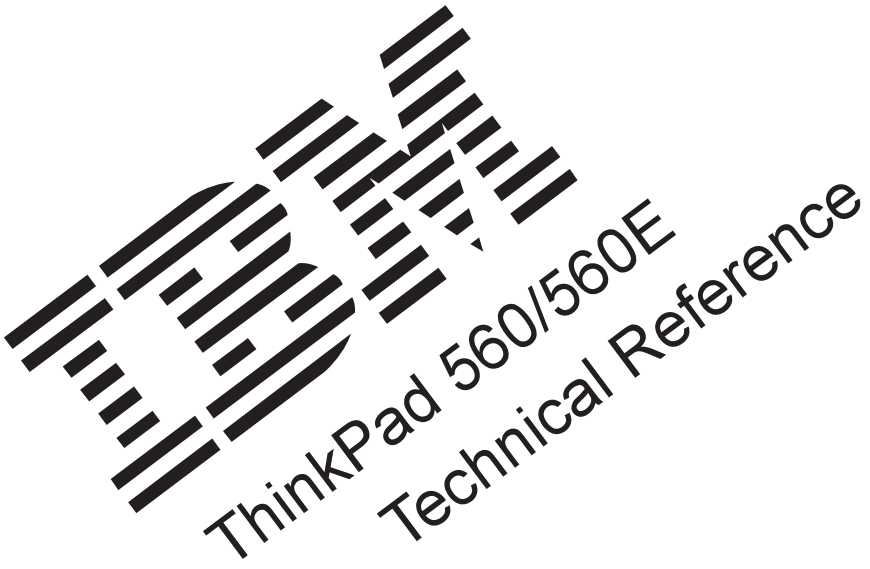


06J0536
S76H-7587-01

Note

Before using this information and the product it supports, be sure to read the general information under “Notices” on page B-1.

Second Edition (July 1997)

Contents

Figures

Tables

Preface

This technical reference contains hardware and software interface information specific to the IBM* ThinkPad* 560/560E computer. This technical reference is intended for those who develop hardware and software products for the computer. Users should understand computer architecture and programming concepts.

This publication consists of the following sections and appendixes:

- Section 1, “System Overview,” describes the system, features, and specifications.
- Section 2, “System Board,” describes the system-specific hardware implementations.
- Section 3, “Subsystems,” describes the hardware functions specific to the ThinkPad 560/560E computers.
- Appendix A, “System Management API (SMAPI) BIOS Overview,” describes the system software interface built into the system, called the System Management Application Program Interface (SMAPI) BIOS, which controls the system information, system configuration, and power management features of the ThinkPad system.
- Appendix B, “Notices,” contains special notices and trademark information.

An index is also included.

This technical reference should be used with the following publications:

IBM Personal System/2 Hardware Interface Technical Reference

IBM Personal System/2 and Personal Computer BIOS Interface

These publications contain additional information on many of the subjects discussed in this technical reference. Information about diskette drives, hard disk drives, adapters, and external options are in separate technical references.

Attention

The term *Reserved* describes certain signals, bits, and registers that should not be changed. Use of reserved areas can cause compatibility problems, loss of data, or permanent damage to the hardware. When the contents of a register are changed, the state of the reserved bits must be preserved. When possible, read the register first and change only the bits that must be changed.

Section 1. System Overview

Description

The *IBM Personal System/2 Hardware Interface Technical Reference* describes devices common to the PS/2* AT-bus system family.

The IBM ThinkPad 560/560E computer (hereafter called the 560, *ThinkPad computer*, or *computer*) is a notebook-size computer that features the AT* bus architecture. Each computer supports one external diskette drive and one internal hard disk drive.

Programs can distinguish the foregoing models of computers from other ThinkPad models by reading the system ID: Interrupt 15H, function code (AH)=23H, (AL)=10H, returns (AL)=0EH for the 560/560E.

The system microprocessor contains an internal cache and cache controller.

Figure 1-1 lists the model bytes, submodel bytes, and system clock speed of the system board.

Model	Model Byte (Hex)	Submodel Byte (Hex)	System Clock
560/560E	FC	01	66 MHz / 60 MHz

Figure 1-1. Model and Submodel Bytes

For a listing of the other systems, refer to the *IBM Personal System/2 and Personal Computer BIOS Interface*.

System Board Devices and Features

Figure 1-2 lists the system board devices and their features. The *IBM Personal System/2 Hardware Interface Technical Reference* describes devices common to PS/2 products by type number.

Device	Type	Features
Microprocessor	–	**ThinkPad 560:** Intel** Pentium** • 100/120/133MHz • 16KB on-chip cache **ThinkPad 560E:** Intel Pentium processor with the MMX technology • 150/166MHz • 32KB on-chip cache
Level 2 cache	–	**ThinkPad 560:** None **ThinkPad 560E:** 256KB
System timers	1	Channel 0: system timer Channel 1: refresh generation Channel 2: tone generator for speaker
ROM subsystem	–	128KB by 4 banks (1KB equals 1024 bytes)
RAM subsystem	–	**ThinkPad 560:** 8 to 40MB (1MB equals 1048576 bytes) **ThinkPad 560E:** 16MB (standard). Expandable up to 48MB with the 32MB DIMM. Expandable up to 80MB with the 2-bank-type 64MB DIMM.
CMOS RAM subsystem	–	128 bytes CMOS RAM with real-time clock/calendar

Figure 1-2 (Part 1 of 3). System Board Devices and Features

Device	Type	Features
Video subsystem	–	SVGA video functions: **ThinkPad 560:** • Up to 256 colors on the DSTN LCD Up to 16 777 216 colors on an external display • Up to 65 536 colors on the TFT LCD Up to 16 777 216 colors on an external display **ThinkPad 560E:** • Up to 65 536 colors on the DSTN LCD Up to 16 777 216 colors on an external display • Up to 262 144 colors on the TFT LCD Up to 16 777 216 colors on an external display See "Video Subsystem" on page 3-2 for more details of the video subsystem.
DMA controller	1	Seven DMA channels (AT compatible) Four 8-bit channels and three 16-bit channels
Interrupt controller	1	15 levels of system interrupts (interrupts are edge-triggered)
Keyboard/auxiliary device controller	1	Internal keyboard TrackPoint III Auxiliary device connector Password security
Diskette drive controller	2	Supports: • 3.5-in. diskette (1.44MB) • 3.5-in. diskette (1.2MB) (Japan Unique) • 3.5-in. diskette (720KB)
Hard disk controller	–	Supports IDE controller
Serial controller port	2	EIA-232-E interface (16550 compatible) Programmable as serial port 1, 2, 3, or 4 One 9-pin, D-sub connector
Parallel controller port	1	Programmable as parallel port 1, 2, or 3 IEEE P1284-A compatible Supports bidirectional input and output Enhanced Parallel Port (EPP) compatible Extended Capabilities Port (ECP) compatible
Expansion bus adapter	–	Supports externally attached devices: • Port replicator
PCMCIA[1] slots**	–	Conforms to the standards and specifications listed in Figure 3-1 on page 3-8. • Two Type I or II PC cards • One Type III PC card

Figure 1-2 (Part 2 of 3). System Board Devices and Features

Device	Type	Features
Audio subsystem	–	Sound Blaster**-Pro compatible
Infrared subsystem	–	Supports: **ThinkPad 560:** • IrDA 1.0 **ThinkPad 560E:** • IrDA 1.1

[1] Personal Computer Memory Card International Association

Figure 1-2 (Part 3 of 3). System Board Devices and Features

System Board I/O Address Map

Figure 1-3 shows the I/O address map.

Address (Hex)	Device
0000–001F	DMA controller (0–3)
0020, 0021	Interrupt controller (Master)
0022–003F	Reserved
0040–0043	System timer 1
0048–004B	Reserved
0060	Keyboard, auxiliary device
0061	System control port B
0064	Keyboard, auxiliary device
0070, 0071	RT/CMOS and NMI mask
0072–0077	Reserved
0078–007C	Reserved
0081–0083, 0087	DMA page registers (0–3)
0089–008B, 008F	DMA page registers (4–7)
0092	System control port A
0094	Reserved
0096	Reserved
0098	System flash ROM control register
00A0, 00A1	Interrupt controller (slave)
00C0–00DF	DMA controller (4–7)
00F0–00FF	Reserved
0102–0107	Reserved
0170–0177	Reserved
01A0–01DF	Reserved
01F0–01F7	Hard disk drive registers
0201	Reserved
0220–022F	Audio subsystem - Sound Blaster 1
0240–024F	Audio subsystem - Sound Blaster 2
026E–026F	Reserved
0278–027A	Parallel port 3
027B–027F	Reserved
02E8–02EF	Serial port 4
02F8–02FF	Serial port 2
0300–0302	Reserved
0330–0331	Reserved
0338–038B	Reserved
0376–0377	Reserved
0378–037A	Parallel port 2
037B–037F	Reserved
0388–038B	Audio subsystem - FM synthesizer
0398–0399	Reserved

Figure 1-3 (Part 1 of 2). System Board I/O Address Map

Address (Hex)	Device
03B4, 03B5, 03BA	Video subsystem
03BC–03BE	Parallel port 1
03C0–03C5	Video subsystem
03C6–03C9	Video DAC
03CA, 03CC, 03CE, 03CF	Video subsystem
03D4, 03D5, 03DA, 3D8, 3D9	Video subsystem
03E0–03E3	PCMCIA interface
03E8–03EF	Serial port 3
03F0–03F7	Diskette drive controller
03F6–03F7	Hard disk drive registers
03F8–03FF	Serial port 1
0D00, 0D01	Reserved
15E8–15EF	Reserved
2100–21FF	Reserved
23C0–23C7	Reserved
43C6, 43C7, 43C8, 43C9	Reserved
46E8	Reserved
83C6, 83C8	Reserved
CF8–CFB	PCI Configuration Address Register
CFC–CFF	PCI Configuration Data Register
F104	Reserved

Figure 1-3 (Part 2 of 2). System Board I/O Address Map

Specifications

Figure 1-4 to Figure 1-7 on page 1-10 list the specifications for the computer.

Performance Specifications

Device		Cycle Time (ns)
Microprocessor (66 MHz–15 ns clock)		
Access to RAM:[1]		
Memory read	Page hit, burst	240 ns
	Page miss, burst	360 ns
Memory write	Page miss, burst	45 ns
Access to ROM:		1000
Refresh rate (typically performed every 15.6 μs)		750 (minimum)
DMA controller (4 MHz–250 μs clock):		1250
Bus cycles (AT):		
8 bit		1000
16 bit		625

[1] The cycle times shown for access to system-board RAM are based on 70 ns EDO memory.

Device		Cycle Time (ns)
Microprocessor (60 MHz–16.5 ns clock)		
Memory read	Page hit, burst	216 ns
	Page miss, burst	350 ns
Memory write	Page miss, burst	50 ns

Figure 1-4. Performance Specifications for the ThinkPad 560/560E

Physical Specifications

Size

Width: 297 mm (11.7 in.)
Depth: 222 mm (8.7 in.)
Height: 31.0 mm (1.22 in.)

Weight[1] (approximate value)

DSTN display:
1.87 kg (4.12 lb)
TFT display:
1.86 kg (4.10 lb)

Air Temperature

System on (without diskette)
5.0°C to 35.0°C (41°F to 95°F)

System on (with diskette)
10.0°C to 35.0°C (50°F to 95°F)

System off
5.0°C to 43.0°C (41°F to 110°F)

Humidity

System (without diskette)
8% to 95%

System (with diskette)
8% to 80%

Maximum altitude[2]: 3048 m (10 000 ft) in unpressurized conditions

Heat output: 35 W (119.4 BTUs/hour) at maximum configuration

Acoustical readings (see Figure 1-7 on page 1-10)

Electrical (see Figure 1-6 on page 1-10)

Electromagnetic compatibility: FCC class B

[1] With battery pack installed.
[2] This is the maximum altitude at which the specified air temperatures apply. At higher altitudes, the maximum air temperatures are lower than those specified.

Figure 1-5. Physical Specifications for the ThinkPad 560/560E

Electrical Specifications

	(35 W)
Input Voltage[1] (V ac)	100–240
Frequency (Hz)	50/60
Input[2] (kVA)	0.132

[1] Range is automatically selected; sine wave input is required.
[2] At maximum configuration.

Figure 1-6. Electrical Specifications for the ThinkPad 560/560E

Acoustical Readings

	L_{WAd} in bels		L_{pAm} in dB		$<L_{pA}>_m$ in dB	
	Operate	**Idle**	**Operate**	**Idle**	**Operate**	**Idle**
	4.0	3.4	34	30	27	22

Notes:

L_{WAd}	Is the declared sound power level for the random sample of machines.
L_{pAm}	Is the mean value of the A-weighted sound pressure levels at the operator position (if any) for the random sample of machines.
$<L_{pA}>_m$	Is the mean value of the A-weighted sound pressure levels at the one-meter position for the random sample of machines.
Operate	Shows the value while using the hard disk drive.

