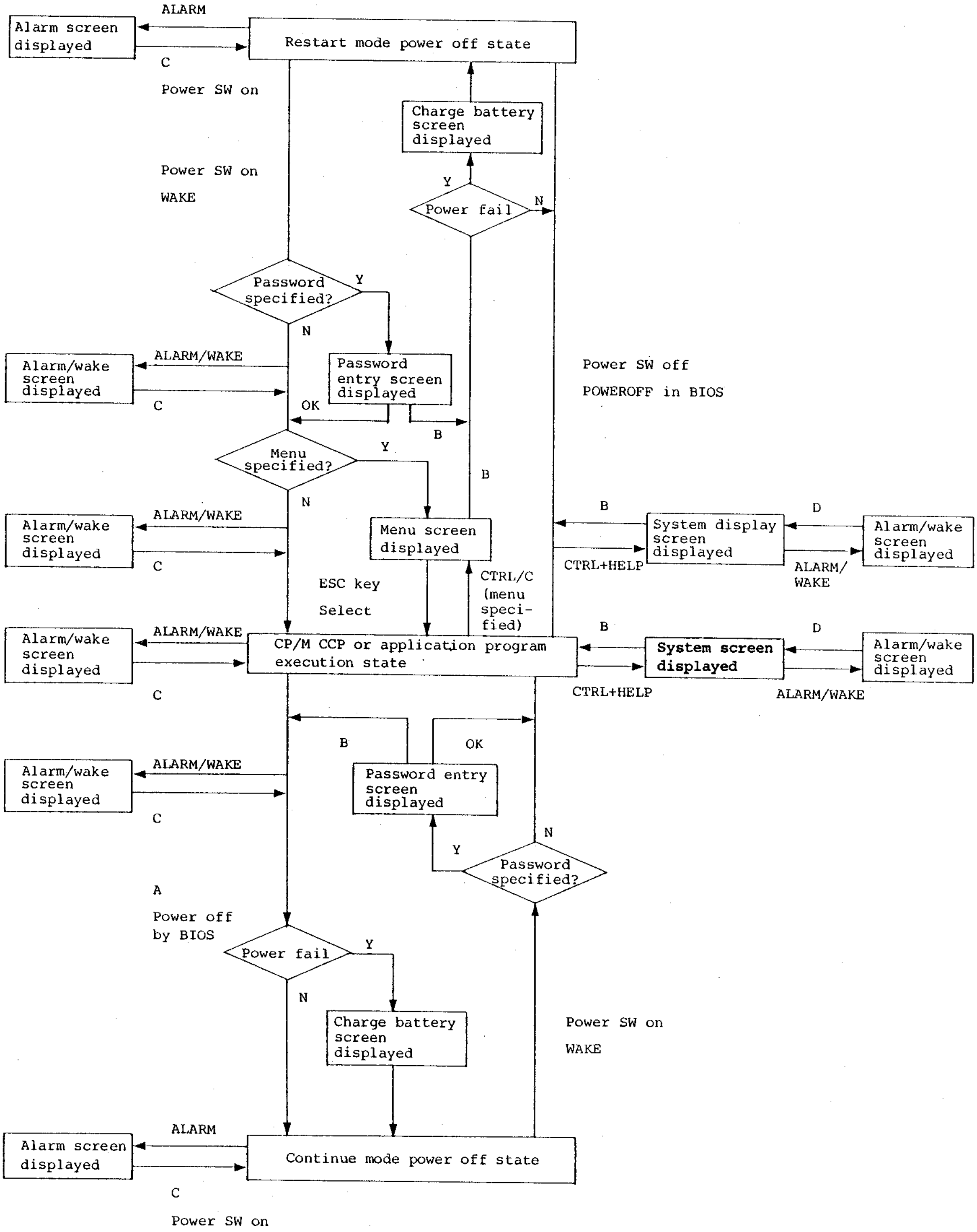
MAPLE State Transition Diagram



ALARM
Alarm screen displayed
Restart mode power off state
C
Power SW on
Charge battery screen displayed
Power SW on
WAKE
Y
Power fail
N
Password specified?
Y
N
Alarm/wake screen displayed
ALARM/WAKE
C
Password entry screen displayed
OK
B
Power SW off
POWEROFF in BIOS
Menu specified?
Y
N
B
Alarm/wake screen displayed
ALARM/WAKE
C
Menu screen displayed
B
System display screen displayed
D
Alarm/wake screen displayed
CTRL+HELP
ALARM/ WAKE
ESC key
Select
CTRL/C (menu speci- fied)
Alarm/wake screen displayed
ALARM/WAKE
CP/M CCP or application program execution state
B
System screen displayed
D
Alarm/wake screen displayed
C
CTRL+HELP
ALARM/WAKE
B
OK
Alarm/wake screen displayed
ALARM/WAKE
Password entry screen displayed
C
N
Y
Password specified?
A
Power off by BIOS
Power fail
Y
N
Charge battery screen displayed
Power SW on
WAKE
ALARM
Alarm screen displayed
Continue mode power off state
C
Power SW on

A - CTRL + Power SW off, Auto power off, Power failure
B - A, Power SW off
C - 5Ø seconds, ESC Key, Power SW off, CTRL + Power SW off, Power failure
D - C, Power SW off

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Chapter 3 MAPLE CP/M Principles of Operation

MAPLE adopts CP/M Version 2.2 as its operating system. Since the basic part of the MAPLE operating system is implemented in ROM, MAPLE CP/M runs in a slightly different way from the CP/M for most disk-based computers. This chapter explains how MAPLE CP/M run on the MAPLE computing system.

