AMD Geode™ GeodeROM Functional Specification

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Contents

List of Figures

List of Tables

1 Overview

1.1 Scope

GeodeROM is the firmware for AMD Geode™ solutions. It is a set of components designed to initialize devices, provide interrupt services, and emulate traditional hardware functionality. GeodeROM is targeted for platform designs using an AMD Geode™ GX1, AMD Geode™ GX, or AMD Geode™ LX processor and companion device or a single chip processor (e.g., SC1100, SC1200, SC1201, SC2200, SC3200). Figure 1-1 illustrates the general functionality of GeodeROM.

1.2 General Description

The functional layout depicts the operational components of the GeodeROM Power-On Self Test (POST), as well as other services. During POST, the Geode devices are initialized along with other devices (such as the SuperI/O) and the SDRAM is identified, configured, and optimized. This document refers to the GeodeROM System Management Mode (SMM) software as AMD's VSA2 (Virtual System Architecture^{TM}) technology. VSA2 software, including emulated hardware, is decompressed and initialized. System ROMs are included to support other special functionality. There may also be adapter ROMs present in the system or ROM binaries embedded in the GeodeROM image. These ROMs are decompressed, shadowed, and initialized. Finally, an operating system is started. GeodeROM also contains some miscellaneous runtime support services.

The GeodeROM image consists of POST code, initialization routines, and other features. The initialization code and various runtime services reside in the upper 64 KB of the GeodeROM image. Features such as option ROMs, VSA2 technology, or a splash screen bitmap are compressed. The compressed binary images are pre-padded to 192 KB. The initialization and support code is concatenated to the 192 KB image.

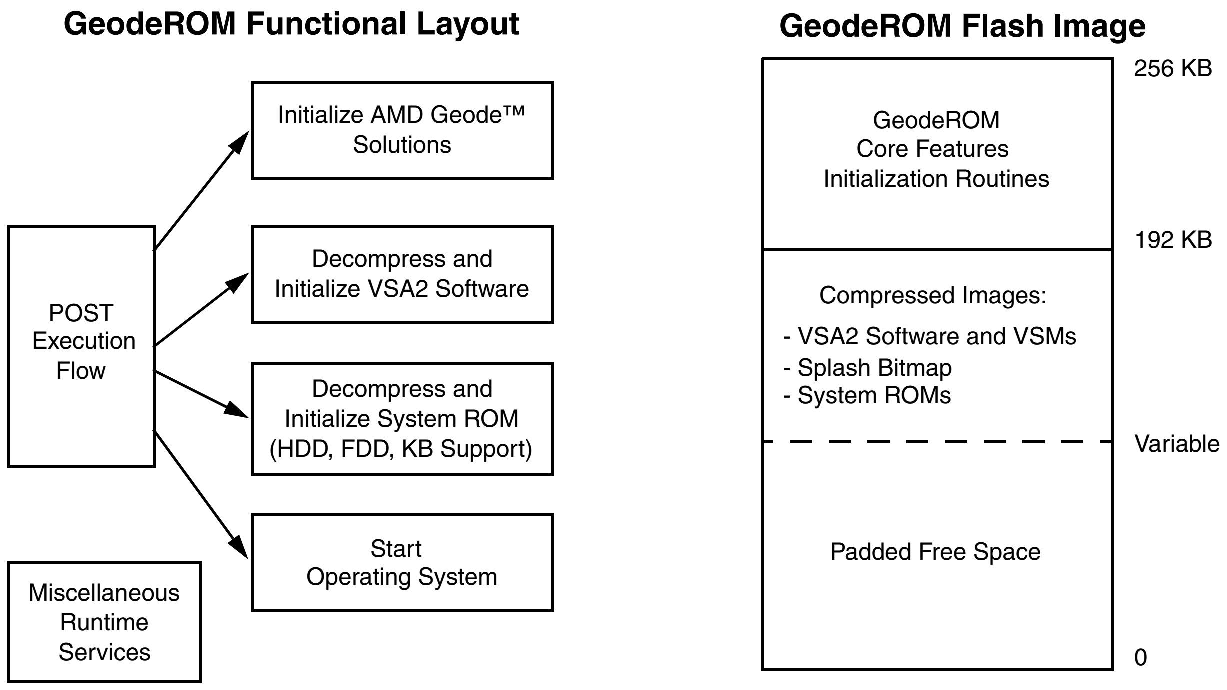

GeodeROM Functional Layout
POST Execution Flow
Initialize AMD Geode™ Solutions
Decompress and Initialize VSA2 Software
Decompress and Initialize System ROM (HDD, FDD, KB Support)
Start Operating System
Miscellaneous Runtime Services
GeodeROM Flash Image
256 KB
GeodeROM Core Features Initialization Routines
192 KB
Compressed Images:
- VSA2 Software and VSMs
- Splash Bitmap
- System ROMs
Variable
Padded Free Space
0

Figure 1-1. GeodeROM Functionality

1.3 Features

GeodeROM provides support to Geode solutions and provides the following initialization and runtime API (application programming interface) support:

- Legacy Power Management
  - GeodeROM provides operating system transparent power management.
- APM (Advanced Power Management) Real Mode/Protected Mode APIs
  - The GeodeROM INT 15h API supports the APM 1.2 functions listed in the “Advanced Power Management (APM) BIOS Interface Specification” available from Microsoft®, Intel, and other sources.
- ACPI (Advanced Configuration and Power Interface)
  - GeodeROM provides configuration tables and methods necessary to support the ACPI 1.0b specification available from Microsoft, Intel, and other sources.
- Boot Menu
  - The system designer can install a menu to activate at POST. The menu provides a list of devices or embedded option ROMs from which to load potential operating systems. It can be especially useful for systems requiring a recovery mechanism, or may be used for demonstrating various bootstrap options.
- Build Environment is Embedded in ROM Image
  - The GeodeROM Flash image contains an encoded list of all the user-defined options. Additionally, any overridden file name and version number is also embedded into the ROM image. This provides a means to determine how the image was created and makes the debugging process easier.
- Enhanced/Large IDE Detection and Configuration
  - Provides a mechanism that identifies and configures ATA devices, such as IDE drives and CompactFlash devices. During a power-on or reset sequence, GeodeROM scans the primary and secondary IDE channels for ATA compliant devices. For each ATA device that is present, GeodeROM performs the ATA “Identify” command to determine the drive’s geometry, capability, and vendor-specific information. The drive and controller timing registers are configured for optimal performance based on the combination of drives attached to the system. If a drive’s geometry exceeds the capability of the standard INT 13h interface, GeodeROM performs CHS (Cylinder/Head/Sector) translation to enable the legacy operating system to utilize the full capacity of the IDE device.
- Bootable CD-ROM Support:
  - Supports bootable CD-ROM drives off of the IDE interface. Floppy emulation formats are supported.
- INT 11h (Equipment List)
  - Provides a traditional INT 11h service (for operating systems) that determines the number and type of installed IBM PC/AT-style peripherals.
- INT 12h (Get Memory Size)
  - This GeodeROM interrupt reports to drivers, applications, and operating systems, the amount of base (< 640 KB) memory available in the system. Typically, this interrupt returns the value 639 (KB), representing the lower ten segments of real mode RAM minus 1 KB that is allocated to an EBDA (Extended BIOS Data Area).
- INT 13h (1.44 MB Floppy Disk Support)
  - Provides support for a 3.5”/1.44 MB floppy disk drive. The GeodeROM INT 13h floppy disk services enable the user to read, write, format, verify, and boot from a 1.44 MB floppy diskette. Additionally, GeodeROM provides disk change line support for the floppy disk drive.
- INT 13h (Fixed Disk Services w/IBM Extensions)
  - In addition to the standard IBM PC/AT-style INT 13h interface, GeodeROM implements the fixed-disk subset of those INT 13h extensions, defined by the “INT 13h Extensions API” IBM document. These extensions enable GeodeROM, in conjunction with certain operating systems, to support drives whose capacity exceeds 8.4 GB. GeodeROM also supports LBA (Logical Block Addressing) for devices larger than 8.4 GB.
- INT 14h (Serial Port BIOS Support)
  - Supports the standard INT 14h interface for initializing, reading and writing data from, and checking the status of the serial port.

- INT 15h Functions
  - — Function 24h (A20 Gate Support)
    - – Contains functions for enabling, disabling, and querying the status of the A20 Gate.
  - — Function 87h (Extended Memory Block Move)
    - – Provides traditional 286 PC/AT-style service to applications, drivers, and operating systems that move blocks of memory to, from, or within extended RAM while executing in real mode.
  - — Function 88h (Get Extended Memory Size)
    - – Provides traditional PC/AT-style service as a means of reporting the amount of installed, extended system DRAM (up to 64 MB) to the operating system.
  - — Function 89h (Enter Protected Mode)
    - – Switches the system into protected mode with support for 286 and higher technology.
  - — Function BEh (ACCESS.bus and NVRAM Access Method)
    - – GeodeROM contains AMD-specific BIOS calls for accessing devices on an ACCESS.bus. A caller provides an ACCESS.bus address and can read or write the device.
    - – GeodeROM contains AMD-specific BIOS calls for accessing data in NVRAM. The caller is not required to know details about the location of this data, but may use the predefined tokens to read or write data in NVRAM.
  - — Function C0h (Get ROM Configuration)
    - – Returns a pointer to the ROM configuration tables that contains system information such as model, sub-model, and other features.
  - — Function C1h (Get EBDA)
    - – Returns the segment address of the EBDA.
  - — Function C2h (PS/2 Mouse Support)
    - – There is optional support for a standard PS/2 mouse in GeodeROM. This is comprised of code to initialize the mouse, the INT 15h Function C2h calls, and the INT 74h code to handle IRQ 12.
  - — Function E8h (Memory Size and Memory Map)
    - – GeodeROM contains support for the E8h functions for determining the system memory size (Function E801h) and for building a system memory map (Function E820h).
- INT 16h (IRQ1 Keyboard Services)
  - — Provides INT 16h keyboard services via a small IBM-style option ROM. GeodeROM also includes an IRQ1 handler to process incoming scan codes and manage the circular scan code buffer that resides in the BDA (BIOS Data Area). To support applications and drivers that intercept scan codes, the IRQ1 handler forwards all scan codes to the INT 15h, Function 4Fh scan code redirect. The keyboard code also supports calling INT 1Bh for Ctrl-Break functionality.
- INT 17h (Parallel Port BIOS Support)
  - — Supports the standard INT 17h interface for initializing, getting status, and writing data to the parallel port.
- INT 1Ah (PCI BIOS INT Support)
  - — Provides a real mode, INT 1Ah interface to many of the B1h class subfunctions defined in revisions 2.2 and newer of the PCI BIOS Specification.
- INT 1Ah (System Time/Date Functions)
  - — Supports most of the standard functions for setting and viewing the system time and date, as well as setting the alarm.
- Companion Device Register Initialization
  - — Downloads a table of default values into the PCI-ISA bridge portion of the Geode device following a power-on reset. Subsequent code sequences (e.g., VSA2 software) may change the default values as features are enabled, disabled, or reconfigured.
- LCD Panel Initialization
  - — GeodeROM can configure and enable an LCD flat panel. TFT panels are supported by default. The system designer selects the panel type and resolution in order to include this support.