All measurements made in accordance with ANSI S12.10 and reported in conformance with ISO 9296.

Figure 1-7. Acoustical Readings for the ThinkPad 560/560E

Power Supply

The power supply converts the ac voltage to dc voltage and provides power for the following:

- System board set
- Diskette drive
- Hard disk drive
- Auxiliary devices
- Keyboard
- LCD panel
- PCMCIA cards

Voltages

The power supply generates five different dc voltages: VCCCPU, VCC3A, VCC5M, VCCSW, and VCC12M. Figure 1-8 shows the maximum current for each voltage.

Output	Voltage (V dc)	Current (A)
VCCCPU	+2.9 or +2.5	2.20
VCC3A	+3.3	2.00
VCC5M	+5.0	3.00
VCCSW	+5.0	0.01
VCC12M	+12.0	0.11

Figure 1-8. Power Supply Maximum Current

Output Protection

A short circuit placed on any dc output (between outputs or between an output and a dc return) latches all dc outputs into a shutdown state, with no hazardous condition to the power supply.

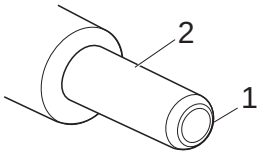
If an overvoltage fault occurs in the power supply, the power supply latches all dc outputs into a shutdown state before any output exceeds 135% of the nominal value of the power supply.

Voltage Sequencing

When power is turned on, the output voltages reach their operational voltages within 2 seconds.

Power Supply Connector

The following connector is used with the AC Adapter. The total power capacity of this connector must not exceed 4.0 A.



Refer to Figure 1-9 for the appropriate adapter pin assignments.

Pin	Voltage
1	+7.0 V dc to +16.0 V dc (depending on charging conditions)
2	Ground

Figure 1-9. Voltage Pin Assignments for 35W AC Adapter

Battery Pack

The ThinkPad computer uses a lithium-ion (Li-Ion) battery pack that meets the following electrical specifications:

Nominal Voltage	+10.8 V dc
Capacity (average)	2.2 ampere hours (AH)
Protection	Overcurrent protection Overvoltage protection Overdischarge protection Thermal protection

Figure 1-10. Battery Pack Specifications

Section 2. System Board

Description

This section describes the microprocessor, connectors, memory subsystems, and miscellaneous system functions and ports for the ThinkPad computers. You can find additional information about these topics in *IBM Personal System/2 Hardware Interface Technical Reference–AT-Bus Subsystems*.

Microprocessor

The ThinkPad 560 uses the Intel Pentium 100/120/133MHz microprocessor. This microprocessor contains a full 32-bit RISC integer core, a built-in math coprocessor, and a 16KB internal cache memory.

The ThinkPad 560E uses the Intel Pentium 150/166MHz microprocessor with the MMX technology. This microprocessor contains a full 32-bit RISC integer core, a built-in math coprocessor, and a 32KB on-chip cache memory.

Cache Memory Operation

The cache memory in the Intel Pentium microprocessor enables the microprocessor to read instructions and data much faster than if the microprocessor had to access system memory. When an instruction is first used or data is first read or written, it is transferred to the cache memory from main memory. This enables future accesses to the instructions or data to occur much faster.

The cache is disabled and empty when the microprocessor comes out of the reset state. The cache is tested and enabled during the power-on self-test (POST).

The cache memory in the Intel Pentium microprocessor is loaded from system memory in 32-byte increments, each referred to as a *cache line*. A cache line is aligned on a paragraph boundary. A reference to any byte contained in a cache line results in the entire line being read into the cache memory (if the data was not already in the cache). When the microprocessor gives up control of the system bus, the cache memory enters “snoop” mode and monitors all write and read operations. If memory data is written to a location in the cache and the cache line is in the “modified” state, the corresponding cache line is written back to system memory and is invalidated.

When the microprocessor performs a memory read, the data address is used to find the data in the cache. If the data is found (a hit), it is read from the cache memory and no external bus cycle occurs. If the data is not found (a miss), an external bus cycle is used to read the data from system memory. If the address of the missed data is in a cacheable address space, the data is stored in the cache memory and the remainder of the cache line is read.

When the microprocessor performs a memory write, the data address is used to search the cache. If the address is found (a hit), the data is written to the cache and no external bus cycle is used to write the data to system memory. (If the address of the write operation was not in the cache memory but was in cacheable address space, the data is read back into the cache memory and the remainder of the cache line is read.)

Cacheable Address Space

Cacheable address space is defined as system memory that resides on the system board (0–640KB and 1MB–40MB or 80MB[1]). Nothing in address range hex A0000–BFFFF, I/O address space, or memory in any AT slot is cached.

ROM address space (hex C0000–C7FFF) is L1 cacheable for *code read operations only*. If data in this address range is already in cache memory and the address range is written to, the cached line is invalidated and is read again from RAM (in which the BIOS is shadowed in).

[1] Cacheability of system memory is up to 64MB in the L2 cache, and is up to 4GB in the on-chip L1 cache.

Keyboard/Mouse Connector

Each ThinkPad computer has a keyboard/mouse connector where the IBM mouse, keyboard, or numeric keypad is connected.

Signals

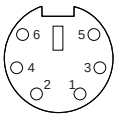
The keyboard and mouse signals are driven by open-collector drivers pulled to 5 V dc through a pull-up resistor. Figure 2-1 lists the signals.

Sink current	20 mA	Maximum
High-level output voltage	5.0 V dc minus pullup	Minimum
Low-level output voltage	0.5 V dc	Maximum
High-level input voltage	2.0 V dc	Minimum
Low-level input voltage	0.8 V dc	Maximum

Figure 2-1. Keyboard and Mouse Signals

Connector

The keyboard/mouse connector uses a 6-pin, miniature DIN connector.



Pin	I/O	Signal Name
1	I/O	Mouse Data
2	I/O	Keyboard Data
3	–	Ground
4	–	+5 V dc
5	I/O	Mouse Clock
6	I/O	Keyboard Clock

Figure 2-2. Keyboard/Mouse Connector Pin Assignments

Note: The maximum current for +5 V dc (pin 4) is 0.5 A for both the mouse and the numeric keypad.

Scan Codes

Figure 2-3 shows the key numbers assigned to keys on the 84-key keyboard (for the U.S. and Japan). Figure 2-4 on page 2-6 shows the key numbers assigned to keys on the 85-key keyboard (for countries other than the U.S. and Japan). For scan codes assigned to each numbered key, refer to the *IBM Personal System/2 Hardware Interface Technical Reference*.

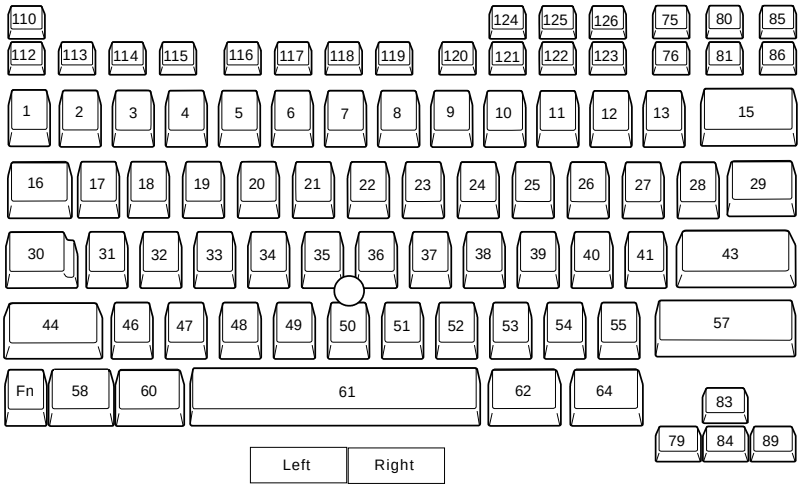


Figure 2-3. Key Numbers for the 84-Key Keyboard

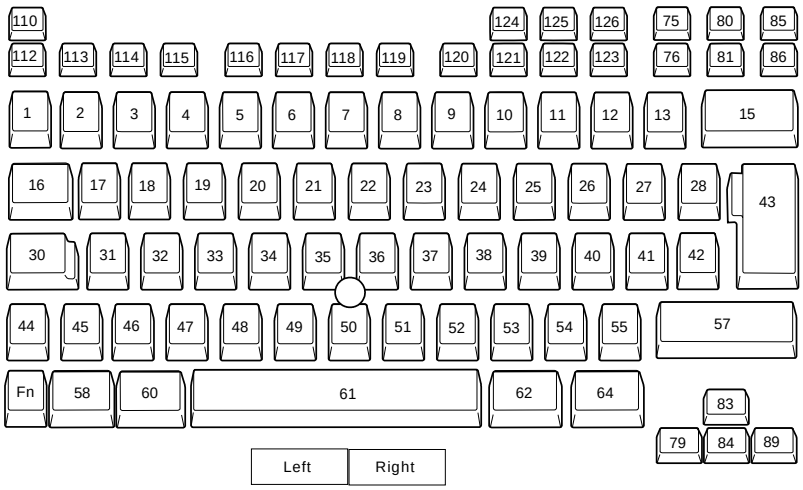


Figure 2-4. Key Numbers for the 85-Key Keyboard

Keyboard ID

The keyboard ID consists of 2 bytes: hex 83AB (the built-in keyboard with the external numeric keypad) or hex 84AB (the built-in keyboard only). Interrupt 16H, function code (AH)=0AH, returns the keyboard ID.

Figure 2-5 shows the key numbers assigned to keys on the external numeric keypad. For scan codes assigned to each numbered key, refer to the *IBM Personal System/2 Hardware Interface Technical Reference*.

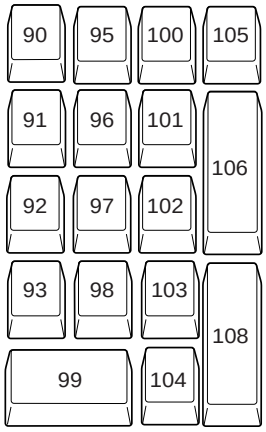


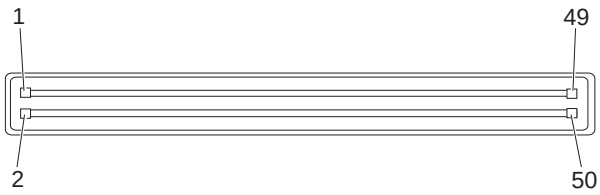
Figure 2-5. Key Numbers for the External Numeric Keypad

Displayable Characters and Symbols

For displayable characters and symbols that are keyable from the keyboard, refer to the *IBM Personal System/2 Hardware Interface Technical Reference*.

Hard Disk Drive Connector

The hard disk drive is connected to the system board. The following shows the pin assignments for the connector on the system board.

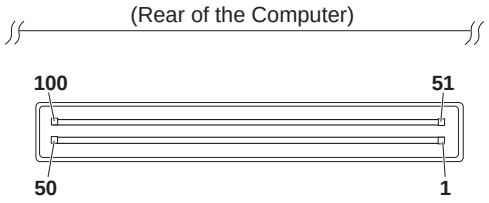


Pin	Signal	Description	Pin	Signal	Description
1	JP1	Jumper (master)	26	–	Not connected
2	JP1	Jumper (master)	27	–	Not connected
3	JP2	Jumper (slave)	28	GND	Ground
4	JP2	Jumper (slave)	29	–HIOW	I/O write
5	–	Not connected	30	GND	Ground
6	–	Not connected	31	–HIOR	I/O read
7	–HRESET	Reset	32	GND	Ground
8	GND	Ground	33	IORDY	I/O ready
9	HD07	Data 7	34	–	Not connected
10	HD08	Data 8	35	–	Not connected
11	HD06	Data 6	36	GND	Ground
12	HD09	Data 9	37	HIRQ	Interrupt Request
13	HD05	Data 5	38	–	Not connected
14	HD10	Data 10	39	HA01	Address 1
15	HD04	Data 4	40	–	Not connected
16	HD11	Data 11	41	HA00	Address 0
17	HD03	Data 3	42	HA02	Address 2
18	HD12	Data 12	43	–HCS0	Chip select 0
19	HD02	Data 2	44	–HCS1	Chip select 1
20	HD13	Data 13	45	–DASP	Drive (active/slave drive present)
21	HD01	Data 1	46	GND	Ground
22	HD14	Data 14	47	+5V	+5V dc
23	HD00	Data 0	48	+5V	+5V dc
24	HD15	Data 15	49	GND	Ground
25	GND	Ground	50	–	Not connected

Figure 2-6. Hard Disk Drive Connector Pin Assignments

External Connector

The Port Replicator is connected through the 100-pin external connector at the bottom of the computer. This connector is installed on the system board and has the following pin assignments:



Pin	Signal	Type	Pin	Signal	Type
1	GND	G	51	GND	G
2	NC	–	52	NC	–
3	AC/DC Power	W	53	AC/CD Power	W
4	AC/DC Power	W	54	AC/DC Power	W
5	AC/DC Power	W	55	AC/DC Power	W
6	AC/DC Power	W	56	AC/DC Power	W
7	NC	–	57	NC	–
8	GND	G	58	GND	G
9	NC	–	59	NC	–
10	5V	W	60	5V	W
11	NC	–	61	NC	–
12	GND	G	62	GND	G
13	GND	G	63	NC	–
14	Data Rate Select 1	F	64	–Index	F
15	–Drive Select 1	F	65	NC	–
16	Data Rate Select 0	F	66	NC	–
17	–Motor Enable 0	F	67	–Track 0	F
18	–Direction In	F	68	NC	–
19	–Step	F	69	–Write Protect	F
20	Write Data	F	70	Read Data	F
21	–Write Enable	F	71	GND	G
22	–Head 1 Select	F	72	–Diskette Change	F

Type Legend:

G: Ground
F: Diskette drive signal
S: Serial port signal
V: Video signal
W: Power line
K: Keyboard/Mouse signal
P: Parallel port signal

Figure 2-7 (Part 1 of 2). 100-Pin External Connector Pin Assignments

Pin	Signal	Type	Pin	Signal	Type
23	GND	G	73	GND	G
24	NC	–	74	SAFE5V	W
25	Mouse Data	K	75	Keyboard Data	K
26	Mouse Clock	K	76	Keyboard Clock	K
27	GND	G	77	GND	G
28	NC	–	78	NC	–
29	NC	–	79	NC	–
30	GND	G	80	GND	G
31	Ring Indicator	S	81	Data Terminal Ready	S
32	Clear to Send	S	82	Transmit Data	S
33	Request to Send	S	83	Receive Data	S
34	Data Set Ready	S	84	Data Carrier Detect	S
35	GND	G	85	GND	G
36	GND	G	86	–STROBE	P
37	–AUTO FD XT	P	87	Data Bit 0	P
38	–ERROR	P	88	Data Bit 1	P
39	–INIT	P	89	Data Bit 2	P
40	–SLCT IN	P	90	Data Bit 3	P
41	Data Bit 4	P	91	Data Bit 5	P
42	Data Bit 6	P	92	Data Bit 7	P
43	–ACK	P	93	BUSY	P
44	PE	P	94	SLCT	P
45	GND	G	95	GND	G
46	RED	V	96	–VIDEO_PDN	V
47	BLUE	V	97	GREEN	V
48	HSYNC	V	98	DDCDATA	V
49	VSYNC	V	99	DDCCLOCK	V
50	GND	G	100	GND	G

Type Legend:

G: Ground
F: Diskette drive signal
S: Serial port signal
V: Video signal
W: Powerline
K: Keyboard/Mouse signal
P: Parallel port signal

Figure 2-7 (Part 2 of 2). 100-Pin External Connector Pin Assignments

Diskette Drive and Controller

Figure 2-8 shows the read, write, and format capabilities of the diskette drive for the ThinkPad computer.

Diskette Type	Format Size		
	720KB	**1.2MB**	**1.44MB**
3.5-inch 1.0MB Diskette	RWF	–	–
3.5-inch 2.0MB Diskette	–	RWF	RWF

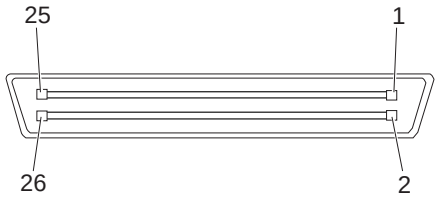
Legend:

1KB (kilobyte)	1024 bytes
1MB (megabyte)	1048576 bytes
R	Read
W	Write
F	Format

Figure 2-8. Diskette Drive Read, Write, and Format Capabilities

Diskette Drive Connector

The external diskette drive is connected through the diskette drive connector, located on the left side of the computer. Figure 2-9 shows the pin assignments of the connector:



Pin	Signal	Type
1	GND	Ground
2	DRATE1	Data Rate Select 1
3	VCC5B	+5V dc
4	–	Reserved
5	GND	Ground
6	–	Reserved
7	GND	Ground
8	–INDEX	Index
9	–	Reserved
10	–	Reserved
11	–DRVSEL0	Drive Select 0
12	DRATE0	Data Rate Select 0
13	–MOTEN0	Motor Enable 0
14	–	Reserved
15	–FDIR	Direction In
16	–FSTEP	Step
17	WRDATA	Write Data
18	–FWREN	Write Enable
19	GND	Ground
20	–TRAK0	Track 0
21	–	Reserved
22	–FWPROTECT	Write Protect
23	RDDATA	Read Data
24	–FSIDE1SEL	Side 1 Select
25	–	Reserved
26	–DISKCHG	Disk Change

Figure 2-9. Diskette Drive Connector Pin Assignments

Memory

The ThinkPad computers use the following types of memory:

- Read-only memory (ROM)
- Random access memory (RAM)
- Real-time clock/complementary metal-oxide semiconductor RAM (RT/CMOS RAM)

ROM Subsystem

The ROM subsystem consists of four banks of 128KB memory. ROM is active when power is turned on and is assigned to the top of the first and last 1MB of address space (hex 000F0000–000FFFFF and hex FFFF0000–FFFFFFFF). After POST checks that system memory is operating correctly, the ROM code is copied to RAM at the same address space, and ROM is disabled.

RAM Subsystem

The RAM subsystem on the system board starts at address hex 00000000 of the address space. The RAM subsystem for the ThinkPad 560 is 64 bits wide.

The 8MB (ThinkPad 560) or 16MB (ThinkPad 560E) base memory is on the system board. One 144-pin 8-byte dual inline memory module (DIMM) connector is provided on the system board. This connector accepts a 8MB, 16MB, 32MB, or 64MB[1] DIMM. The memory capacity can be increased up to 40MB (ThinkPad 560) or 80MB (ThinkPad 560E) when a DIMM is used (see “System Board Memory Connector for DIMM” on page 2-14).

The total amount of usable memory is less than the amount of memory installed because of ROM-to-RAM remapping and power management.

[1] A 64MB DIMM is supported by ThinkPad 560E only.

System Memory Map

Memory is mapped by the memory controller registers.

Figure 2-10 shows the memory map for a correctly functioning system. Memory can be mapped differently if POST detects an error in system board memory or RT/CMOS RAM. In the figure, the variable *x* represents the number of 1MB blocks of system board memory starting at or above the hex 100000 boundary.

Hex Address Range	Function
00000000 to 0009FFFF	640KB system board RAM
000A0000 to 000BFFFF	Video RAM
000C0000 to 000C7FFF	System board video BIOS ROM mapped to RAM
000C8000 to 000EFFFF	Channel ROM
000F0000 to 000FFFFF	64KB system board ROM mapped to RAM
00100000 to (00100000 + *x*MB)	*x*MB system board RAM
FFFF0000 to FFFFFFFF	64KB system board ROM (same as 000F0000 to 000FFFFF)

Figure 2-10. System Memory Map

System Board Memory Connector for DIMM

The system board of ThinkPad 560 has one DIMM connector that directly accepts one 144-pin DIMM of one of the following three different capacities: 8MB, 16MB, or 32MB.

The system board of ThinkPad 560E has one DIMM connector that directly accepts one 144-pin DIMM of one of the following four different capacities: 8MB, 16MB, 32MB, or 64MB (2-bank type).

Figure 2-11 on page 2-15 shows the pin assignments for the DIMM connector.

Pin	Signal	Pin	Signal	Pin	Signal
1	Ground	49	MD42	97	MD25
2	Ground	50	MD21	98	MD38
3	MD15	51	MD41	99	MD24
4	MD48	52	MD22	100	MD39
5	MD14	53	MD40	101	+3.3V dc
6	MD49	54	MD23	102	+3.3V dc
7	MD13	55	Ground	103	MA6
8	MD50	56	Ground	104	MA7
9	MD12	57	Ground	105	MA8
10	MD51	58	Ground	106	MA11
11	+3.3V dc	59	Ground	107	Ground
12	+3.3V dc	60	Ground	108	Ground
13	MD11	61	not connected	109	MA9
14	MD52	62	Not connected	110	Ground
15	MD10	63	+3.3V dc	111	MA10
16	MD53	64	+3.3V dc	112	Ground
17	MD9	65	Not connected	113	+3.3V dc
18	MD54	66	Not connected	114	+3.3V dc
19	MD8	67	–WE	115	–CAS3
20	MD55	68	Not connected	116	–CAS4
21	Ground	69	–RAS2	117	–CAS7
22	Ground	70	Not connected	118	–CAS0
23	–CAS1	71	–RAS3	119	Ground
24	–CAS6	72	Not connected	120	Ground
25	–CAS5	73	Ground	121	MD56
26	–CAS2	74	Not connected	122	MD7
27	+3.3V dc	75	Ground	123	MD57
28	+3.3V dc	76	Ground	124	MD6
29	MA0	77	Ground	125	MD58
30	MA3	78	Ground	126	MD5
31	MA1	79	Ground	127	MD59
32	MA4	80	Ground	128	MD4
33	MA2	81	+3.3V dc	129	+3.3V dc
34	MA5	82	+3.3V dc	130	+3.3V dc
35	Ground	83	MD31	131	MD60
36	Ground	84	MD32	132	MD3
37	MD47	85	MD30	133	MD61
38	MD16	86	MD33	134	MD2
39	MD46	87	MD29	135	MD62
40	MD17	88	MD34	136	MD1
41	MD45	89	MD28	137	MD63
42	MD18	90	MD35	138	MD0
43	MD44	91	Ground	139	Ground
44	MD19	92	Ground	140	Ground
45	+3.3V dc	93	MD27	141	I²C Data
46	+3.3V dc	94	MD36	142	I²C Clock
47	MD43	95	MD26	143	+3.3V dc
48	MD20	96	MD37	144	+3.3V dc

Figure 2-11. DIMM Connector Pin Assignments

RT/CMOS RAM

The RT/CMOS RAM (real-time clock/complementary metal-oxide semiconductor RAM) module contains the real-time clock and 128 bytes of CMOS RAM. The clock circuitry uses 14 bytes of this memory; the remainder is allocated to configuration and system-status information. A battery is built into the module to keep the RT/CMOS RAM active when the power supply is not turned on.

Figure 2-12 lists the RT/CMOS RAM bytes and their addresses.

Address (Hex)	RT/CMOS RAM Bytes
000–00D	Real-time clock
00E	Diagnostic status
00F	Shutdown status
010	Diskette drive type
011	Hard disk 2 and 3 drive type
012	Hard disk 0 and 1 drive type
013	Reserved
014	Equipment
015, 016	Low and high base memory
017, 018	Low and high expansion memory
019	Hard disk 0 extended byte
01A	Hard disk 1 extended byte
01B	Hard disk 2 extended byte
01C	Hard disk 3 extended byte
01D–02D	Reserved
02E, 02F	Checksum
030, 031	Low and high usable memory above 1MB
032	Date-century
033–07F	Reserved

Figure 2-12. RT/CMOS RAM Address Map

RT/CMOS Address and NMI Mask Register (Hex 0070)

The NMI mask register is used with the RT/CMOS data register (hex 0071) to read from and write to the RT/CMOS RAM bytes.

Attention

The operation following a write to hex 0070 should access hex 0071; otherwise, intermittent failures of the RT/CMOS RAM can occur.

Bit	Function
7	NMI mask
6–0	RT/CMOS RAM address

Figure 2-13. RT/CMOS Address and NMI Mask Register (Hex 0070)

Bit 7 When this write-only bit is set to 1, the NMI is masked (disabled). This bit is set to 1 by a power-on reset.

Bits 6–0 These bits are used to select RT/CMOS RAM addresses.

RT/CMOS Data Register (Hex 0071)

The RT/CMOS data register is used with the RT/CMOS address and NMI mask register (hex 0070) to read from and write to the RT/CMOS RAM bytes.

Bit	Function
7–0	RT/CMOS data

Figure 2-14. RT/CMOS Data Register (Hex 0071)

RT/CMOS RAM I/O Operations

During I/O operations to the RT/CMOS RAM addresses, you should mask interrupts to prevent other interrupt routines from changing the RT/CMOS address register before data is read or written. After I/O operations, you should leave the RT/CMOS address and NMI mask register (hex 0070) pointing to status register D (hex 00D).

Attention

The operation following a write to hex 0070 should access hex 0071; otherwise, intermittent failures of the RT/CMOS RAM can occur.

Writing to the RT/CMOS RAM requires the following:

1. Write the RT/CMOS RAM address to the RT/CMOS address and NMI mask register (hex 0070).
2. Write the data to the RT/CMOS data register (hex 0071).
3. Write the address, hex 0F, to the RT/CMOS and NMI mask register; this leaves hex 0070 pointing to the shutdown status byte (hex 0F).
4. Read address hex 0071 to restore the RT/CMOS.

Reading from the RT/CMOS RAM requires the following steps:

1. Write the RT/CMOS RAM address to the RT/CMOS and NMI mask register (hex 0070).
2. Read the data from the RT/CMOS data register (hex 0071).
3. Write the address, hex 0F, to the RT/CMOS and NMI mask register; this leaves hex 0070 pointing to the shutdown status byte (hex 0F).
4. Read address hex 0071 to restore the RT/CMOS.