3.1 CP/M Memory Organization

3.1.1 Roles of CP/M Modules in ROM and RAM

MAPLE CP/M switches between two 32K-byte banks during execution using a bank switching technique as shown in the figure on the next page. One is a ROM bank containing the major portions of CP/M OS and the other is a RAM bank which makes up the first half of the 64K main RAM memory. The CP/M modules (CCP, BDOS, and BIOS) are apparently loaded in RAM as they are on ordinary disk-based computers. This means that MAPLE application programs can use the CP/M functions in the same way as those which use the standard CP/M. In fact, however, only a 100H bytes of a system area containing the entry points to the BDOS and BIOS are loaded in RAM, making the most part of the RAM

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available for application programs. Actual BDOS and BIOS operations are performed in the OS in ROM that is activated through bank switching. Control is returned to the application program again through bank switching to RAM after processing is terminated.

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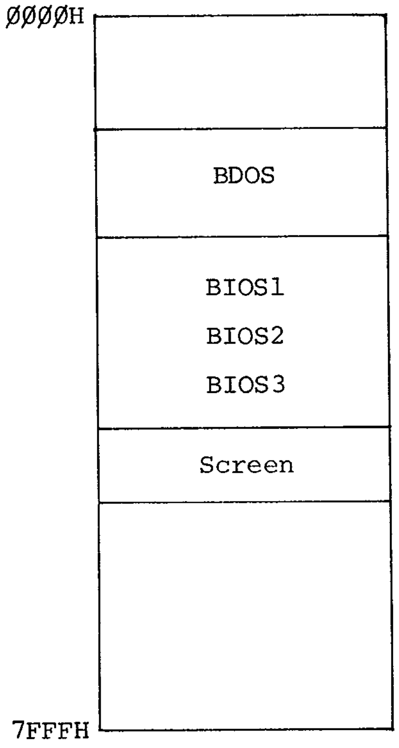