- Legacy USB
  - GeodeROM can be configured to support legacy USB, thereby allowing the use of a USB keyboard and mouse before a driver is loaded by the operating system. Associated with this functionality is a “virtual keyboard controller” module, allowing for a standard keyboard BIOS look and feel, in the absence of a keyboard controller.
- USB Floppy Boot Support:
  - Supports booting USB floppy drives in systems without a standard floppy drive.
- Legacy BIOS Entry Points
  - GeodeROM provides the legacy BIOS function entry points for use by legacy software as a compatibility feature.
- PCI ‘_32_’ Services Directory Table
  - Provides a ‘_32_’ bit service directory that provides the operating system information regarding the location of the 32-bit PCI BIOS API. Some operating systems use the information in this table to determine the presence and location of 32-bit, flat-mode PCI BIOS services. The ‘_32_’ bit service directory is described in revisions 2.1 and newer of the PCI BIOS Specification.
- PCI BIOS 32-Bit Protected Mode API
  - Provides a flat-mode, 32-bit protected mode interface to those PCI bus access functions defined in revisions 2.1 and newer of the PCI BIOS Specification.
- Power-On Splash Screen (supports .BMP format)
  - Contains special sequences of ROM-based code for displaying OEM-supplied splash screens during the power-on sequence, rather than the traditional text-mode DRAM count and similar displays. The current GeodeROM implementation supports 320x200, 640x480, 800x600, 1024x768, and 1280x1024 .BMP file formats.
- Power-On Time Option ROM Invocation/Initialization
  - Shadows and invokes any option ROMs that adhere to the format specified in documents such as “The IBM PS/2 Model 60 Technical Reference Manual.” Such option ROMs contain a special “55h/AAh” header, size byte, and initialization entry point. GeodeROM searches for and invokes any valid ROMs that reside on 2 KB boundaries in region C800:0h-DF80:0h. Option ROMs can be found on ISA cards, PCI devices, or be embedded in the GeodeROM image.
- Power-On Time PCI Enumeration/Configuration
  - Automatically detects, initializes, and configures PCI 2.1 compliant devices that appear in PCI configuration space following a power-on sequence. GeodeROM contains a resource allocation module that assigns I/O, address space, and IRQ resources to PCI devices, and ensures the resources assigned to the devices are conflict free. GeodeROM also programs the steering and edge/level values of IRQs assigned to PCI devices during the power-on sequence.
- Protected Mode Reset
  - GeodeROM supports the 286-style reset typically used for returning the microprocessor from protected mode to real mode. Functions 05h and 0Ah are currently supported. The caller resets the microprocessor by writing the function value into CMOS location 0Fh and resetting the system.
- Compression/Decompression for BIOS Modules (Plus Compression Utility)
  - Provides developers the capability of storing code and data modules in compressed form within the system Flash or EEPROM device. Compressed modules contain a header that identifies the type, size, target decompression segment, compression method, and other information used to build or manipulate the compressed module. During a power-on or reset sequence, and following DRAM bank configuration, GeodeROM decompresses such modules into system shadow RAM space. Compression usage has the advantage of conserving build time ROM device space, enabling developers to include significantly more functionality in a ROM device than would be possible without the use of compression. A DOS utility is provided that compresses source ROM modules and supplies these modules with the correct header information.
- SDRAM Bank Sizing/Geode Processor DRAM Controller Initialization
  - Determines the amount of memory installed in the system’s SDRAM banks, configures the processor’s SDRAM controller with the appropriate row/column information, and initializes the SDRAM timings. If the SDRAM modules support SPD (Serial Presence Detection) EEPROMs, special GeodeROM code queries the SPD EEPROMs via a standard ACCESS.bus interface and may optimize the SDRAM timings based on the reported capabilities of a particular SDRAM module.

- SMI (System Management Interrupt)-Based Memory Access Capability
  - — An SMI handler feature useful for debugging in unfamiliar or highly protected environments has the ability to read or write addressable locations in the system. This is done through a virtual register access.
- VSA2 Software Initialization
  - — Contains sequences of code to decompress, load, and invoke the SMI handler. These sequences also initialize SMI-specific registers, such as SMAR (System Management Address Register) SMHR (System Management Header Register) and GX_BASE. Each is required for successful initialization of the VSA2 software.
- Summary Screen
  - — Displays a summary of vital system information (such as hardware found, CPU revision and speed, memory size, etc.) immediately before starting the operating system.
- SuperI/O Device Initialization
  - — The SuperI/O device initialization portion of GeodeROM is a platform-dependent module that initializes the traditional ISA bus components that reside in the SuperI/O device. For example, in a system that contains National's PC97317 SuperI/O, this portion of the GeodeROM code configures and assigns resources to the floppy disk controller, serial COM ports, parallel LPT port, and 8042 keyboard controller.
- Text-Based Configuration Utility
  - — The GeodeROM build process includes a series of questions to which the system designer provides information about the board wiring, options to install, and generally how GeodeROM should behave. The tool runs automatically the first time the build process takes place and on subsequent builds uses the information from a saved option file (XPRESCFG.OPT).
- Virtual Real-Time Clock and CMOS
  - — The real-time clock (RTC) VSM (VSA2 Modular Component) simulates an RTC, including CMOS for platforms or designs that do not provide a hardware RTC. While the CMOS and clock states cannot be maintained across a power loss, a system designer may elect to forego a physical RTC, still allowing many types of software to run effectively.
- Virtual UART
  - — The UART VSM simulates the functionality of one or more UARTs. The module provides the look and feel of a standard UART, and has the flexibility for delivering or retrieving data from some hardware sources (e.g., an on-board microcontroller).
- CMOS Setup
  - — GeodeROM setup provides a configurable engine for configuring a target platform.

2 Introduction

This functional specification discusses supported GeodeROM software interfaces, and use of the GeodeROM source code, including project builds and current functionality modification. This specification is intended for BIOS, or deployment engineers working on AMD Geode™ solutions.

2.1 Supported INT/Functions

GeodeROM supports several INT instructions and associated functions/subfunctions, summarized in Table 2-1. Included in the table is a page reference where the corresponding INT/function/subfunction's description is located.

Table 2-1. Summary of Supported INTx Functions

Function	Subfunction	Function Description	Reference
INT 09h: Miscellaneous Service		Keyboard	Page 209
INT 10h: Miscellaneous Service		Video BIOS	Page 209
INT 11h: Miscellaneous Service		Equipment List	Page 210
INT 12h: Miscellaneous Service		Get Memory Size	Page 210
INT 13h: Removable and Non-Removable Media Support (INT 13h and INT 40h Interrupt Handler)			
00h	---	Reset Disk Subsystem	Page 32, Page 44
01h	---	Get Disk Subsystem Status	Page 33, Page 46
02h	---	Read Sectors	Page 34, Page 47
03h	---	Write Sectors	Page 35, Page 48
04h	---	Verify Sectors	Page 36, Page 49
05h	---	Format Track (Floppy Disk)	Page 37
08h	---	Get Drive Parameters	Page 38, Page 50
09h	---	Set Drive Parameters	Page 51
0Ch	---	Seek To Cylinder	Page 52
0Dh	---	Alternate Disk Subsystem Reset	Page 39, Page 53
10h	---	Test Drive Ready	Page 53
11h	---	Recalibrate Drive	Page 54
14h	---	Perform Disk Self-Diagnostic	Page 54
15h	---	Get Disk Type	Page 39, Page 55
16h	---	Get Disk Change Status	Page 40
17h	---	Set Disk Type	Page 41
18h	---	Set Media Type	Page 42
41h	---	Check Extensions Present	Page 57
42h	---	Extended Read Sectors	Page 58
43h	---	Extended Write Sectors	Page 58
44h	---	Extended Verify Sectors	Page 59

Table 2-1. Summary of Supported INTx Functions (Continued)