Real-Time Clock Bytes (Hex 000–00D): Bit definitions and addresses for the real-time clock bytes are shown in Figure 2-15.

Address (Hex)	Function	Byte Number
000	Seconds	0
001	Second alarm	1
002	Minutes	2
003	Minute alarm	3
004	Hours	4
005	Hour alarm	5
006	Day of week	6
007	Date of month	7
008	Month	8
009	Year	9
00A	Status register A	10
00B	Status register B	11
00C	Status register C	12
00D	Status register D	13

Figure 2-15. Real-Time Clock Bytes (Hex 000–00D)

Note: The Setup program initializes status registers A and B when the time and date are set. Interrupt 1AH is the BIOS interface to read and set the time and date; it initializes the registers in the same way that the Setup program does.

Status Register A (Hex 00A)

Bit	Function
7	Update in progress
6–4	22-stage divider
3–0	Rate-selection bits

Figure 2-16. Status Register A (Hex 00A)

Bit 7 When set to 1, this bit indicates that the time-update cycle is in progress. When set to 0, it indicates that the current date and time can be read.

Bits 6–4 These bits identify which time-base frequency is being used. The system initializes these bits to binary 010, which selects a 32.768-kHz time base. This is the only value supported by the system for proper timekeeping.

Bits 3–0 These bits allow the selection of a divider output frequency. The system initializes the rate-selection bits to a binary 0110, which selects a 1.024-kHz

square-wave output frequency and a
976.562-microsecond periodic interrupt rate.

Status Register B (Hex 00B)

Bit	Function
7	Set
6	Enable periodic interrupt
5	Enable alarm interrupt
4	Enable update-ended interrupt
3	Enable square wave
2	Date mode
1	24-hour mode
0	Enable daylight-saving time

Figure 2-17. Status Register B (Hex 00B)

Bit 7 When set to 0, this bit updates the cycle, normally by advancing the count at a rate of one cycle per second. When set to 1, it immediately ends any update cycle in progress, and the program can initialize the 14 time bytes without any further updates occurring until this bit is set to 0.

Bit 6 This is a read/write bit that allows an interrupt to occur at a rate specified by the rate and divider bits in status register A. When set to 1, this bit enables the interrupt. The system initializes this bit to 0.

Bit 5 When set to 1, this bit enables the alarm interrupt. The system initializes this bit to 0.

Bit 4 When set to 1, this bit enables the update-ended interrupt. The system initializes this bit to 0.

Bit 3 When set to 1, this bit enables the square-wave frequency as set by the rate-selection bits in status register A. The system initializes this bit to 0.

Bit 2 This bit indicates whether the binary-coded-decimal (BCD) or binary format is used for time-and-date calendar updates. When set to 1, this bit indicates the binary format. The system initializes this bit to 0.

Bit 1 This bit indicates whether the hours byte is in 12-hour or 24-hour mode. When set to 1, this bit indicates the 24-hour mode. The system initializes this bit to 1.

Bit 0 When set to 1, this bit enables the daylight-saving-time mode. When set to 0, this bit disables the daylight-saving-time mode, and the clock reverts to standard time. The system initializes this bit to 0.

Status Register C (Hex 00C)

Bit	Function
7	Interrupt request flag
6	Periodic interrupt flag
5	Alarm interrupt flag
4	Update-ended interrupt flag
3–0	Reserved

Figure 2-18. Status Register C (Hex 00C)

Note: Interrupts are enabled by bits 6, 5, and 4 in status register B.

Bit 7 When set to 1, this bit indicates that an interrupt has occurred; bits 6, 5, and 4 indicate the type of interrupt.

Bit 6 When set to 1, this bit indicates that a periodic interrupt has occurred.

Bit 5 When set to 1, this bit indicates that an alarm interrupt has occurred.

Bit 4 When set to 1, this bit indicates that an update-ended interrupt has occurred.

Bits 3–0 These bits are reserved.

Status Register D (Hex 00D)

Bit	Function
7	Valid RAM
6–0	Reserved

Figure 2-19. Status Register D (Hex 00D)

Bit 7 This read-only bit monitors the internal battery. When set to 1, this bit indicates that the real-time clock has power. When set to 0, it indicates that the real-time clock has lost power and the data in CMOS is no longer valid.

Bits 6–0 These bits are reserved.

CMOS RAM Configuration

Figure 2-20 shows the bit definitions for the CMOS RAM configuration bytes.

Diagnostic Status Byte (Hex 00E)

Bit	Function
7	Real-time clock power
6	Configuration record and checksum status
5	Incorrect configuration
4	Memory size mismatch
3	Hard disk controller/drive C initialization status
2	Time status indicator
1, 0	Reserved

Figure 2-20. Diagnostic Status Byte (Hex 00E)

Bit 7 When set to 1, this bit indicates that the real-time clock has lost power.

Bit 6 When set to 1, this bit indicates that the checksum is incorrect.

Bit 5 This bit indicates the results of a power-on check of the equipment byte (hex 014). When set to 1, this bit indicates that the configuration information is incorrect.

Bit 4 When set to 1, this bit indicates that the memory size does not match the configuration information.

Bit 3 When set to 1, this bit indicates that the controller or hard disk drive failed initialization.

Bit 2 When set to 1, this bit indicates that the time is invalid.

Bits 1, 0 These bits are reserved.

Shutdown Status Byte (Hex 00F): This byte is defined by the power-on diagnostic programs.

Diskette Drive Type Byte (Hex 010): This byte indicates the type of the installed diskette drive.

Bit	Drive Type
7–4	Diskette drive type
3–0	Reserved

Figure 2-21. Diskette Drive Type Byte (Hex 010)

Bits 7–4 These bits indicate the diskette drive type.

Bits 7–4	Description
0 1 1 0	Diskette drive (2.88MB)
0 1 0 0	Diskette drive (1.44MB)
Note: Combinations not shown are reserved.	

Figure 2-22. Diskette Drive Type Bits 7–4

Bits 3–0 These bits are reserved.

Hard Disk Drive Type Byte (Hex 011): This byte defines the type of hard disk drive installed. Hex 00 indicates that no hard disk drive is installed.

Bit	Drive Type
7–4	Hard disk drive type 2
3–0	Hard disk drive type 3

Figure 2-23. Hard Disk Type Byte (Hex 011)

Bit 7–4	Description
0 0 0 0	No drive installed for hard disk drive 2
1 1 1 1	Use CMOS 1BH for hard disk drive 2

Figure 2-24. Hard Disk Drive Type 2 (Bits 7–4)

Bit 3–0	Description
0 0 0 0	No drive installed for hard disk drive 3
1 1 1 1	Use CMOS 1CH for hard disk drive 3

Figure 2-25. Hard Disk Drive Type 3 (Bits 3–0)

Hard Disk Drive Type Byte (Hex 012): This byte defines the type of hard disk drive installed. Hex 00 indicates that no hard disk drive is installed.

Bit	Drive Type
7–4	Hard disk drive 0
3–0	Hard disk drive 1

Figure 2-26. Hard Disk Drive Type Byte

Reserved Bytes (Hex 013): These bytes are reserved.

Equipment Byte (Hex 014): This byte defines the basic equipment in the system for the power-on diagnostic tests.

Bit	Description
7, 6	Number of diskette drives
5, 4	Display operating mode
3, 2	Reserved
1	Coprocessor presence
0	Diskette drive 0 presence

Figure 2-27. Equipment Byte

Bits 7, 6 These bits indicate the number of installed diskette drives.

Bits 7,6	Number of Diskette Drives
0 0	One drive
0 1	Reserved
1 0	Reserved
1 1	Reserved

Figure 2-28. Installed Diskette Drive Bits

Bits 5, 4 These bits indicate the operating mode of the display attached to the video port.

Bits 5,4	Display Operating Mode
0 0	Reserved
0 1	40-column mode
1 0	80-column mode
1 1	Monochrome mode

Figure 2-29. Display Operating Mode Bits

Bits 3–2 These bits are reserved.

Bit 1 When set to 1, this bit indicates that a coprocessor is installed.

Bit 0 When set to 1, this bit indicates that physical diskette drive 0 is installed.

Low and High Base Memory Bytes (Hex 015 and Hex 016): The low and high base memory bytes define the amount of memory below the 640KB address space.

The value in these bytes represents the number of 1KB blocks of base memory. For example, hex 0280 indicates 640KB. The low byte is hex 015; the high byte is hex 016.

Low and High Expansion Memory Bytes (Hex 017 and Hex 018): The low and high expansion memory bytes define the amount of memory above the 1MB address space.

The value in these bytes represents the number of 1KB blocks of expansion memory. For example, hex 0800 indicates 2048KB. The low byte is hex 017; the high byte is hex 018.

Reserved Bytes (Hex 01D–02D): These bytes are reserved.

Configuration Checksum Bytes (Hex 02E and Hex 02F): The configuration checksum bytes contain the checksum character for bytes hex 010 through hex 02D of the 64-byte CMOS RAM. The high byte is hex 02E; the low byte is hex 02F.

Low and High Usable Memory Bytes (Hex 030 and Hex 031): The low and high usable memory bytes define the total amount of contiguous memory from 1MB to 20MB.

The hexadecimal values in these bytes represent the number of 1KB blocks of usable memory. For example, hex 0800 is equal to 2048KB. The low byte is hex 30; the high byte is hex 31.

Date-Century Byte (Hex 032): Bits 7 through 0 of the date-century byte contain the binary-coded decimal value for the century. For information about reading and setting this byte, refer to the *IBM Personal System/2 and Personal Computer BIOS Interface*.

Reserved Bytes (Hex 033–07F): These bytes are reserved.

Miscellaneous System Functions and Ports

This section provides information about nonmaskable interrupts (NMIs), the power-on password, and hardware compatibility.

Nonmaskable Interrupt (NMI)

The NMI signals the system microprocessor that a parity error or a channel check timeout has occurred. This situation can cause lost data or an overrun error on some I/O devices. The NMI masks all other interrupts. The interrupt return (IRET) instruction restores the interrupt flag to the state it was in before the interrupt occurred. A system reset causes a reset of the NMI.

The NMI requests from system board parity and channel check are subject to mask control with the NMI mask bit in the RT/CMOS Address register. See “RT/CMOS Address and NMI Mask Register (Hex 0070)” on page 2-17. The power-on default of the NMI mask is 1 (NMI disabled). Before the NMI is enabled after a power-on reset, the parity-check states are initialized by POST.

Attention

The operation following a write to hex 0070 should access hex 0071; otherwise, intermittent failures of the RT/CMOS RAM can occur.

System Control Port B (Hex 0061)

Bit definitions for the write and read functions of this port are shown in the following figures:

Bit	Function
7–4	Reserved
3	Reserved (should be 0)
2	Enable parity check
1	Enable speaker data
0	Timer 2 gate to speaker

Figure 2-30. System Control Port B (Hex 0061, Write)

Bit	Function
7	Parity check
6	Channel check
5	Timer 2 output
4	Toggles with each refresh request
3	Reserved
2	Enable parity check
1	Enable speaker data
0	Timer 2 gate to speaker

Figure 2-31. System Control Port B (Hex 0061, Read)

Bit 7 When set to 1, this bit indicates that the PCI System Error (SERR#) was pulsed active.

Bit 6 When set to 1, this bit indicates a channel check has occurred.

Bit 5 When read, this bit indicates the condition of the timer/counter 2 'output' signal.

Bit 4 When read, this bit toggles for each refresh request.

Bit 3 Reserved.

Bit 2 When set to 0, this bit enables the PCI System Error (SERR#). This bit is set to 1 during a power-on reset.

Bit 1 When set to 1, this bit enables the speaker data.

Bit 0 When set to 1, this bit enables the timer 2 gate.

System Control Port A (Hex 0092)

Bit	Function
7–3	Reserved
2	Reserved (must be set to 0)
1	Alternate gate A20
0	Alternate hot reset

Figure 2-32. System Control Port A (Hex 0092)

Bits 7–3 These bits are reserved.

Bit 2 This bit is reserved.

Bit 1 This bit is used to enable the 'address 20' signal (A20) when the microprocessor is in the real address mode. When this bit is set to 0, A20 cannot be used in real mode addressing. This bit is set to 0 during a system reset.

Bit 0 This bit provides an alternative method of resetting the system microprocessor. This alternative method supports operating systems requiring faster operation than that provided on the IBM Personal Computer AT. Resetting the system microprocessor switches the microprocessor from protected mode to real address mode.

This bit is set to 0 by either a system reset or a write operation. When a write operation changes this bit from 0 to 1, the 'processor reset' signal is pulsed after the reset has occurred. While the reset is occurring, the latch remains set so that POST can read this bit. If the bit is set to 0, POST assumes that the system was just powered on. If the bit is set to 1, POST assumes that the microprocessor has been switched from protected mode to real mode.