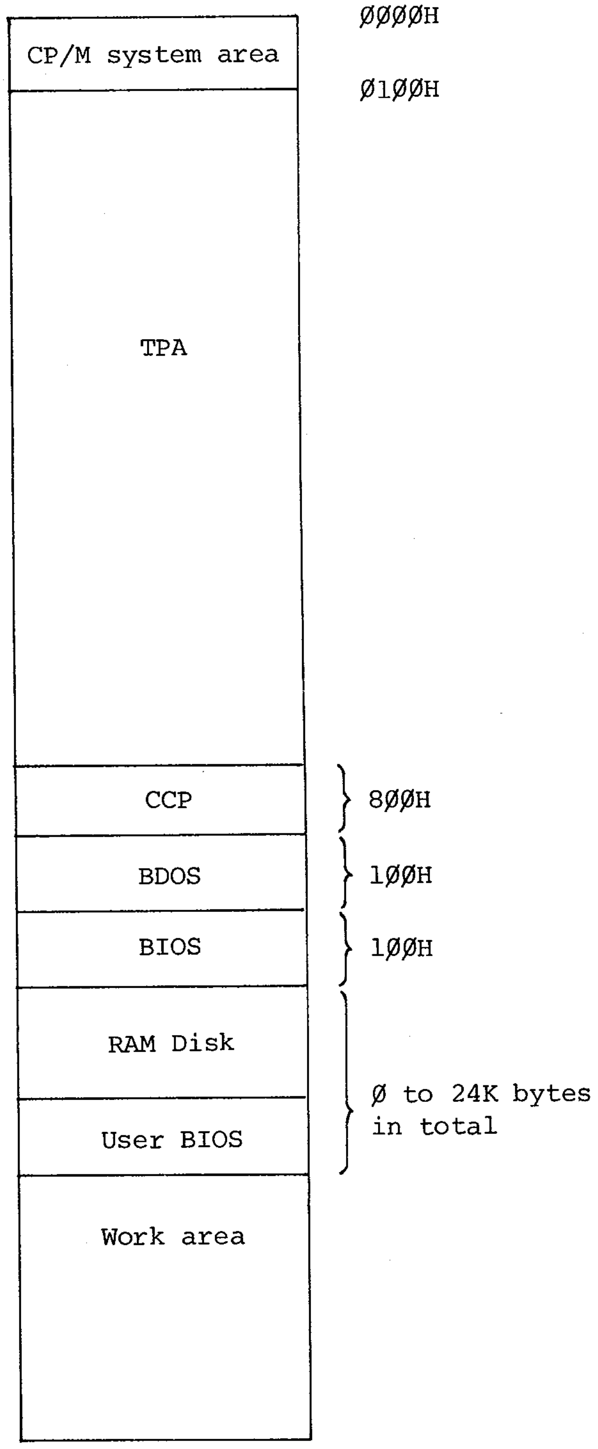

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The addresses of the CCP, BDOS, and BIOS in RAM differ depending on the total size of the RAM disk implemented and the user BIOS area (0 - 24K bytes). The size of the CP/M system ranges from 59.5K to 45.5K bytes. The RAM disk and user BIOS sizes can be changed by the CONFIG program.

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3.1.2 Procedure for Constructing a CP/M System in RAM

On MAPLE, the CP/M system can be loaded from ROM into RAM by three routines: system initialize, reset (CBOOT), and WBOOT. This subsection describes the function of these routines and the timing when they are invoked as well as the interactions between them. The STOP and CTRL/STOP functions for interrupting program execution are also explained here.

The user can take the following measures (must be attempted in this sequence) when his program hangs up:

1. Press the STOP key.
2. Press STOP key while holding down the CTRL key.
3. Press the RESET switch.
4. Hold the SHIFT and GRPH keys simultaneously and press the RESET switch on the side of MAPLE.
5. Press the 75Ø8 RESET switch.

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	Operation	Initiated by	When
System initialize	1. Initializes system area 1. 2. Resets the slave CPU 63Ø1. 3. Checks the extended RAM disk unit. 4. Performs system initialization. Sets the year, month, day, hour, minute, and second and the size of the RAM disk and User BIOS. (ASCII Version 1.Ø and Japanese-language OS) 5. In ASCII Version B, the system initialization formats the RAM disk and only initializes the system as follows without performing system initialization: Date and time: 19ØØ/ØØ/ØØ ØØ:ØØ:ØØ Sunday RAM DISK: 9K bytes User BIOS: Ø bytes	1. Pressing the 75Ø8 RESET switch. 2. Holding the SHIFT and GRPH keys down and pressing the RESET switch.	1. Using the system for the first time after purchase. 2. 75Ø8 hangs up. 3. The extension unit is installed or removed.
Reset	1. Initializes system area 2. 2. Resets the slave CPU 63Ø1. 3. Loads the BIOS to RAM. 4. Checks the RAM disk checksum. 5. Sets the screen to the mode specified by CONFIG.	1. Pressing the RESET switch.	1. Z8Ø hangs up. 2. 63Ø1 hangs up.
WBOOT	1. Flushes the FD buffer. 2. Sets the cursor to the mode set up by CONFIG.	1. Entering C or the STOP key in CCP mode. 2. Sending control to WBOOT in the program. 3. Turning power on in restart mode.	1. Control jumps to BIOS WBOOT.

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	Operation	Initiated by	When
CTRL/STOP	1. Interrupts the current I/O operation. 2. Clears the key buffer and loads it with Ø3H.	1. When holding down the CTRL key and pressing the STOP key.	1. Interrupting application program performing an I/O operation. The application program must terminate on receiving Ø3H.
STOP	1. Clears the key buffer and loads it with Ø3H.	1. Pressing the STOP key.	1. When interrupting the application program must terminate on receiving Ø3H.