Function	Subfunction	Function Description	Reference
47h	---	Extended Seek To Cylinder	Page 59
48h	---	Extended Get Drive Parameters	Page 60
INT 14h: Serial Port BIOS Support			
00h	---	Initialize Port	Page 83
01h	---	Write Character to Port	Page 85
02h	---	Read Character from Port	Page 85
03h	---	Get Port Status	Page 86
INT 15h: System Service Support			
24h	00h	Disable A20 Gate	Page 103
	01h	Enable A20 Gate	Page 104
	02h	Get A20 Gate Status	Page 104
	03h	A20 Support	Page 105
4Fh	---	Key Scan Hook	Page 105
53h	00h	APM Installation Check	Page 106
	01h	APM Real Mode Interface Connect	Page 107
	02h	APM Protected Mode 16-Bit Interface Connect	Page 108
	03h	APM Protected Mode 32-Bit Interface Connect	Page 108
	04h	APM Interface Disconnect	Page 109
	05h	CPU Idle	Page 110
	06h	CPU Busy	Page 111
	07h	Set Power State	Page 112
	08h	Enable/Disable Power Management	Page 113
	09h	Restore APM BIOS Power-On	Page 114
	0Ah	Get Power Status	Page 115
	0Bh	Get PM Event	Page 116
	0Ch	Get Power State	Page 117
	0Dh	Enable/Disable Device Power Management	Page 118
	0Eh	APM Driver Version	Page 119
	0Fh	Engage/Disengage Power Management	Page 120
	10h	Get Capabilities	Page 121
	11h	Get/Set/Disable Resume Timer	Page 122
	12h	Enable/Disable Resume on Ring	Page 123
	13h	Enable/Disable TImer Based Requests	Page 124
86h	---	BIOS Wait	Page 125
87h	---	Extended Memory Block Move	Page 126
88h	---	Get Extended Memory Size	Page 127
89h	---	Enter Protected Mode	Page 127
90h	---	Device Busy	Page 128
91h	---	Interrupt Complete	Page 129

Table 2-1. Summary of Supported INTx Functions (Continued)

Function	Subfunction	Function Description	Reference
BEh	00h	Read ACCESS.bus Byte	Page 131
	01h	Write ACCESS.bus Byte	Page 132
	02h	Write ACCESS.bus Block	Page 132
	03h	Read NVRAM Data	Page 132
	04h	Write NVRAM Data	Page 133
	05h	Get Default NVRAM Value	Page 134
	06h	Get NVRAM Checksum	Page 134
	07h	Set NVRAM Checksum	Page 135
	08h	Reset NVRAM Default	Page 135
	09h	Get NVRAM Table Address	Page 136
	0Ah	ACCESS.bus Block Read	Page 142
	20h	Get SCxxxx External Clock Speed	Page 143
	21h	Get SCxxxx Device Type	Page 143
	31h	SCxxxx Read ACCESS.bus Device	Page 144
	32h	SCxxxx Write ACCESS.bus Device	Page 144
	35h	Owl Board Specific Feature Access	Page 145
	A0h	Wait for Key Timeout	Page 146
	A1h	Get ROM Data	Page 147
	A2h	CPU Memory Register Read Int	Page 148
	A3h	CPU Memory Register Write Int	Page 148
	A4h	Get CPU Speed	Page 149
	A5h	Check CMOS	Page 149
	A6h	Check CMOS Power	Page 150
	A7h	Get PCI Speed	Page 150
	A8h	Set Warning	Page 151
	A9h	Read Companion Chip DWORD	Page 151
	AAh	CPU Register Read	Page 152
	ABh	CPU Register Write	Page 152
	ACh	Eat Key	Page 153
	B0h	Get Shadow	Page 153
	B1h	Set Shadow	Page 154
	F0h-FFh	User Defined Interrupts	Page 154
C0h	---	Get ROM Configuration	Page 155
C1h	---	Get EBDA Address	Page 155
C2h	00h	Enable/Disable Pointing Device	Page 156
	01h	Reset Pointing Device	Page 157
	02h	Set Sample Rate	Page 157
	03h	Set Resolution	Page 158
	04h	Read Device Type	Page 158
	05h	Initialize Pointing Device Interface	Page 159
	06h	Pointing Device Extended Commands	Page 159
	07h	Set Pointing Device Handler Address	Page 160

Table 2-1. Summary of Supported INTx Functions (Continued)

Function	Subfunction	Function Description	Reference
E8h	01h	Get System Memory Size	Page 160
	20h	Get System Memory Map	Page 161
INT 16h: Human Interface Device Support			
00h	---	Wait For Character	Page 89
01h	---	Check For Key Present	Page 90
02h	---	Get Shift Status	Page 90
03h		Set Keyboard Typematic Rate	Page 91
05h	---	Insert Key Code In Keyboard Buffer	Page 91
10h	---	Get Extended Key Code	Page 92
11h	---	Check For Enhanced Key Code	Page 92
12h	---	Get Extended Shift Status	Page 93
INT 17h Parallel Port BIOS Support			
00h	---	Print a Character	Page 87
01h	---	Initialize Parallel Port	Page 88
02h	---	Get Port Status	Page 88
INT 1Ah: System Time and Date Support			
00h	---	Get System Time Status	Page 95
01h	---	Set System Time	Page 96
02h	---	Get Real-Time Clock Time Status	Page 96
03h	---	Set Real-Time Clock Time	Page 97
04h	---	Get Real-Time Clock Date Status	Page 97
05h	---	Set Real-Time Clock Date	Page 98
06h	---	Set Real-Time Clock Alarm	Page 98
07h	---	Cancel Real-Time Clock Alarm	Page 98
09h	---	Get Real-Time Clock Alarm Status	Page 99
0Ah	---	Read System Day Counter	Page 99
0Bh	---	Set System Day Counter	Page 99
0Eh	---	Get Real-Time Clock Date/Time Alarm and Status	Page 100
0Fh	---	Initialize Real-Time Clock	Page 100
INT 1Ah: PCI BIOS Support			
B1h	01h	PCI BIOS Present	Page 75
	02h	Find PCI Device	Page 76
	03h	Find PCI Class Code	Page 77
	06h	Generate Special Cycle	Page 78
	08h	Read Config BYTE	Page 79
	09h	Read Config WORD	Page 80
	0Ah	Read Config DWORD	Page 80
	0Bh	Write Config BYTE	Page 81
	0Ch	Write Config WORD	Page 81
	0Dh	Write Config DWORD	Page 82
	0Eh	Get PCI Interrupt Routing Options	Page 82

Table 2-1. Summary of Supported INTx Functions (Continued)