When bit 0 is used to reset the system microprocessor to the real mode, use the following procedure:

1. Disable all maskable and nonmaskable interrupts.
2. Reset the system microprocessor by writing a 1 to bit 0.
3. Issue a Halt instruction to the system microprocessor.
4. Reenable all maskable and nonmaskable interrupts.

If you do not follow this procedure, the results are unpredictable.

Note: Whenever possible, use BIOS as an interface to reset the system microprocessor to the real mode. For more information about resetting the system microprocessor, refer to the *IBM Personal System/2 and Personal Computer BIOS Interface*.

Power-On Password

RT/CMOS RAM has 8 bytes reserved for the power-on password and the check character. The 8 bytes are initialized to hex 00. The microprocessor can access these bytes only during POST. After POST is completed, if a power-on password is installed, the password bytes are locked and cannot be accessed by any program.

During power-on password installation, the password (1 to 7 characters) is stored in the security space.

Installing the password is a function of the built-in system program *Easy-Setup*. The power-on password does not appear on the screen when it is installed, changed, or removed. After the power-on password has been installed, it can be changed or removed only during POST.

The computer also can have a keyboard password. For more information, see the keyboard and auxiliary device controller section of the *IBM Personal System/2 Hardware Interface Technical Reference*.

Selectable Drive-Startup Sequence

Selectable drive-startup (selectable boot) allows you to control the startup sequence of the drives in your computer. The order in which the computer looks for the drives for your operating system is the *drive-startup sequence*. If you are working with multiple operating systems, you might want to change the drive-startup sequence to load the operating system from the hard disk without first checking the diskette drive, or to do a remote program load (RPL).

Attention

When changing your startup sequence, you must be extremely careful when doing write operations (such as copying, saving, or formatting). Your data or programs can be overwritten if you select the wrong drive.

For more information about the selectable drive-startup sequence, refer to the *ThinkPad User's Guide*.

Hardware Compatibility

The computer supports most of the interfaces used by the IBM Personal Computer AT* and the Personal System/2* (PS/2*) products. In many cases, command and status organization of these interfaces are maintained.

The functional interfaces for the computer are compatible with the following:

- The Intel 8259 interrupt controllers (edge trigger mode).
- The Intel 8254 timers driven from 1.193 MHz (channels 0, 1, and 2).
- The Intel 8237 DMA controller-address/transfer counters, page registers, and status fields only. The command and request registers, and the rotate and mask functions, are not supported. The mode register is partially supported.
- The NS16550 serial communications controller.
- The Intel Pentium microprocessor (ThinkPad 560) *or* the Intel Pentium processor with the MMX technology (ThinkPad 560E).
- The Intel 8086**, 8088**, 80286**, 80386**, and i486DX microprocessors.
- The Intel 8087**, 80287**, 80387** math coprocessors.
- The Intel 82077AA** diskette drive controller.
- The keyboard interface at addresses hex 0060 and hex 0064.
- Display modes supported by the IBM Monochrome Display and Printer Adapter, the IBM Color/Graphics Monitor Adapter, and the IBM Enhanced Graphics Adapter.

- The parallel printer ports (Parallel 1, Parallel 2, and Parallel 3) in compatibility mode.

Error Codes

POST returns a three or more character code message to indicate the type of test that failed. Figure 2-33 lists the failure indicated with the associated error code.

Error Code	Description
101	Interrupt failure.
102	Timer failure.
103	Timer interrupt failure.
104	Protected mode failure.
105	Last 8042 command not accepted.
107	NMI test failure.
108	Timer bus test failure.
109	Low meg-chip select test.
110	Planar parity.
111	I/O parity.
118	Planar parity error logged.
158	A supervisor password is set, but no hard disk password is set.
159	The hard disk password is not identical to the supervisor password.
161	Dead battery.
163	Date and time are not set; clock not updated.
173	CMOS CRC error.
174	Configuration error.
175	Bad EEPROM CRC 1.
177	Bad supervisor password checksum.
178	EEPROM is not functional.
179	NVRAM error log full.
183	Supervisor password is needed.
184	Bad power-on password checksum.
185	Corrupted startup boot sequence.
186	Inconsistency between EEPROM and security lock latch 2.
188	Bad EEPROM CRC 2.
189	Too many passwords attempted.
190	Critically low battery condition detected.
191XX	PM initialization error.
195	Configuration mismatch error found during hibernation wake-up.
196	Critical error found during hibernation wake-up.
201	Memory data error.
202	Memory line error 00 through 15.
203	Memory line error 16 through 23.
215	Memory test failure on on-board memory.
221	ROM to RAM remap error.
301	Keyboard error.

Figure 2-33 (Part 1 of 2). Error Codes

Error Code	Description
601	Diskette drive or controller error.
602	No valid boot record on diskette.
604	Invalid diskette drive error.
1101	Serial-A test failure.
1201	Serial-B test failure.
1701	Hard disk controller failure.
1780, 1790	Hard disk 0 error.
1781, 1791	Hard disk 1 error.
2401	System board video error.
8081	PCMCIA presence test failure (PCMCIA revision number also checked).
8082	PCMCIA register test failure.
8601	System bus error (8042 mouse interface).
8602	External mouse error.
8603	System bus error or mouse error.
8611	System bus error (I/F between 8042 and IPDC).
8612	TrackPoint III error.
8613	System board or TrackPoint III error.
I9990301	Hard disk error.
I9990302	Invalid hard disk boot record.
I9990303	Bank-2 flash ROM checksum error.
I9990305	No bootable device.

Figure 2-33 (Part 2 of 2). Error Codes

Section 3. Subsystems

This section describes the video, DSP, IR, and PCMCIA subsystems of the ThinkPad computers. If also provides the Programmable Option Select (POS) information for the video, DSP, and IR subsystems.

Video Subsystem

The video subsystem consists of the SVGA video controller and video random-access memory. The video subsystem supports TFT and DSTN displays.

The video subsystem also supports PS/2 analog displays without any additional adapters.

Note: Use of any video subsystem features not documented in this book can result in future incompatibility.

ThinkPad 560

- Displaying output on the LCD or both on the LCD and monitor:

Resolution	Supported Color Depth	
	TFT models	**DSTN models**
640×480	256 and 65 536	256
800×600	256 and 65 536	256
1024×768 (virtual screen)	256 and 65 536	256

- Displaying output on the monitor:

Resolution	Frame Rate	Supported Color Depth	
		TFT models	**DSTN models**
	60Hz		
	72Hz	256, 65 536, and 16 777 216	256, 65 536, and 16 777 216
	75Hz		
640x480	85Hz		
	60Hz		
	75Hz	256 and 65 536	256 and 65 536
800x600	85Hz		
	60Hz		
	75Hz		
	85Hz		
1024x768	43.5Hz (interlace)	256	256

ThinkPad 560E

- Displaying output on the LCD or both on the LCD and monitor:

Resolution	Supported Color Depth
640×480	256, 65 536, and 16 777 216
800×600	
1024×768 (virtual screen)	256 and 65 536

- Displaying output on the monitor:

Resolution	Refresh Rate	Supported Color Depth
640×480	60Hz	256, 65 536, and 16 777 216
	72Hz	
	75Hz	
	85Hz	
800×600	60Hz	
	75Hz	
	85Hz	256 and 65 536
1024×768	60Hz	
	75Hz	
	43.5Hz (interlace)	
1280×1024	60Hz	256
	43.5Hz (interlace)	

Video Modes

The video subsystem supports the modes listed in Table 3-1 on page 3-4. VESA105 and VESA112 modes are supported only for the external PS/2 display.

Table 3-1 (Page 1 of 2). BIOS Video Modes for the ThinkPad Computer

Mode (Hex)	Type	Colors	Alpha-numeric Format	Buffer Start Address	Box Size	Maxi-mum Pages	Pels	Expanded Size (to 800×600)
0, 1	A/N	16	40×25	B8000	8×8	8	320×200	800×600
0*, 1*	A/N	16	40×25	B8000	8×14	8	320×350	800×525
0#, 1#	A/N	16	40×25	B8000	8×16	8	320×400	800×600
2, 3	A/N	16	80×25	B8000	8×8	8	640×200	800×600
2*, 3*	A/N	16	80×25	B8000	8×14	8	640×350	800×525
2#, 3#	A/N	16	80×25	B8000	8×16	8	640×400	800×600
4, 5	APA	4	40×25	B8000	8×8	1	320×200	800×600
6	APA	2	80×25	B8000	8×8	1	640×200	800×600
7*	A/N	–	80×25	B0000	8×14	8	640×350	800×525
7#	A/N	–	80×25	B0000	8×16	8	640×400	800×600
D	APA	16	40×25	A0000	8×8	8	320×200	800×600
E	APA	16	80×25	A0000	8×8	4	640×200	800×600
F	APA	–	80×25	A0000	8×14	2	640×350	800×525
10	APA	16	80×25	A0000	8×14	2	640×350	800×525
11	APA	2	80×30	A0000	8×16	1	640×480	800×600
12	APA	16	80×30	A0000	8×16	1	640×480	800×600
13	APA	256	40×25	A0000	8×8	1	320×200	800×600
VESA101	APA	256	–	A0000	–	1	640×480	800×600

Table 3-1 (Page 2 of 2). BIOS Video Modes for the ThinkPad Computer

Mode (Hex)	Type	Colors	Alpha-numeric Format	Buffer Start Address	Box Size	Maxi-mum Pages	Pels	Expanded Size (to 800×600)
VESA103	APA	256	–	A0000	–	1	800×600	–
VESA105	APA	256	–	A0000	–	1	1024×768	–
VESA107	APA	256	–	A0000	–	1	1280×1024	–
VESA110	APA	32768	–	A0000	–	1	640×480	–
VESA111	APA	65536	–	A0000	–	1	640×480	–
VESA112	APA	16 777 216	–	A0000	–	1	640×480	–
VESA114	APA	65536	–	A0000	–	1	800×600	–
VESA115	APA	16 777 216	–	A0000	–	1	800×600	–
VESA117	APA	65536	–	A0000	–	1	1024×768	–

Note:

- A border screen is not supported on the LCD.
- Modes VESA107, VESA115, and VESA117 are supported by ThinkPad 560E only.

Audio Subsystem

Sound Blaster Support Function

The Sound Blaster support function provides three system settings: I/O address, IRQ level, and DMA channel.

I/O Address	IRQ Level	DMA Channel
0220–022F (Default)	IRQ 5 (Default)	DMA 0
0240–024F	IRQ 7	DMA 1 (Default)
0338–033F (FM synthesizer)	IRQ 10	–
	IRQ 11	–

Audio Port Specifications

- Audio Output:
  - ⅛-inch mini-jack for headphone
  - Headphone speaker output: 22 mW (32 ohm) maximum
  - Maximum output level: 2.4 V pp
  - Output impedance: 75 ohm
- Audio Input:
  - ⅛-inch mini-jack for microphone or line input
  - Microphone gain: 26 dB minimum, 48.5 dB maximum
  - Maximum input level:
    Microphone: 125 mV pp
    Line In: 4.0 V pp
  - Input impedance:
    Microphone: 47 k ohm
    Line In: 30 k ohm

Infrared (IR) Subsystem

The IR subsystem of ThinkPad 560 is designed to be compatible with the IrDA** Serial Infrared Physical Layer Link Specification Version 1.0 and Data Link Specification Version 1.0.

The IR subsystem of ThinkPad 560E is designed to be compatible with the IrDA** Serial Infrared Physical Layer Link Specification Version 1.0 or 1.1 and Data Link Specification Version 1.0.

System Settings

The I/O address can be selected from the following with the system utility program. The IR subsystem uses one serial port address.

I/O Address	
03F8–03FF	Serial port 1 (Default)
02F8–02FF	Serial port 2
03E8–03EF	Serial port 3
02E8–02EF	Serial port 4

PCMCIA Subsystem

The system board has two 68-pin PCMCIA (Personal Computer Memory Card International Association) slots that support three different types of PC cards: Type I, Type II, and Type III PC cards. The Type I and Type II PC cards can be installed into either the upper or the lower slot, or into both slots at the same time. The Type III PC card, however, must be installed only in the lower slot. The Type II PC card cannot be used in the upper slot when a Type III PC card is used.

The PCMCIA slots are designed according to the following PCMCIA standards and specifications:

Standards and Specifications	Characteristics
PCMCIA Card Standard	Release 2.0 or 2.1
PCMCIA Socket Services Interface Specifications	Release 2.0 or 2.1
PCMCIA Card Services Interface Specifications	Release 2.0 or 2.1
PC Card Physical Configuration	Type II and Type III
Supported voltage	5.0 V dc only

Figure 3-1. PCMCIA Standards and Specifications

Pin Assignments

Figure 3-2 shows the pin assignments for the PCMCIA slots.