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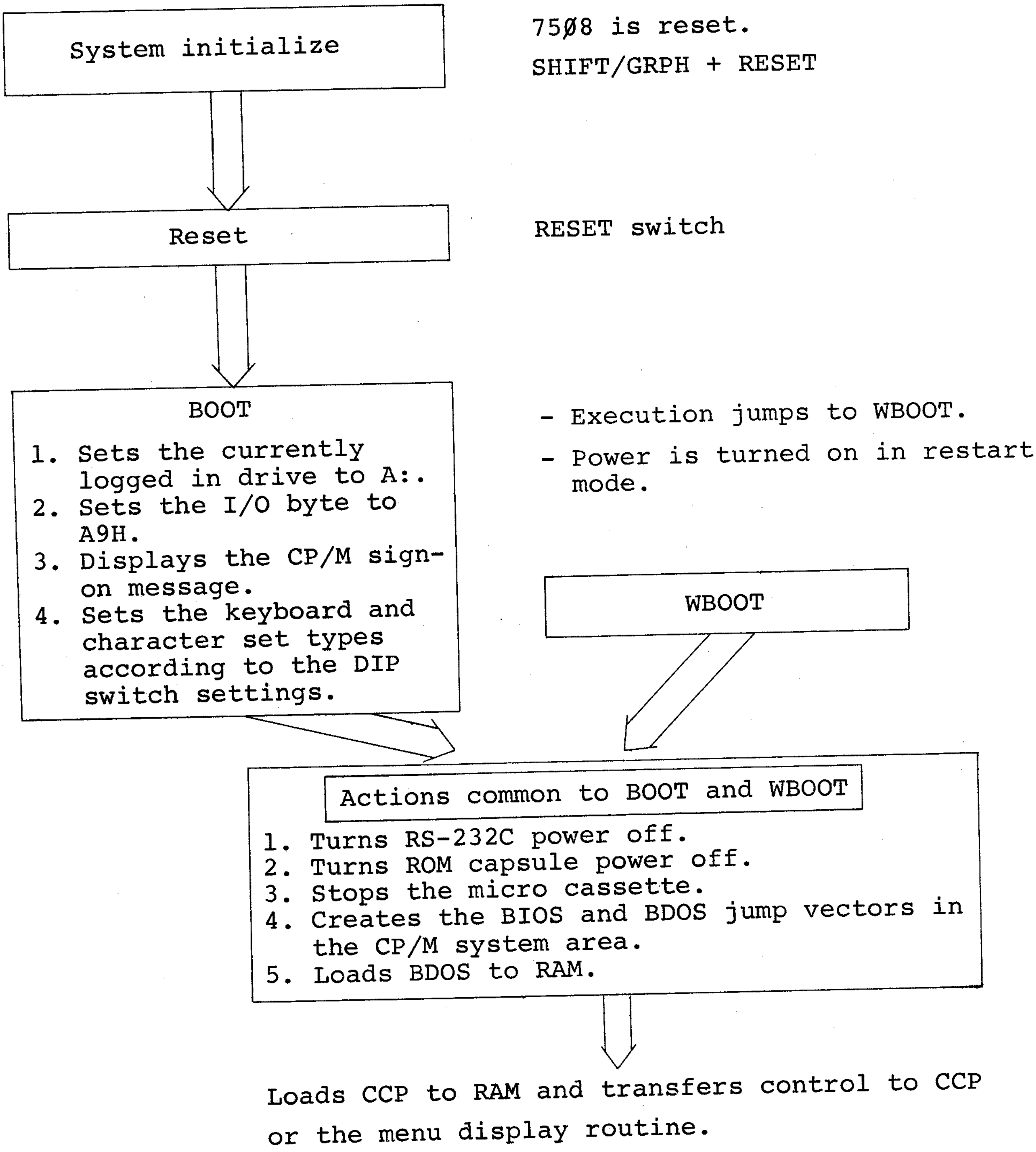
Relationships among the system initialize, reset, and WBOOT



System initialize

75Ø8 is reset.

SHIFT/GRPH + RESET

Reset

RESET switch

BOOT

1. Sets the currently logged in drive to A:.
2. Sets the I/O byte to A9H.
3. Displays the CP/M sign-on message.
4. Sets the keyboard and character set types according to the DIP switch settings.

- Execution jumps to WBOOT.
- Power is turned on in restart mode.

WBOOT

Actions common to BOOT and WBOOT

1. Turns RS-232C power off.
2. Turns ROM capsule power off.
3. Stops the micro cassette.
4. Creates the BIOS and BDOS jump vectors in the CP/M system area.
5. Loads BDOS to RAM.

Loads CCP to RAM and transfers control to CCP or the menu display routine.

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System areas 1, 2, and 3

The RAM work area that MAPLE uses is classified into the following two types:

1. Work areas initialized at a specific timing before use.
2. Work areas used only temporarily.

The work area of the first type is divided into three types called system areas 1, 2, and 3 according to the timing at which initial values are set.

	Initialized when	Work area contents
System area 1	System initialize is invoked.	Initial values of flags indicating PASSWORD and MAPLE basic status.
System area 2	Reset is invoked.	Initial values related to BIOS.
System area 3	WBOOT is invoked.	Initial values related to BDOS.

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3.2 BDOS Function Processing Flow

When BDOS is called by a MAPLE application program, control is first transferred to the entry point to the BDOS in RAM. Then the OS switches banks and maps the memory addresses ØØØØH to 7FFFH into ROM, then calls the real BDOS in ROM. Upon completion of processing, the OS switches the bank to RAM and returns control to the application program with return information loaded in registers.

The BDOS in ROM calls directly the BIOS in ROM.