Function	Subfunction	Function Description	Reference
INT 6Dh: Video BIOS			
00h	---	Set Video Mode	Page 165
01h	---	Set Cursor Type	Page 166
02h	---	Set Cursor Position	Page 166
03h	---	Get Cursor Position	Page 167
04h	---	Read Light Pen	Page 167
05h	---	Set Active Display Page	Page 168
06h	---	Scroll Up	Page 168
07h	---	Scroll Down	Page 169
08h	---	Read Character	Page 169
09h	---	Write Character Attribute	Page 170
0Ah	---	Write Character	Page 170
0Bh	---	Set CGA Palette	Page 171
0Ch	---	Write DOT	Page 171
0Dh	---	Read DOT	Page 172
0Eh	---	Write TTY	Page 172
0Fh	---	Get Mode	Page 173
10h	---	Palette Handler	Page 173
	00h	Set Individual Palette Register	Page 173
	01h	Set Overscan Register	Page 173
	02h	Set All Palette and Overscan Registers	Page 174
	03h	Toggle Intensity/Blinking Bit	Page 174
	07h	Read Individual Palette Register	Page 174
	08h	Read Overscan Register	Page 175
	09h	Read All Palette and Overscan Registers	Page 175
	10h	Read Individual RAMDAC Register	Page 175
	12h	Set Block of RAMDAC Registers	Page 176
	13h	Select Color Page	Page 176
	15h	Get Individual RAMDAC Register	Page 176
	17h	Get Block of RAMDAC Registers	Page 177
	1Ah	Get Color PAge	Page 177
	1Bh	Sum RAMDAC to Gray Scale	Page 178

Table 2-1. Summary of Supported INTx Functions (Continued)

Function	Subfunction	Function Description	Reference
11h	---	Font Handler	Page 178
	00h	Load User Font	Page 178
	01h	Load 8x14 Font	Page 179
	02h	Load 8x8 Font	Page 179
	03h	Set Font Block	Page 179
	04h	Load 8x16 Font	Page 180
	10h	Load User Font with Fixup	Page 180
	11h	Load 8x14 Font with Fixup	Page 181
	12h	Load 8x8 Font with Fixup	Page 181
	14h	Load 8x16 Font with Fixup	Page 181
	20h	Load Upper 8x8 Graphics Character Set	Page 182
	21h	Load User Graphics Character Set	Page 182
	22h	Load 8x14 Graphics Character Set	Page 183
	23h	Load 8x8 Graphics Character Set	Page 183
	24h	Load 8x16 Graphics Character Set	Page 184
	30h	Get Font Information	Page 184
12h	---	Video Subsystem Configuration (EGA/VGA)	Page 185
	10h	Return Video Information	Page 185
	20h	Alternate Print Screen	Page 185
	30h	Select Scan Lines	Page 186
	31h	Enable/Disable Palette Loading	Page 186
	32h	Enable/Disable Video Subsystem	Page 187
	33h	Enable/Disable Summing to Gray Scales	Page 187
	34h	Enable/Disable Cursor Emulation	Page 187
	35h	Display Switch	Page 188
	36h	Enable/Disable Video Screen	Page 188
13h	---	Write String	Page 189
1Ah	---	Get DCC Information	Page 190
1Bh	---	Get Functionality Information	Page 191
1Ch	---	Save/Restore State	Page 191
VESA BIOS Extensions			
00h	---	Return VBE Controller Information	Page 193
01h	---	Return VBE Mode Information	Page 194
02h	---	Set VBE Mode	Page 194
03h	---	Get VBE Mode	Page 194
04h	---	VBE Save/Restore State	Page 195
	00h	Return Buffer Size in BX	Page 195
	01h	Save State	Page 195
	02h	Restore State	Page 196
05h	---	VBE Set/Get Bank	Page 196
	00h	Set Bank	Page 196
	01h	Get Bank	Page 197

Table 2-1. Summary of Supported INTx Functions (Continued)

Function	Subfunction	Function Description	Reference
06h	---	VBE Set/Get Logical Scan Line Length	Page 197
	00h	Set Scan Line Length in Pixels	Page 197
	01h	Get Scan Line Length	Page 197
	02h	Set Scan Line Length in Bytes	Page 198
	03h	Get Maximum Scan Line Length	Page 198
07h	---	VBE Set/Get Display Start	Page 199
	00h	Set Display Start	Page 199
	01h	Get Display Start	Page 199
	80h	Set Display Start During Vertical Retrace	Page 199
08h	---	VBE Set/Get RAMDAC Palette Format	Page 200
	00h	Set Format	Page 200
	01h	Get Format	Page 200
09h	---	VBE Set/Get RAMDAC Palette Data	Page 201
	00h	Set RAMDAC Data	Page 201
	01h	Get RAMDAC Data	Page 201
	02h	Set Secondary RAMDAC Data	Page 202
	03h	Get Secondary RAMDAC Data	Page 202
	80h	Set RAMDAC Data During Vertical Retrace with Blanking Enabled	Page 202
0Ah	---	Return VBE Protected Mode Information	Page 203
10h	---	VBE Display Power Management Signaling	Page 204
	00h	Version Number/Supported Power State	Page 204
	01h	Requested Power State	Page 204
	02h	Controller’s Currently Requested Power State	Page 205
11h	---	Flat Panel Interface Extensions (FP)	Page 205
12h	---	Cursor Interface Extensions (CI)	Page 205
13h	---	Audio Interface Extensions (AI)	Page 205
14h	---	OEM Extensions	Page 206
	00h	Refresh Rate Select	Page 206
	02h	Set Display Enable	Page 206
	03h	Set Fixed Timings	Page 207
	07h	Get Version Numbers	Page 207
15h	---	VBE Display Data Channel (DDC)	Page 208
16h	---	Graphics System Configuration (GC)	Page 208

2.2 Acronyms and Definitions

This specification uses several acronyms. Table 2-2 lists, in alphabetical order, the acronyms and their definitions.

Table 2-2. Acronyms and Definitions

Acronym	Definition
API	Application Programming Interface
APM	Advanced Power Management
BDA	BIOS Data Area
BIOS	Basic I/O System
CHS	Cylinder/Head/Sector
EBDA	Extended BIOS Data Area
HID	Human Interface Device
LBA	Large Block Address
OEM	Original Equipment Manufacturer
PM	Power Management
POST	Power-On Self Test
SIO	SuperI/O
SMAR	System Management Address Register
SMHR	System Management Header Register
SMI	System Management Interrupt
SMM	System Management Mode
SoftVGA	SMI-based handler in the AMD Geode GX1 processor
SoftVG	SMI-based handler in the AMD Geode GX processors*
TSR	Terminate, Stay Resident
VSA	Virtual System Architecture™
VSM	Virtual Support Module

3 Code Structure

The following subsections discuss the GeodeROM directory structure.

3.1 User Directory

All project-specific files are stored in the user directory. The default user directory is XPRESS\USER, but it is not recommended as a project user directory. Rather a separate subdirectory outside the Xpress tree should be made to hold the user directories. A sample makefile is included in the XPRESS\USER directory.