Pin	Signal	Pin	Signal
1	Ground	35	Ground
2	D3	36	–CD1
3	D4	37	D11
4	D5	38	D12
5	D6	39	D13
6	D7	40	D14
7	–CE1	41	D15
8	A10	42	–CE2
9	–OE	43	RFSH
10	A11	44	RFU (–IOR)
11	A9	45	RFU (–IOW)
12	A8	46	A17
13	A13	47	A18
14	A14	48	A19
15	–WE/–PGM	49	A20
16	RDY/–BSY (IREQ)	50	A21
17	+5 V dc	51	+5 V dc
18	V pp1	52	V pp2
19	A16	53	A22
20	A15	54	A23
21	A12	55	A24
22	A7	56	A25
23	A6	57	RFU
24	A5	58	RESET
25	A4	59	–WAIT
26	A3	60	RFU (–INPACK)
27	A2	61	–REG
28	A1	62	BVD2 (–SPKR)
29	A0	63	BVD1 (–STSCHG)
30	D0	64	D8
31	D1	65	D9
32	D2	66	D10
33	WP (–IOIS16)	67	–CD2
34	Ground	68	Ground

Figure 3-2. PCMCIA PC Card Slot Pin Assignments

The maximum current for +5 V dc (±5%) is 0.5 A for each slot, total of 1.0 A for both slots.

The maximum current for +12 V dc is 0.1 A (including both slots and V pp). When the computer is in suspend mode, it requires a current of 0.05 A.

Appendix A. System Management API (SMAPI) BIOS Overview

What is SMAPI BIOS?

The ThinkPad Basic Input/Output System (BIOS) provides a special software interface, called the System Management Application Program Interface (SMAPI) BIOS, to control the following unique features of the ThinkPad system:

System Information
: This BIOS provides unique ThinkPad information, such as the system identifier (system ID).

System Configuration
: The ThinkPad SMAPI BIOS provides system configuration control for such features as display device selection or resource configuration for built-in devices.

Power Management
: Through the SMAPI BIOS, the operating system or application software can control the ThinkPad power management features (the Power mode or Suspend/Hibernation/Resume options).

“Header Image” on page A-4 describes how to use the SMAPI BIOS.

Header Image

Systems that support SMAPI BIOS must provide the following header image in the F000 segment system ROM area at the 16-byte boundary. The client needs to search and find this SMAPI BIOS header image to get the entry point for the service.

Field	Offset	Length	Value
Signature	00h	4 bytes	'$SMB' (ASCII)
Version (Major)	04h	Byte	01h
Version (Minor)	05h	Byte	00h
Length	06h	Byte	20h
Checksum	07h	Byte	–
Information Word	08h	Word	–
Reserved 1	0Ah	Word	–
Real mode 16-bit offset to entry point	0Ch	Word	–
Real mode 16-bit code segment address	0Eh	Word	–
Reserved 2	10h	Word	–
16-bit protected mode offset to entry point	12h	Word	–
16-bit protected mode code segment base address	14h	Dword	–
32-bit protected mode offset to entry point	18h	Dword	–
32-bit protected mode code segment base address	1Ch	Dword	–

Signature ASCII Code '$SMB' is stored at the top of the header image.

Version (Major/Minor)
Indicates the SMAPI BIOS version.

Length The length of the header image.

Checksum Checksum byte area. The client verifies that this header image is valid by using this checksum; the client should check all header image bytes, and the result will be zero bytes.

Information Word

This area identifies the BIOS service level defined below.

```
Information Word
        Bit 0    : Real/V86 mode interface support
        Bit 1    : 16-bit protected mode support
        Bit 2    : 32-bit protected mode support
        Bit 3-15 : Reserved
```

Real Mode Entry Point

The entry point is specified in segment, offset format. Clients using Real/V86 mode can use this area for the far-call value.

16-bit/32-bit Protected Mode Entry Point

The code base code address specifies the physical address for this BIOS, and the client must prepare the selector for this BIOS. The length should be 64KB.

Calling Convention

The client can invoke the SMAPI BIOS with a far-call to the entry point that is specified in the header file. All parameters for the BIOS and other results are stored in the client data area; the client needs to prepare an input parameter / output parameter area in its data area, and informs this area by pushing those pointers onto the its stack before the far-calls.

The SMAPI BIOS uses the stack/data area directly with the selector when the BIOS is invoked. Therefore, the caller needs to define the same privilege level as the BIOS.

Parameter Structure

The memory allocation for the input/output field should be prepared by the caller. The input field specifies the function request to the SMAPI BIOS, and the BIOS fills in the return value to the output field.

Input Field

Field	Offset	Length
Major Function Number	00h	Byte
Minor Function Number	01h	Byte
Parameter 1	02h	Word
Parameter 2	04h	Word
Parameter 3	06h	Word
Parameter 4	08h	Dword
Parameter 5	0Ch	Dword

Output Field

Field	Offset	Length
Return Code	00h	Byte
Auxiliary Return Code	01h	Byte
Parameter 1	02h	Word
Parameter 2	04h	Word
Parameter 3	06h	Word
Parameter 4	08h	Dword
Parameter 5	0Ch	Dword

Sample in Assembler Language

```
;
; Input Parameter Structure
;
SMB_INPARM              STRUC
 @SMBIN_FUNC            DB      ?
 @SMBIN_SUB_FUNC        DB      ?
 @SMBIN_PARM_1          DW      ?
 @SMBIN_PARM_2          DW      ?
 @SMBIN_PARM_3          DW      ?
 @SMBIN_PARM_4          DD      ?
 @SMBIN_PARM_5          DD      ?
SMB_INPARM              ENDS


;
; Output Parameter Structure
;

SMB_OUTPARM             STRUC
 @SMBOUT_RC             DB      ?
 @SMBOUT_SUB_RC         DB      ?
 @SMBOUT_PARM_1         DW      ?
 @SMBOUT_PARM_2         DW      ?
 @SMBOUT_PARM_3         DW      ?
 @SMBOUT_PARM_4         DD      ?
 @SMBOUT_PARM_5         DD      ?
SMB_OUTPARM             ENDS
```

Sample in C Language

```
//
// Input Parameter Structure
//
typedef struct {
   BYTE     SMBIN_FUNC     ;
   BYTE     SMBIN_SUB_FUNC ;
   WORD     SMBIN_PARM_1   ;
   WORD     SMBIN_PARM_2   ;
   WORD     SMBIN_PARM_3   ;
   DWORD    SMBIN_PARM_4   ;
   DWORD    SMBIN_PARM_5   ;
} INPARM, *PINPARM ;


//
// Output Parameter Structure
//
typedef struct {
   BYTE     SMBOUT_RC      ;
   BYTE     SMBOUT_SUB_RC  ;
   WORD     SMBOUT_PARM_1  ;
   WORD     SMBOUT_PARM_2  ;
   WORD     SMBOUT_PARM_3  ;
   DWORD    SMBOUT_PARM_4  ;
   DWORD    SMBOUT_PARM_5  ;
} OUTPARM, *POUTPARM ;


typedef INPARM    far * FPINPARM ;
typedef OUTPARM   far * FPOUTPARM ;
```

Calling Convention Pseudo Code

The following describes the calling convention using pseudo code.

Assembler Language

```
InputParm       SMB_INPARM      < >
OutputParm      SMB_OUTPARM     < >

16-bit

        push    ds
        mov     ax, offset OutputParm
        push    ax
        push    ds
        mov     ax, offset InputParm
        push    ax
        call    dword ptr SmapiBios
        add     sp, 8


32-bit
        push    ds
        mov     eax, offset OutputParm
        push    eax
        push    ds
        mov     eax, offset InputParm
        push    eax
        call    fword ptr SmapiBios
        add     sp, 16
```

C Language

```
typedef WORD (far * SMB)(FPINPARM, FPOUTPARM) ;



SMB         SmapiBios ;
INPARM      InputParm ;
OUTPARM     OutputParm ;
WORD        RC ;

RC = SmapiBios(&InputParm, &OutputParm) ;
```

Return Codes

The following return codes are stored in both the AL (AX) register and the return code field of the output parameter.

00h	No Error
53h	SMAPI function is not available
81h	Invalid parameter
86h	Function is not supported
90h	System error
91h	System is invalid
92h	System is busy
A0h	Device error (Disk Read Error)
A1h	Device is busy
A2h	Device is not attached
A3h	Device is disabled
A4h	Request parameter is out of range
A5h	Request parameter is not accepted

All other values are reserved.

Function Description

System Information Service

Get System Identification

Input Field

```
Major Function Number - 00h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Return Value Format
                        = 00h - ASCII Format
                        = 01h - Binary Format
Parameter 1           - System ID
Parameter 2           - Country Code
Parameter 3           - System BIOS revision
Parameter 4           - (Bit 16-31) Reserved
                      - (Bit  0-15) System Management BIOS revision
Parameter 5           - (Bit 16-31) Reserved
                      - (Bit  0-15) SMAPI BIOS Interface revision
```

Get CPU Information

Input Field

```
Major Function Number - 00h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - CPU ID
                        (Bit 15- 8) Microprocessor Type
                        (Bit  7- 0) Microprocessor Stepping Level
                        = FFFFh : Unknown
Parameter 3           - Clock Information
                        (Bit 15- 8) CPU clock (units: MHz)
                        = FFh : Unknown
                        (Bit  7- 0) Internal clock (units: MHz)
                        = FFh : Unknown
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Display Device Information

Input Field

```
Major Function Number - 00h
Minor Function Number - 02h
Parameter 1           - (Bit 8    ) LCD information
                        (Bit 9    ) External CRT information
                        (Bit 15-10) Reserved
                        (Bit  7- 0) Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - (Bit 15- 8)
                        Built-in display device (panel)
                        information 1
                        = 00h : Monochrome STN LCD
                        = 01h : Monochrome TFT LCD
                        = 02h : Color STN LCD
                        = 03h : Color TFT LCD
                        = FFh : Unknown
                        (Bit  7- 0)
                        Built-in display device (panel)
                        information 2
                        = 00h : 640x480
                        = 01h : 800x600
                        = 02h : 1024x768
                        = FFh : Unknown
Parameter 2           - (Bit 15- 8) External CRT monitor
                                    information
                        = 00h : External CRT is not attached
                        = 10h : Color monitor
                        = 20h : Monochrome monitor
                        = FFh : Unknown
                        (Bit  7- 0) Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Slave Micro Control Unit Information

Input Field

```
Major Function Number - 00h
Minor Function Number - 06h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Return Value Format
                        = 00h - ASCII Format
                        = 01h - Binary Format
Parameter 1           - Reserved
Parameter 2           - Slave Controller Revision
                       (= 0FFFFh) - Not valid
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get System Sensor Status

Input Field

```
Major Function Number - 00h
Minor Function Number - 07h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Current Status
                        Bit 8 - LID Status
                             = 0 : Open
                             = 1 : Close
                        Bit 9 - Keyboard Status
                             = 0 : Close
                             = 1 : Open
                        Bit 10- AC Adapter
                             = 0 : Not attached
                             = 1 : Attached
                        Bit 15- 11 : Reserved
                        (Bit  7- 0) Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Video Information

Input Field

```
Major Function Number - 00h
Minor Function Number - 08h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Video BIOS revision
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Refresh Rate Capability

Input Field

```
Major Function Number - 00h
Minor Function Number - 09h
Parameter 1           - Reserved
Parameter 2           - mode
                        = 00xxh - VGA modes.
                        (Bit 0-7 is ignored.)
                        = 0100h - 640x400x256
                        = 0101h - 640x480x256
                        = 0110h - 640x480x32K
                        = 0111h - 640x480x64K
                        = 0112h - 640x480x16M
                        = 0102h - 800x600x16
                        = 0103h - 800x600x256
                        = 0113h - 800x600x32K
                        = 0114h - 800x600x64K
                        = 0104h - 1024x768x16
                        = 0105h - 1024x768x256
                        = 0116h - 1024x768x32K
                        = 0117h - 1024x768x64K
                        = 0118h - 1024x768x16M
                        = 0106h - 1280x1024x16
                        = 0107h - 1280x1024x256
                        = 0119h - 1280x1024x32K
                        = 011Ah - 1280x1024x64K
                        = 011Bh - 1280x1024x16M
                        = 0A00h - 1600x1200x16
                        = 0A01h - 1600x1200x256
                        = 0A02h - 1600x1200x32K
                        = 0A03h - 1600x1200x64K
                        = 0A04h - 1600x1200x16M
                        = 0109h - 1056x350x16
                        = 010Ah - 1056x473x16
                        = 010Ch - 1056x480x16
                        = Others : Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Refresh rate capability for
                        specified mode:
                        Bit 0 - 60Hz available.
                        Bit 1 - 72Hz available.
                        Bit 2 - 75Hz available.
                        Bit 3 - 43Hz(I) available.
                        Bit 4 - 56Hz available.
                        Bit 5 - 70Hz available.
                        Bit 6 - 85Hz available.
                        Bit 7 - 48Hz(I) available.
                        Bit 8-15 : Reserved (must be B'0').
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