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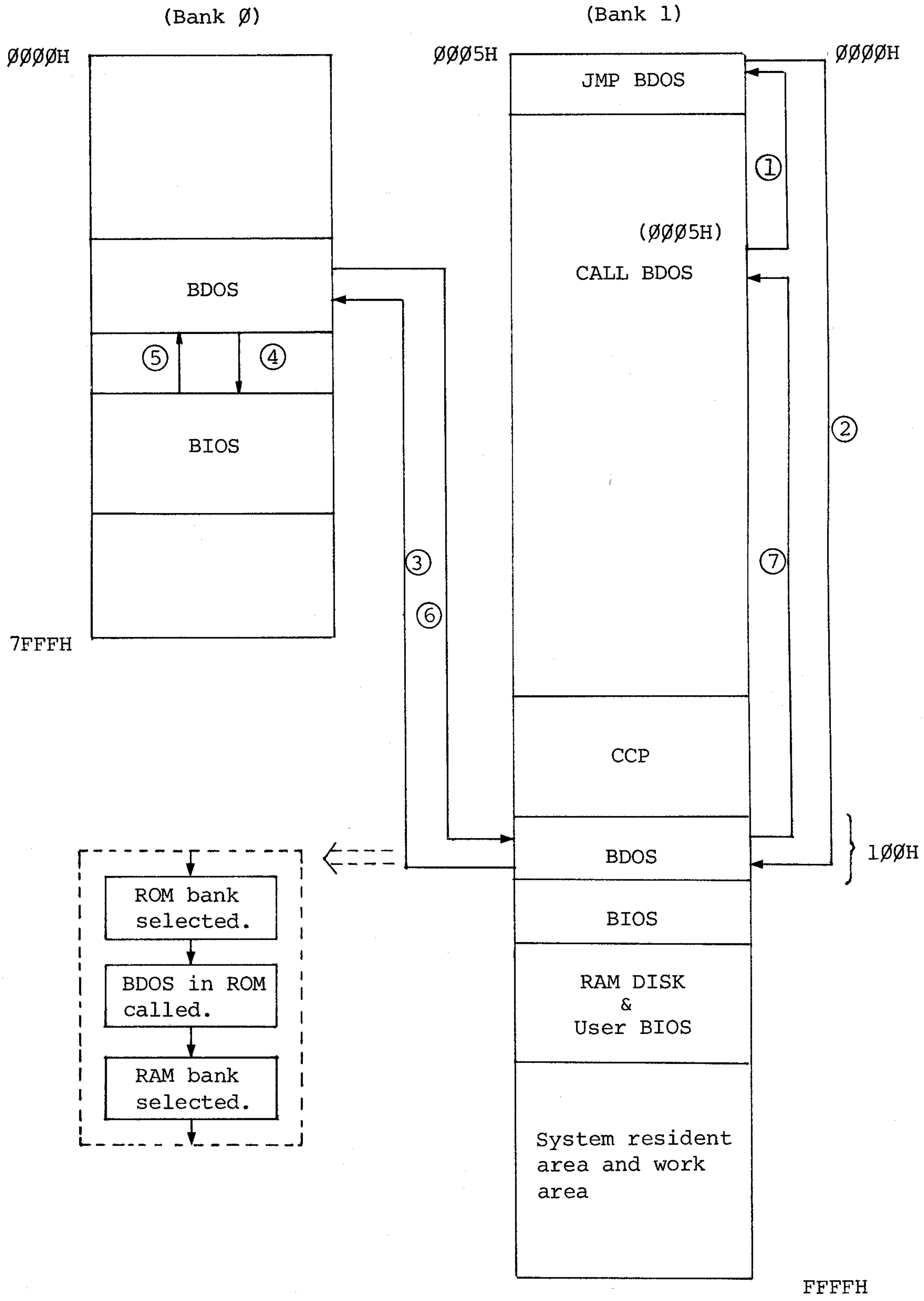
BDOS call processing flow



3.3 BDOS Error Recovery Procedure

BDOS can display four types of error conditions. Since these errors are handled totally under BDOS control, it is likely that they destroy the current screen image, initiates a warm boot on receipt of user response from the keyboard after the error display, or even destroy memory data. One of countermeasures to avoid this is to make the application program report and handle error conditions for itself. The MAPLE OS permits the application program to take the following two measures against error conditions to achieve this:

1. Receiving BDOS error information as a return code.
2. Rewriting the jump vector for BDOS error processing and performing user-supplied error processing.

The four types of BDOS errors are:

1. Bad Sector
2. Bad Select
3. R/O Disk
4. R/O File

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3.3.1 Receiving BDOS Error Information in Return Code

(1) Changing the BDOS error reporting mode

The application program can receive any BDOS error information directly in CPU registers by calling location ØØ12H (SET ERROR) in OS ROM (bank Ø). It can also have BDOS return any error information by calling location ØØ15H (RESET ERROR) in OS ROM.

The application program must use BIOS CALLX (WBOOT + 69H) to directly call a routine in OS ROM. In this case, the program must reserve a stack area at a location 8ØØØH or higher in RAM.

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(2) Return codes

Register / Error	A	H	
BAD SECTOR	FFH	Ø1H	Standard CP/M BDOS errors
BAD SELECT	FFH	Ø2H	
R/O DISK	FFH	Ø3H	
R/O FILE	FFH	Ø4H	
MCT ERROR	FFH	Ø5H	BDOS errors unique to MCT

For Bad Sector errors, BDOS stores more detailed error information in memory.