A sample project user directory structure is as follows:

```
XPRESS\
PROJECTS\PROJ1
    \PROJ2
```

The files typically found in the user directory are:

- Makefile - The makefile establishes the build environment, then calls the master makefile.
- Splash.bmp - A standard Microsoft® Windows® bitmap file used if splash screen support is needed.
- Userrule.mak - Any additional components that need to be compiled may be added here.
- Xromcfg.opt - The configurator save file for the project.
- User option ROMS
- Overrides

3.2 Overrides

Any source file (.asm) in the build may be overridden by copying the file into the user directory or the project directory. When GeodeROM is rebuilt, the copy of the file in one of these directories is used instead of the copy in the Xpress tree. Figure 3-1 depicts the GeodeROM core. The SMI handler may be overridden by files VSA.ROM or VSA2.ROM copied into the user directory. This allows easy changes on a project-by-project basis. Any files needing changes for a project should be changed this way. Editing the files in the Xpress tree is discouraged as it creates problems when upgrading to a new GeodeROM release.

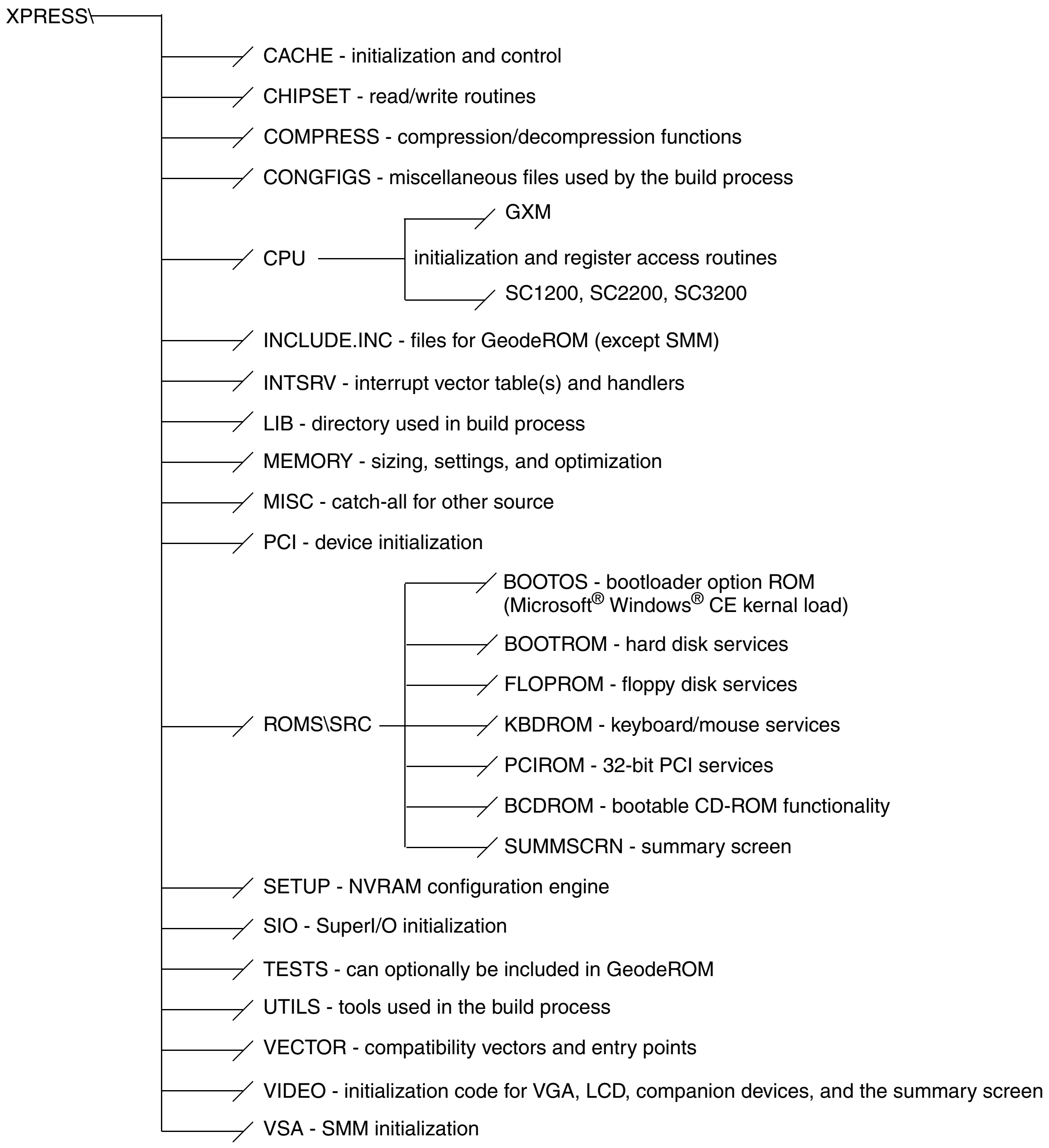

XPRESS\
CACHE - initialization and control
CHIPSET - read/write routines
COMPRESS - compression/decompression functions
CONGFIGS - miscellaneous files used by the build process
CPU
GXM
initialization and register access routines
SC1200, SC2200, SC3200
INCLUDE.INC - files for GeodeROM (except SMM)
INTSRV - interrupt vector table(s) and handlers
LIB - directory used in build process
MEMORY - sizing, settings, and optimization
MISC - catch-all for other source
PCI - device initialization
ROMS\SRC
BOOTOS - bootloader option ROM (Microsoft® Windows® CE kernal load)
BOOTROM - hard disk services
FLOPROM - floppy disk services
KBDROM - keyboard/mouse services
PCIROM - 32-bit PCI services
BCDROM - bootable CD-ROM functionality
SUMMSCRN - summary screen
SETUP - NVRAM configuration engine
SIO - SuperI/O initialization
TESTS - can optionally be included in GeodeROM
UTILS - tools used in the build process
VECTOR - compatibility vectors and entry points
VIDEO - initialization code for VGA, LCD, companion devices, and the summary screen
VSA - SMM initialization

Figure 3-1. Xpress Tree

4 POST

This section outlines the POST (Power-On Self Test) execution flow for GeodeROM, along with the associated checkpoints that are sent to I/O Port 80h. POST is executed out of xpress.asm. The basic numbering scheme is as follows:

- Reset - 69h, 71h
- Core functions - Numbered in chronological order, starting at 00h
- User functions - 80h and 81h
- Intermediate checkpoints - Numbered in chronological order, beginning on a 10h boundary
- Failing tests - Numbered with xFh and the system halts