System Configuration Service

Get Display Device State

Input Field

```
Major Function Number - 10h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Request Type
                        = 0000h : Current hardware
                        = 0001h : CMOS (effective after reboot)
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Display Device Function Capability
                        (Bit 0) Display Function Type
                              = 0 : Not Supported
                              = 1 : Supported
                        (Bit 15- 1) Reserved
Parameter 2           - (Bit 15- 8) Display current status
                        Bit 0 - Built-in display (panel) status
                              = 0 : Disable
                              = 1 : Enable
                        Bit 1 - CRT status
                              = 0 : Disable
                              = 1 : Enable
                        Bit 2 - TV status
                              = 0 : Disable
                              = 1 : Enable
                        Bit 6 - 3 : Reserved
                        Bit 7 - Dual Enable Flag
                              = 0 : Disable
                              = 1 : Enable
                        (Bit  7- 0) Display Fucntion Type
                              = 00h : Model with no TV out
                              = 01h : Model with no simultaneous
                                      display of TV and CRT
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set Display Device State

Input Field

```
Major Function Number - 10h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - Request display status
                        Bit 0 - Built-in display (panel) status
                              = 0 : Disable
                              = 1 : Enable
                        Bit 1 - CRT status
                              = 0 : Disable
                              = 1 : Enable
                        Bit 2 - TV status
                              = 0 : Disable
                              = 1 : Enable
                        Bit 5 - 3 : Reserved
                        Bit 6 - Monitor Detection Ignore
                              = 0 : Do not ignore (should be)
                              = 1 : Ignore
                        Bit 7 - Dual Enable Flag
                              = 0 : Disable
                              = 1 : Enable
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Pointing Device State

Input Field

```
Major Function Number - 11h
Minor Function Number - 02h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Request Type
                           = 00h - Current hardware
                           = 01h - CMOS (effective after reboot)
                        (Bit  7- 0) Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Pointing device current status
                        Bit 8 - Built-in Pointing device status
                           = 0 : Disable
                           = 1 : Enable
                        Bit 9 - External Pointing device status
                           = 0 : Disable
                           = 1 : Enable
                        Bit 15- 10: Reserved
                        (Bit  7- 0) Pointing device capability
                        Bit 0 - Built-in Pointing device status
                           = 0 : Status is not controllable
                           = 1 : Status is controllable
                        Bit 1 - External Pointing device status
                           = 0 : Status is not controllable
                           = 1 : Status is controllable
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set Pointing Device State

Input Field

```
Major Function Number - 11h
Minor Function Number - 03h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8)
                        Pointing device current status
                        Bit 8 - Built-in Pointing device status
                           = 0 : Disable
                           = 1 : Enable
                        Bit 9 - External Pointing device status
                           = 0 : Disable
                           = 1 : Enable
                        Bit 15- 10: Reserved
                        (Bit  7- 0) Request Type
                           = 00h - Current hardware
                           = 01h - CMOS (effective after reboot)
                        Bit  7- 2: Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Hotkey Sticky/Lock

Input Field

```
Major Function Number - 13h
Minor Function Number - 02h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Capability
                        Bit 9-8 - Fn Key Lock
                       (Bit 9, bit 8) =
                         (0, 0) - Not Supported
                         (0, 1) - Sticky Fn Key support
                         (1, 1) - Sticky and
                                  Lock Fn Key support
                         (1, 0) - Reserved
                        Bit 15-10 - Reserved
                       (Bit  7- 0) Current Status
                        Bit 1-0 - Fn Key Lock
                       (Bit 1, bit 0) =
                         (0, 0) - Disable
                         (0, 1) - Enable Sticky
                                  Fn Key support
                         (1, 1) - Enable Sticky and
                                  Lock Fn Key support
                         (1, 0) - Reserved
                        Bit  7- 2 - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set Hotkey Sticky/Lock Support

Input Field

```
Major Function Number - 13h
Minor Function Number - 03h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Reserved
                       (Bit  7- 0) Request Status
                        Bit 1-0 - Sticky/Lock Fn
                                  key support
                       (Bit 1, bit 0) =
                         (0, 0) - Disable
                         (0, 1) - Enable Sticky
                                  Fn Key support
                         (1, 1) - Enable Sticky and
                                  Lock Fn Key support
                         (1, 0) - Reserved
                        Bit 7-2 - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Power Management Service

Get Power Management Mode (BL=00h)

Input Field

```
Major Function Number - 22h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Power management mode
                             Battery operation
                             = 00h - High Performance mode
                             = 01h - Auto Power Management mode
                             = 02h - Manual Power Management mode
                        (Bit  7- 0) Power management mode
                             AC operation
                             = 00h - High Performance mode
                             = 01h - Auto Power Management mode
                             = 02h - Manual Power Management mode
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set Power Management Mode

Input Field

```
Major Function Number - 22h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Power management mode
                             Battery operation
                             = 00h - High Performance mode
                             = 01h - Auto Power Management mode
                             = 02h - Manual Power Management mode
                        (Bit  7- 0) Power management mode
                             AC operation
                             = 00h - High Performance mode
                             = 01h - Auto Power Management mode
                             = 02h - Manual Power Management mode
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Timer Control

Input Field

```
Major Function Number - 22h
Minor Function Number - 02h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Capability of Timer Control
                        Bit 8 - System
                        (Hibernation/Suspend) timer
                                = 0 : Not Supported
                                = 1 : Supported
                        Bit 9 - Standby timer
                                = 0 : Not Supported
                                = 1 : Supported
                        Bit 10 - LCD off timer
                                = 0 : Not Supported
                                = 1 : Supported
                        Bit 11 - HDD off timer
                                = 0 : Not Supported
                                = 1 : Supported
                        Bit 15-12 - Reserved
                       (Bit  7- 0) Timer Control
                            Bit 0 - System (Hibernation/Suspend)
                                    timer
                                      = 0 : Disable
                                      = 1 : Enable
                            Bit 1 - Standby timer
                                      = 0 : Disable
                                      = 1 : Enable
                            Bit 2 - LCD off timer
                                      = 0 : Disable
                                      = 1 : Enable
                            Bit 3 - HDD off timer
                                      = 0 : Disable
                                      = 1 : Enable
                            Bit 7-4 - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set Timer Control

Input Field

```
Major Function Number - 22h
Minor Function Number - 03h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Reserved
                        (Bit  7- 0) Timer Control
                         Bit 0 - System
                             (Hibernation/Suspend) timer
                                     = 0 : Disable
                                     = 1 : Enable
                         Bit 1 - Standby timer
                                     = 0 : Disable
                                     = 1 : Enable
                         Bit 2 - LCD off timer
                                     = 0 : Disable
                                     = 1 : Enable
                         Bit 3 - HDD off timer
                                     = 0 : Disable
                                     = 1 : Enable
                         Bit 7-4 - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Event Bit Definition

```
Bit 2-0 - Reserved
Bit 3   - Standby
Bit 4   - Suspend
Bit 5   - RediSafe
Bit 6   - Hibernation
Bit 7   - Power off
```

Note: If bits are duplicated, the highest bit is available.

Get System Event Global Condition

Input Field

```
Major Function Number - 30h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Capability for event
                              Bit 8 - RediSafe is
                              controlled by global conditions.
                              (RediSafe bit is ignored
                              in each event condition.)
                               = 0 - Not Supported
                               = 1 - Supported
                        (Bit  7- 0) Global event condition
                              Bit 0 - Enable RediSafe
                              if suspend is selected.
                               = 0 - Disable
                               = 1 - Enable
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set System Event Global Condition

Input Field

```
Major Function Number - 30h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Reserved
                        (Bit  7- 0) Global condition for event
                         Bit 0 - Enable safe suspend if suspend
                         is selected.
                          = 0 - Disable
                          = 1 - Enable
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get System Event 1 Condition

Input Field

```
Major Function Number - 31h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - hardware and software
                        event definition
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 3           - Reserved
Parameter 4           - (Bit 31-16) Reserved
                        (Bit 15- 0) Power switch detection
                                    event definition
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 5           - (Bit 31-16) Reserved
                        (Bit 15- 0) LID close detection
                                    event definition
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
```

Set System Event 1 Condition

Input Field

```
Major Function Number - 31h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - Condition for hardware and software event
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 3           - Reserved
Parameter 4           - (Bit 31-16) Reserved
                        (Bit 15- 0) Condition for power
                                    switch detection
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                       (See page A-32.)
Parameter 5           - (Bit 31-16) Reserved
                        (Bit 15- 0) Condition for
                                    LID close detection
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get System Event 2 Condition

Input Field

```
Major Function Number - 32h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - System timer expiry
                        event definition
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 3           - Reserved
Parameter 4           - (Bit 31-16) Reserved
                        (Bit 15- 0) Standby timer expiry
                                    event definition
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 5           - (Bit 31-16) Reserved
                        (Bit 15- 0)
                         Hibernation timer during suspend
                         mode expiry event definition.
                         Bit 15-8 - Capability
                         (See page A-32.)
                         Bit 7-0  - Condition
                         (See page A-32.)
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set System Event 2 Condition

Input Field

```
Major Function Number - 32h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - Condition for System timer expiry
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 3           - Reserved
Parameter 4           - (Bit 31-16) Reserved
                        (Bit 15- 0) Condition for Standby
                                    timer expired
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 5           - (Bit 31-16) Reserved
                        (Bit 15- 0) Condition for Hibernation
                        timer during suspend mode expired
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get System Timer

Input Field

```
Major Function Number - 32h
Minor Function Number - 02h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Power mode Select
                          = 00h - Reserved
                          = 01h - Manual PM mode (AC)
                          = 02h - Manual PM mode (Battery)
                          = F3h - High Performance mode
                          = F4h - Auto Pwr Mgmt mode
                         (Bit  7- 0) Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - (Bit 15- 8) System Timer Capability
                        Bit 8 = 0 - Timer cannot be specified
                                in each Power mode
                                = 1 - Timer can be specified
                                in each Power mode
                         Bit 15-9 - Reserved
                        (Bit  7- 0) Reserved
Parameter 2           - (Bit 15- 8) Reserved
                        (Bit  7- 0) System Timer initial value
                        (units: minutes)
                               = 00h - Disable system timer
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set System Timer

Input Field

```
Major Function Number - 32h
Minor Function Number - 03h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Power mode Select
                               = 00h - All mode
                               = 01h - Manual PM mode (AC)
                               = 02h - Manual PM mode (Battery)
                               = F3h - High Performance mode
                               = F4h - Auto Pwr Mgmt mode
                        (Bit  7- 0) System Timer initial
                               value (units: minutes)
                               = 00h - Disable system timer
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Standby Timer

Input Field

```
Major Function Number - 32h
Minor Function Number - 04h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Power mode Select
                          = 00h - Reserved
                          = 01h - Manual PM mode (AC)
                          = 02h - Manual PM mode (Battery)
                          = F3h - High Performance mode
                          = F4h - Auto Pwr Mgmt mode
                        (Bit  7- 0) Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - (Bit 15- 8) Standby Timer Capability
                         Bit 8 = 0 - Timer cannot be specified
                                 in each Power mode
                                 = 1 - Timer can be specified
                                 in each Power mode
                                  Bit 15-9 - Reserved
                                 (Bit  7- 0) Reserved
Parameter 2           - (Bit 15- 8) Reserved
                        (Bit  7- 0) Standby Timer initial
                        value (units: minutes)
                             = 00h - Disable standby timer
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set Standby Timer

Input Field

```
Major Function Number - 32h
Minor Function Number - 05h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Power mode Select
                          = 00h - All mode
                          = 01h - Manual PM mode (AC)
                          = 02h - Manual PM mode (Battery)
                          = F3h - High Performance mode
                          = F4h - Auto Pwr Mgmt mode
                          (Bit  7- 0) Standby Timer initial value
                          (units: minutes)
                          = 00h - Disable standby timer
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get Hibernation Timer

Input Field

```
Major Function Number - 32h
Minor Function Number - 06h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Reserved
                        (Bit  7- 0) Hibernation Timer during
                                    suspend mode initial value
                                    (units: minutes)
                        = 00h - Disable hibernation timer
                                during suspend mode
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set Hibernation Timer

Input Field

```
Major Function Number - 32h
Minor Function Number - 07h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Reserved
                        (Bit  7- 0) Hibernation Timer during
                                    suspend mode initial value
                                    (units: minutes)
                         = 00h - Disable hibernation timer
                                 during suspend mode
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get System Event 3 Condition

Input Field

```
Major Function Number - 33h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Critical low battery condition
                               detection event definition
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 3           - Reserved
Parameter 4           - (Bit 16-31) Reserved
                        (Bit 0 -15) Out of environment condition
                        detection event definition
                        Bit 15-8 - Capability
                        (See page A-32.)
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 5           - Reserved
```

Set System Event 3 Condition

Input Field

```
Major Function Number - 33h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - (Bit 15- 8) Reserved
                        (Bit  7- 0) Condition for critical
                        low battery condition detection
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 3           - Reserved
Parameter 4           - (Bit 31- 8) Reserved
                        (Bit  7- 0) Condition for out-of-environment
                        condition detection
                        Bit 7-0  - Condition
                        (See page A-32.)
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
                        Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get System Resume Condition