BIOSERROR EQU 0F536H

Data in memory	Error type	
Ø1H	Read error	
Ø2H	Write error	
Ø3H	Write protected.	←Write protected
Ø4H	Timeout	
Ø5H	Seek error	(MCT only)
Ø6H	CTRL/STOP pressed.	(MCT only)
Ø7H	Power turned off.	

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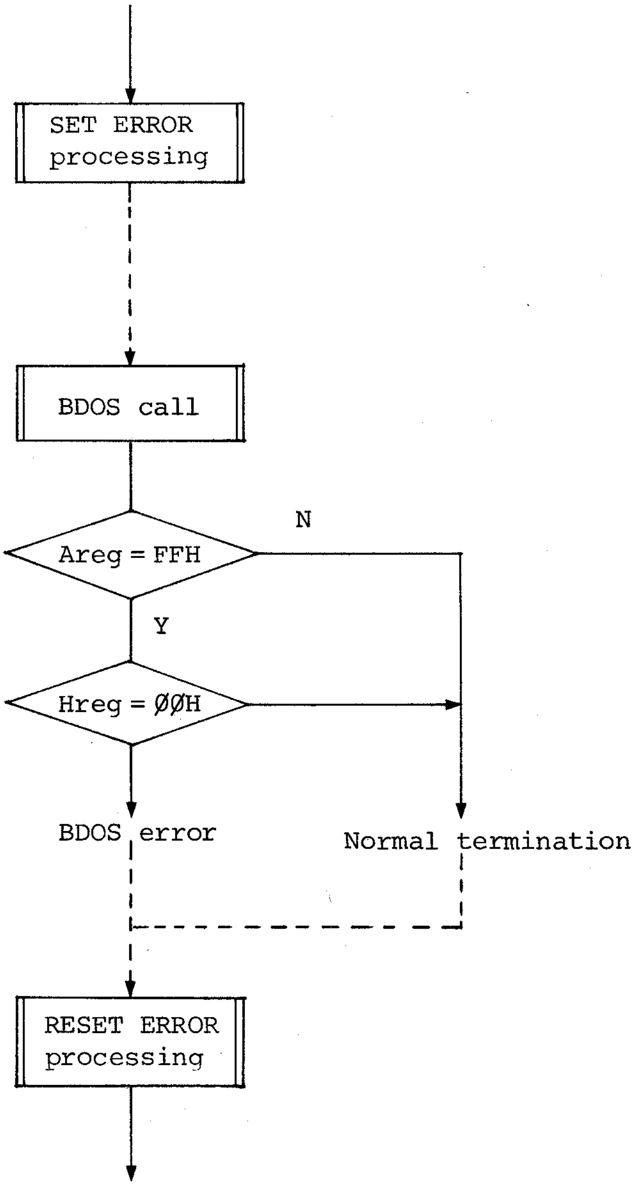
(3) Procedure for identifying errors

Some of the BDOS functions returns 0FFH to the A register as a usual return code. Therefore, the calling program must identify errors by examining the H register as well as the A register. See the figure below.



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(4) Programming notes

1) Once SET ERROR is executed, BDOS performs no error processing and continues only to return error status until a RESET ERROR or WBOOT is executed.

2) After execution of SET ERROR, the results are not guaranteed unless the application program performs its own error checking and recovery processing.

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3.3.2 Rewriting the Jump Vector for Processing BDOS Errors

Four jump vectors for processing BDOS errors are located at the beginning of BDOS in RAM. The application program can handles error conditions in its own way by changing the contents of these jump vectors.

```
ERRVCTR: <-----------------
                Address ((Contents of RAM addresses 6 and 7)+3)
   DW   PERERR <---- Address of parameter error processing routine
                      (Bad Sector error)
   DW   SELERR <---- Address of select error processing routine
                      (Bad Select error)
   DW   RODERR <---- Address of read only disk error processing
                     routine (R/O Disk error)
   DW   ROFERR <---- Address of read only file error processing
           ↑         routine (R/O File error)
           |

        The application program can perform its own error
        processing by changing the above addresses.
```

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Programming notes:

(1) On return, the stack area is switched to that for the application program because the stack area for the BDOS was used during BDOS processing.

(2) Bank 1 is selected (all RAM).

(3) The user error processing routine must contain no BDOS calls if it is to return control to BDOS with a RET statement.

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3.4 BIOS Function Operation Flow

(1) Outline

The major BIOS operations are carried out by BIOS in ROM as BDOS operations are. To achieve these, when a call to BIOS is made from an application program, the OS receives the call in the BIOS in RAM, switches the active bank to the system bank, and calls the BIOS in the system bank (ROM). After completion of the BIOS processing, the OS returns to the BIOS in RAM with various return information and result data, switching again to the user bank, and returns control to the application program.

The BIOS in RAM always resides in addresses higher than 8ØØØH so that it is not affected by bank switching.