4.1 Post Codes

Post Code	Sub Code	Function Name	Function Description
F0h	F0h	Reset Vector	Output just prior to a jump to startTest.
80h	---	startTest/UserPreInit	Just after startTest. Beginning of POST proper. User-added code to be run first.
00h		startTest/preSioInit	Contains board-specific code to initialize SuperI/O (SIO).
	60h	preSioInit	Entering SIO code.
	61h	preSioInit	
	6Bh	preSioInit	Invalid SIO response - try again.
01h	---	startTest/clockInit	Chipset level clock initialize.
	24h	clockInit	After preparing the memory mapped configuration base of the system clock control registers.
	25h	clockInit	After setting up UNREAL mode (ES and FS set to 4 GB flat selectors).
	26h	clockInit	After checking if the clock is already setup (getting this code indicates the clock was not already setup).
	27h	clockInit	After inhibiting writes to CX5520_CLK_CTRL0 and loading values from CX5520_SCLK and CS5520_SCLK_CTRL0.
	28h	clockInit	Before entering the clock programming loop.
	30h	clockInit	End of one iteration through the clock programming loop.
	37h	clockInit	Reset pressed; entering infinite loop.
	E1h	clockInit	Entering clockInit; see if block is already configured.
	E2h	clockInit	Put configuration block on new address.
	E3h	clockInit	Start Timer 1 and exit.

Post Code	Sub Code	Function Name	Function Description
02h[1]	---	startTest/cpuRegInit	CPU configuration registers initialize.
	A9h	UserCpuInit/ RestoreFromRam	Entering RestoreFromRam. Invalidate cache tags and clear GPE and PM1A events.
	AAh	RestoreFromRam	Clear ACPU_BIOS_ST event, set GPWIO0 active-low, prepare GPWIOs, enable SCI generation and RTC wakeup.
	ABh	RestoreFromRam/memResume	Call memResume.
	ACh	memResume	Enter memResume.
	ADh	memResume	Done restoring memory controllers; enable DIMMs.
	E0h	RestoreFromRam/chipsetInit	Begin initialization process.
	E1h	chipsetInit	Start of a single loop iteration.
	E2h	chipsetInit	End of a single loop iteration.
	E8h	chipsetInit/LPCBusInit	LPC Bridge initialization.
	EAh	chipsetInit/GPIOInit	GPIOs initialization.
	2Ch	chipsetInit/ConfigBaseAddr	Configuration base address is invalid. HLT.
	2Dh	chipsetInit/Id_CPU	Invalid crystal in use. HLT.
	B1h	RestoreFromRam/GoToSleep	Enter S3V (take memory out of self-refresh, put CPU to sleep).
	AFh	GoToSleep	Interrupts cleared; setting 1 sec. RTC alarm.
	A3h	GoToSleep	Alarm set; generate and clear SMI so CPU will Suspend.
	BDh	RestoreFromRam	Check for memory restore.
	B2h	RestoreFromRam	Memory is on; set Bus Interface Unit registers to known.
	B3h	RestoreFromRam	Running from RAM; setup a temporary stack.
	D4h	RestoreFromRam/lcdInit	Initialize LCD panel and DSTN controller, setup scratch pad, clear SMI registers.
	B4h	RestoreFromRam	Should not execute - software should be in SMM.
	BFh	RestoreFromRam	Cause software SMI (resume to SMM).
	84h	RestoreFromRam	Should not execute - software should be in SMM.
	83h	RestoreFromRam	Should not execute - software should be in SMM.
03h	---	startTest/unReal	Precedes creating a 32-bit real mode descriptors in ES and FS.
04h	---	startTest/cpuMemRegInit	Initializes memory controller registers.
05h	---	startTest/clockInit	Geode CPU tests.
	20h	clockInit	Test entry.
	28h	clockInit	Verify CPU stepping ID.
	2Ah	clockInit	Verify CPU feature flags.
	2Eh	clockInit	Test passed. Exit.
	2Fh	clockInit	Test failed. HLT.

Post Code	Sub Code	Function Name	Function Description
06h	---	startTest/memSetup	Autosize memory controller DIMM1 and DIMM0.
	70h	memSetup	Set the clock drive strength and shift value. Mask the clocks.
	72h	memSetup	Set the data, address, and control drive. Clear reference timer and VGA wrap.
	73h	memSetup	Initialize register; no DIMMs installed.
	74h	memSetup	Initialize CAS latency.
	75h	memSetup	Begin sizing DIMMs.
	76h	memSetup	Memory Controller enable and perform refresh.
	7E	memSetup	MemSetup complete. Exit
	7Fh	memSetup	memSetup error. Enable the DIMMs and begin an infinite loop toggling all the data and address lines.
07h	---	startTest/memSetUpStack	Set up a stack.
	90h	memSetUpStack	Beginning to create the stack.
	9Eh	memSetUpStack	Stack creation succeeded. Exit.
	9Fh	memSetUpStack	Stack creation failure. HLT.
08h	---	startTest/memTest	Test memory address lines.
	B0h	memTest	Begin testing memory.
	BEh	memTest	Memory test succeeded. Exit.
	BFh	memTest	Memory test failed. Enable the DIMMs and begin an infinite diagnostic loop toggling all the data and address lines.
09h	---	startTest/shadowRom	Copy ROM from F000:0000h to RAM at F000:0000h.
0Ah	---	startTest/PCIDelay	Delay between PCIRST# and first configuration cycle.
0Bh	---	startTest/cacheInit	Test and initialize cache.
	CFh	cacheInit	Cache initialization failure. HLT.
0Ch	---	startTest/northBridgeInit	Initialize North Bridge.
	E8h	northBridgeInit	Begin North Bridge register initialization.
0Dh	---	startTest/chipsetInit	Load Geode South Bridge with values.
	E0h	chipsetInit	Begin initialization process.
	E1h	chipsetInit	Start of a single loop interation.
	E2h	chipsetInit	End of a single loop iteration.
	E8h	chipsetInit/LPCBusInit	LPC Bridge initialization.
	EAh	chipsetInit/GPIOInit	GPIOs initialization.
	2Ch	chipsetInit/ConfigBaseAddr	Configuration base address is invalid. HLT.
	2Dh	chipsetInit/Id_CPU	Invalid crystal in use. HLT.
0Eh	---	startTest/sioTest	SIO test/initialize.
	60h	sioTest	SIO test entry.
	61h	sioTest	SIO present/register initialize (not SP1SC10 or SP4SC40 boards).
	6Ah	sioTest	ACCESS.bus initialize (SP1SC10 and SP4SC40 boards).
	6Eh	sioTest	SIO test exit.
0Fh	---	startTest/pcATjunk	Initialize Timer 1, DMA, low 640 KB (including stack), and 2nd MB of RAM.
10h	---	startTest/intTable	Initialize interrupt table and timer to 18.2 tics/sec. (also clears equipment list in itable.asm).
16h		startTest/BDAInit	Initialize the BIOS Data Area (BDA) and XBDA.
11h	---	startTest/memInfo	Query memory controller for RAM size, and store it.