Input Field

```
Major Function Number - 34h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Condition for resuming trigger
                        from system suspend mode
                        Bit 0 - Resume switch by hardware
                        Bit 1 - LID open detection
                        Bit 2 - RTC alarm (Resume Timer)
                                detection
                        Bit 3 - RI from the Serial Device
                                detection
                        Bit 15-4 - Reserved
Parameter 3           - Capability for resuming trigger from
                        the system suspend mode
                        Bit 0 - Resume switch by hardware
                        Bit 1 - LID open detection
                        Bit 2 - RTC alarm (Resume Timer)
                                detection
                        Bit 3 - RI from the Serial Device
                                detection
                        Bit 15-4 - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Set System Resume Condition

Input Field

```
Major Function Number - 34h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - Condition for resuming trigger
                        from the system suspend mode
                        Bit 0 - Resume switch by hardware
                        Bit 1 - LID open detection
                        Bit 2 - RTC alarm (Resume Timer)
                                detection
                        Bit 3 - RI from the Serial Device
                                detection
                        Bit 15-4 - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Get System Resume Timer

Input Field

```
Major Function Number - 34h
Minor Function Number - 02h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - TOD of Resume Timer (BCD format)
                        Bit  7-0  - Seconds   (0 - 59)
                        Bit 15-8  - Minutes   (0 - 59)
                        Bit 23-16 - Hours     (0 - 23)
                        Bit 31-24 - Reserved
Parameter 5           - Date of Resume Timer (BCD format)
                        Bit  7-0  - Day       (1 - 31)
                        Bit 15-8  - Month     (1 - 12)
                        Bit 23-16 - Year      (0 - 99)
                        Bit 30-24 - Reserved
                        Bit 31    - Resume Date Validation
                                  = 0 - Valid (Specified day)
                                  = 1 - Invalid (Every day)
```

Set System Resume Timer

Input Field

```
Major Function Number - 34h
Minor Function Number - 03h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - TOD of Resume Timer (BCD format)
                        Bit  7-0  - Seconds   (0 - 59)
                        Bit 15-8  - Minutes   (0 - 59)
                        Bit 23-16 - Hours     (0 - 23)
                        Bit 31-24 - Reserved
Parameter 5           - Date of Resume Timer (BCD format)
                        Bit  7-0  - Day       (1 - 31)
                        Bit 15-8  - Month     (1 - 12)
                        Bit 23-16 - Year      (0 - 99)
                        Bit 30-24 - Reserved
                        Bit 31    - Resume Date Validation
                                  = 0 - Valid (Specified day)
                                  = 1 - Invalid (Every day)
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Request System Standby

Input Field

```
Major Function Number - 70h
Minor Function Number - 00h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Request System Suspend

Input Field

```
Major Function Number - 70h
Minor Function Number - 01h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Request System Hibernation

Input Field

```
Major Function Number - 70h
Minor Function Number - 02h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Request System Off

Input Field

```
Major Function Number - 70h
Minor Function Number - 03h
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Output Field

```
Return Code           - Error Status
Auxiliary Return Code - Reserved
Parameter 1           - Reserved
Parameter 2           - Reserved
Parameter 3           - Reserved
Parameter 4           - Reserved
Parameter 5           - Reserved
```

Samples

Data Structure

Assembler Language

```
;
;  Smapi BIOS Header
;
SMB_HEADER                STRUC
 @SMBHDR_SIG              DB      4 dup (?)
   ; +00 - Signature
 @SMBHDR_VER              DB      ?
   ; +04 - Major version
 @SMBHDR_VER_VER          DB      ?
   ; +05 - Minor version
 @SMBHDR_LEN              DB      ?
   ; +06 - Length
 @SMBHDR_CHKSUM           DB      ?
   ; +07 - Checksum
 @SMBHDR_INFO             DW      ?
   ; +08 - Information Word
 @SMBHDR_RSV1             DW      ?
   ; +0A - Reserve 1
 @SMBHDR_R_OFFSET         DW      ?
   ; +0C - Real mode Offset
 @SMBHDR_R_SEGMENT        DW      ?
   ; +0E - Real mode Segment
 @SMBHDR_RSV2             DW      ?
   ; +10 - Reserve 2
 @SMBHDR_P16_OFFSET       DW      ?
   ; +12 - 16-bit protected mode offset
 @SMBHDR_P16_BASE         DD      ?
   ; +14 - 16-bit protected mode base address
 @SMBHDR_P32_OFFSET       DD      ?
   ; +18 - 32-bit protected mode offset
 @SMBHDR_P32_BASE         DD      ?
   ; +1C - 32-bit protected mode base address
SMB_HEADER                ENDS
```

Parameters

```
;
;Input Parameter
;
SMB_INPARM                STRUC
 @SMBIN_FUNC              DB      ?
 @SMBIN_SUB_FUNC          DB      ?
 @SMBIN_PARM_1            DW      ?
 @SMBIN_PARM_2            DW      ?
 @SMBIN_PARM_3            DW      ?
 @SMBIN_PARM_4            DD      ?
 @SMBIN_PARM_5            DD      ?
SMB_INPARM                ENDS


;
;Output Parameter
;
SMB_OUTPARM               STRUC
 @SMBOUT_RC               DB      ?
 @SMBOUT_SUB_RC           DB      ?
 @SMBOUT_PARM_1           DW      ?
 @SMBOUT_PARM_2           DW      ?
 @SMBOUT_PARM_3           DW      ?
 @SMBOUT_PARM_4           DD      ?
 @SMBOUT_PARM_5           DD      ?
SMB_OUTPARM               ENDS
```

C Language

```
//
//  SMAPI BIOS Header
//
typedef struct {
   BYTE     SMBHDR_SIG[4]    ; // Signature
   BYTE     SMBHDR_VER         ; // Major Version
   BYTE     SMBHDR_VER_VER     ; // Minor Version
   BYTE     SMBHDR_LEN         ; // Length
   BYTE     SMBHDR_CHKSUM      ; // Checksum
   WORD     SMBHDR_INFO        ; // Information word
   WORD     SMBHDR_RSV1        ; // Reserve 1
   WORD     SMBHDR_R_OFFSET    ; // Real mode offset
   WORD     SMBHDR_R_SEGMENT   ; // Real mode segment
   WORD     SMBHDR_RSV2        ; // Reserve 2
   WORD     SMBHDR_P16_OFFSET
     ; // 16-bit Protect mode offset
   DWORD    SMBHDR_P16_BASE
     ; // 16-bit Protect mode base address
   DWORD    SMBHDR_P32_OFFSET
     ; // 32-bit Protect mode offset
   DWORD    SMBHDR_P32_BASE
     ; // 32-bit Protect mode base address
} SMB_HEADER, *PSMB_HEADER ;
```

Parameters

```
//
// Input Parameter
//
typedef struct {
   BYTE     SMBIN_FUNC       ;
   BYTE     SMBIN_SUB_FUNC   ;
   WORD     SMBIN_PARM_1     ;
   WORD     SMBIN_PARM_2     ;
   WORD     SMBIN_PARM_3     ;
   DWORD    SMBIN_PARM_4     ;
   DWORD    SMBIN_PARM_5     ;
} INPARM, *PINPARM ;

//
// Output Parameter
//
typedef struct {
   BYTE     SMBOUT_RC        ;
   BYTE     SMBOUT_SUB_RC    ;
   WORD     SMBOUT_PARM_1    ;
   WORD     SMBOUT_PARM_2    ;
   WORD     SMBOUT_PARM_3    ;
   DWORD    SMBOUT_PARM_4    ;
   DWORD    SMBOUT_PARM_5    ;
} OUTPARM, *POUTPARM ;
```

Function Declaration

C Language

```
//
// Smapi BIOS function
//
typedef WORD (far * SMB)(PINPARM, POUTPARM) ;
```

Installation Check

Assembler Language: **Real Mode**

```
;
;  FindSmapi
; -----------
;
;   On Entry : None
;   On Exit    : CF = 0 .. Find out
;                   DX - Segment
;                   BX - Pointer to Header
;
;                CF = 1 .. No Smapi BIOS
;

FindSmapi         Proc    Near

        push      eax
        push      cx
        push      si
        push      ds

        mov       ax, BIOS_SEG      ; F000 Segment
        mov       ds, ax
        mov       bx, 0             ; Start Point
        mov       cx, SMB_CAND_CNT  ; Total Check Count
        mov       eax, 'BMS$'  ; Target Strings

  @@:
        cmp       eax, dword ptr ds:[bx].@SMBHDR_SIG
        je        short @f
        add       bx, 10h      ; Next Paragraph
        loop      @b
        stc
        jmp       short FindSmapiFin
```

```
   @@:  ;         Find Smapi Head
        mov       dx, BIOS_SEG

        ;         Calculate Checksum.. next.
        pushf                ; Save Direction flag
        cld                  ; Clear it
        mov       si, bx
        xor       ax, ax
        movzx     cx,byte ptr ds:[bx].@SMBHDR_LEN
   @@:
        lodsb
        add       ah, al
        loop      @b

        popf                 ; Restore Direction flags
        cmp       ah, 1      ; Checksum is OK?
        cmc

FindSmapiFin:
        pop       ds
        pop       si
        pop       cx
        pop       eax
        ret

FindSmapi         Endp
```

C Language

```
typedef struct {
   BYTE     SMBHDR_SIG[4]         ; // Signature
   BYTE     SMBHDR_VER              ; // Major Version
   BYTE     SMBHDR_VER_VER          ; // Minor Version
   BYTE     SMBHDR_LEN              ; // Length
   BYTE     SMBHDR_CHKSUM           ; // Checksum
   WORD     SMBHDR_INFO             ; // Information Word
   WORD     SMBHDR_RSV1             ; // Reserve 1
   WORD     SMBHDR_R_OFFSET         ; // Real Mode Offset
   WORD     SMBHDR_R_SEGMENT        ; // Real Mode Segment
} SMB_HEADER_REAL, far * PFSMB_HEADER_REAL ;
```

```
BOOLEAN GetSmapiEntry(PSMB pFunc)
{
   PFSMB_HEADER_REAL        MyPtr = 0xF0000000 ;
   WORD                     cnt = 0 ;
   BYTE                     cksum = 0 ;

   //
   // 1) Search for signature first
   //
   while((cnt++ < 0x1000) &&
         !(((MyPtr->SMBHDR_SIG)[0] == '$') &&
            ((MyPtr->SMBHDR_SIG)[1] == 'S') &&
            ((MyPtr->SMBHDR_SIG)[2] == 'M') &&
            ((MyPtr->SMBHDR_SIG)[3] == 'B') )) {
      MyPtr++ ;
   }


   //
   //  2) Find the Signature?
   //
   if (cnt >= 0x1000) {
      // We cannot find it.
      return FALSE ;
      } else {
      //
      //  3) Calculate Checksum
      //
      for (cnt = 0 ; cnt < MyPtr->SMBHDR_LEN ; cnt++)
         cksum += (BYTE)((MyPtr->SMBHDR_SIG)[cnt]) ;

      if (cksum) {
         // Bad Checksum
         return FALSE ;
      } else {
         // Build Return Address
         (*pFunc) = ( (DWORD)(MyPtr->SMBHDR_R_OFFSET) +
                ((DWORD)(MyPtr->SMBHDR_R_SEGMENT)) << 16) ) ;
         return TRUE ;
      }
   }
}
```

BIOS Call

Assembler Language: **16-Bit Protected Mode**

```
;
; Build Input Parameter Field
;

mov       al, SMB_GET_SYSID
mov       [bx].@Func, al

mov       ax, offset OutputParm
push      ax
mov       ax, offset InputParm
push      ax
call      _SmapiBios
add       sp, 4

;
; Get information from Output Parm
;
or        ax, ax
jnz       Error

mov       bx, offset OutputParm
mov       al, [bx].@Parm1
```

32-Bit Protected Mode

```
;
; Build Input Parameter Field
;
mov       ebx, offset InputParm
mov       al, SMB_GET_SYSID
mov       [ebx].@Func, al

mov       eax, offset OutputParm
push      eax
mov       eax, offset InputParm
push      eax
call      _SmapiBios
add       sp, 8

;
; Get information from Output Parm
;
or        ax, ax
jnz       Error

mov       ebx, offset OutputParm
mov       ax, [ebx].@Parm1
```

C Language

```
WORD  GetSystemID()
{
   SMB         SmapiEntry ;
   INPARM      MyInput ;
   OUTPARM     MyOutput ;
   WORD        Rc = -1 ;

   if (GetSmapiEntry(&SmapiEntry)) {

      MyInput.SMBIN_FUNC        = 0 ;
      MyInput.SMBIN_SUB_FUNC    = 0 ;

      if (SmapiEntry(&MyInput, &MyOutput)) {
        // No System ID is available
      } else {
        Rc = MyOutput.SMBOUT_PARM_1 ;
      }

   } else {
      // No Smapi BIOS interface.
      // Try to use CBIOS INT 15.
   }
   return Rc ;
}
```

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Part Number: 06J0536

Printed in the United States of America