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(2) PREBIOS and PSTBIOS

Some BIOS routines uses the slave CPU functions (e.g., screen and microcassette handling). Since the main and slave CPUs communicate commands and data using a specific protocol, if the main CPU attempts to request the slave CPU to do one operation while it has already instructed the slave CPU to do another operation, the protocol will be destroyed and the communication between the main and slave CPUs hang up. BIOS controls the slave CPU properly while BIOS alone is using the slave CPU. If, however, an interrupt is generated which calls for a service by the slave CPU (e.g., alarm, power off, or power failure interrupt), it will try to have the interrupt source use the slave CPU, ignoring the execution sequence established between the main and slave CPU, causing the MAPLE to hang up.

PREBIOS and PSTBIOS are provided to solve this problem. When a call is made to BIOS, the OS executes PREBIOS to set on a flag indicating that BIOS processing is in progress. If an interrupt requesting for a slave CPU service is generated while this flag is on, the interrupt handling routine checks this flag and, knowing that the slave CPU is used by a BIOS routine, makes the

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interrupt-driven processing pending after turning on a flag indicating that an interrupt is held pending.

When the BIOS processing is completed, the OS starts PSTBIOS, which in turns executes any pending interrupt routines, clears the flag indicating the execution of a BIOS routine, and returns control to the application program.

The flowchart on the next page shows the relationship between PREBIOS, PSTBIOS, and BIOS processing.

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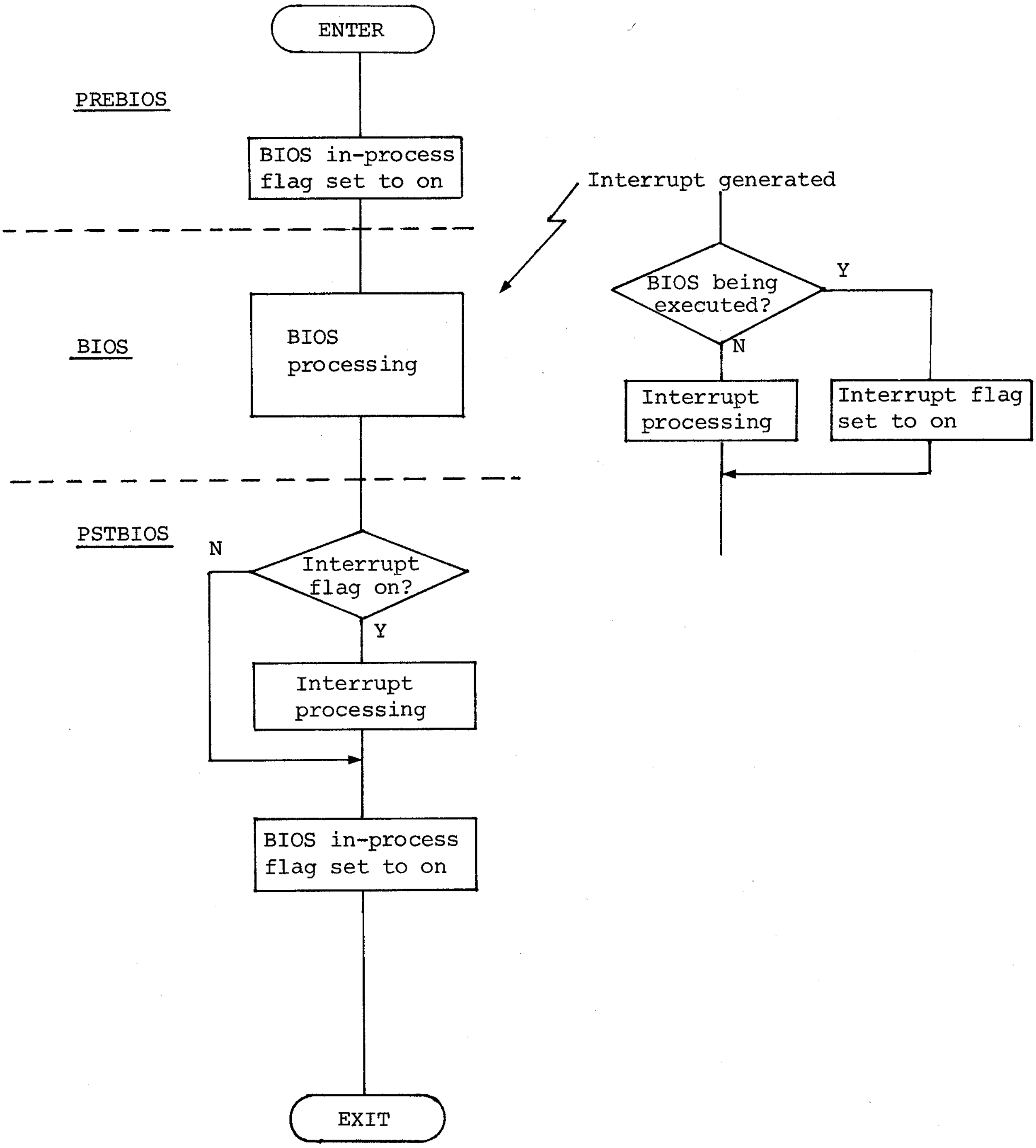

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(3) Calling a BIOS routine from an application program

The entry address into the BIOS WBOOT in RAM is located in addresses 1 and 2 in RAM. To use a BIOS call, the user program must call BIOS specifying the address obtained by adding the function offset to this BIOS entry address. Since every BIOS routine ends with a RET statement, control returns the statement immediately following the CALL statement that called the BIOS routine.

SAMPLE PROGRAM

The sample program below calls a BIOS routine with the function's offset from the WBOOT (multiple of 3) in the IX register pair.

```
BIOS:
     PUSH      BC
     LD        BC, (0001H)    ;Entry point to WBOOT.
     ADD       IX, BC
     POP       BC
     JP        (IX)           ;Jump to BIOS.
```

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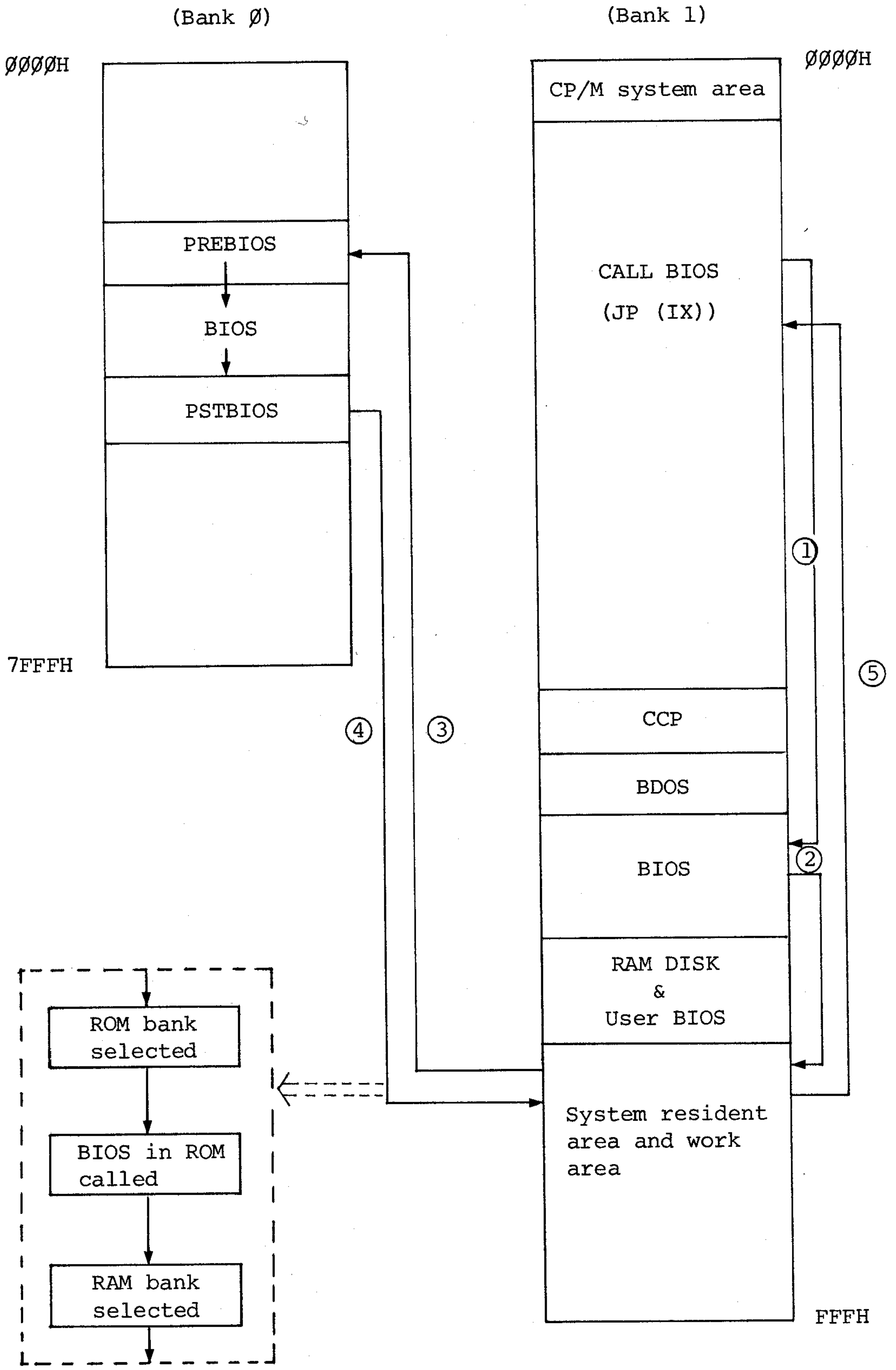
(4) BIOS call operation flow



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