Post Code	Sub Code	Function Name	Function Description
14h	---	keyboardInit	Wakeup the keyboard controller.
12h	---	startTest/romCopy	Initialize the Soft A20, power management, SMI handler, and virtual audio SMM system.
	D0h	romCopy	Enter ROM copy routine.
	D1h	romCopy	Begin image decompress loop.
	D2h	romCopy	Call VSA/SMM initialization code. Virtual register initialization.
	10h	romCopy/VSA_Init	Begin VSA initialization.
	11h	VSA_Init	Load System Manager and VSMs into memory.
	12h	LoadVSA	System Manager image found. Applying patches to System Manager.
	14h	CopyModule	Begin copying module.
	15h	CopyModule	Module copy succeeded and another VSM was found.
	16h	VSA_Init	Back from loading VSMs.
	17h	VSA_Init	Back from cleanup.
	18h	VSA_Init	Back from software SMI (initialized VSA).
	19h	VSA_Init	Go enable SMI.
	1Ah	VSA_Init	Back (enabled SMI).
	1Bh	VSA_Init	Return to BIOS.
	EEH	VSA_Init	VSA installation/setup error.
	14h	romCopy/lcdInit	Keyboard controller initialization (then clear the keyboard buffer).
	D3h	romCopy	Initialize VGA BIOS.
	D4h	romCopy/lcdInit	Initialize LCD panel and DSTN controller.
	D5h	romCopy	Display splash screen.
	D6h	romCopy	Hard disk drive initialize.
	D7h	romCopy	System option ROM scan and initialize/PCI32 fixup.
	DEh	romCopy	Set ROM addresses (C0000h-C7FFFh) for read only access. romCopy exit.
82h	---	startTest/equip-check	Additional BDA initialization.
17h	---	startTest/pciScan	Scan PCI bus and display to screen.
18h	---	startTest/userRomInit	User added (or board-specific) code to prepare for ROM scan. Simply returns for most boards; active code for SP1SC10, SP4SC30, and SP4SC31 boards.
19h	---	startTest/ResetLimits	Reset all descriptors to real mode 1 MB size.
81h	---	startTest/UserPostInit	Board-specific code to be run right before boot.
1Ah	---	startTest/summary_screen	Display summary screen.
1Bh	---	startTest	Attempt to boot via INT 19h then INT 18h.
1Fh	---	---	Boot failure - GeodeROM halted.

1. Subcodes between bold lines apply to Restore-From-RAM only.

5 Removable Media

This chapter discusses the support GeodeROM provides for removable media devices, such as floppy disk drives.

5.1 Floppy Disk Drive Support

GeodeROM provides INT 40h and boot support for one 1.44 MB, 3.5” floppy disk drive. As in a traditional boot ROM, only device 0 (A: drive) is bootable. The proper access method for the INT 40h functions is through the INT 13h service routines. GeodeROM supports the INT 40h functions listed in Table 5-1 for the floppy drive:

Table 5-1. INT 40h Functions

Function Number/Name	Page Number
Function 00h - Reset Disk Subsystem	32
Function 01h - Get Disk Subsystem Status	33
Function 02h - Read Sectors	34
Function 03h - Write Sectors	35
Function 04h - Verify Sectors	36
Function 05h - Format Track (Floppy Disk)	37
Function 08h - Get Drive Parameters	38
Function 0Dh - Alternate Disk Subsystem Reset	39
Function 15h - Get Disk Type	39
Function 16h - Get Disk Change Status	40
Function 17h - Set Disk Type	41
Function 18h - Set Media Type	42

The format of the caller-supplied parameters and return values adheres to standard industry descriptions of the INT 13h API for floppy drives as outlined in many references, such as the “IBM PC/AT Technical Reference Manual”, and “PC Interrupts”.

5.2 INT 13h Functions Descriptions

This section describes the parameters and return values for each floppy disk-specific INT 13h function in the GeodeROM device. This section is intended as a guide. Developers interested in extending and/or debugging the GeodeROM INT 13h interface should consult the documentation listed on the AMD Geode™ Developer Support site.

INT 13h provides the operating system with a series of functions for communicating with the system’s fixed and floppy disk drives. The INT 13h interface is a cornerstone of PC/AT compatibility because it ensures that software applications such as DOS and Microsoft® Windows® can read and write disk-based data in a uniform fashion, across a broad variety of architectures.

5.2.1 Function 00h - Reset Disk Subsystem

Description:

In an ATA drive-equipped system, this function toggles bit four, in register six, of the Control Register Block. This causes the disk(s) to recalibrate internally and seek to cylinder zero.

Supports:

Fixed disks and floppy disks.

Passed:

Parameter	Description
AH	00h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: 00h = Operation completed successfully (fixed, floppy) 01h = Illegal/unrecognized command (fixed, floppy) 02h = Sector address mark not found (fixed, floppy) 03h = Attempt to write to write-protected disk (fixed, floppy) 04h = Sector not found (fixed, floppy) 05h = Reset failure (fixed only) 06h = Diskette change signal (floppy only) 07h = Parameter activity failed (fixed only) 08h = DMA overrun (floppy only) 09h = DMA operation would have crossed a 64 KB boundary (floppy only) 0Ah = Bad or invalid sector (fixed only) 0Bh = Bad or invalid cylinder (fixed only) 0Ch = Invalid cylinder number (fixed only) 0Dh = Invalid number of sectors supplied during format (fixed only) 0Eh = Controller detected control data address mark (fixed only) 0Fh = DMA arbitration failure (fixed only) 10h = CRC/ECC bad (fixed only) 11h = Data corrected using ECC (fixed only) 20h = Controller failed self test (fixed only) 40h = Error during seek (fixed only) 80h = Command timed out (fixed only) AAh = Drive not ready (fixed only) BBh = Unknown error (fixed only) CCh = Write error (fixed only) E0h = Status register error (fixed only) FFh = Media sense failed (fixed only)

Special Instructions:

If DL $\leq$ 80h, both the fixed disks and floppy disks reset.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 33.
INT 13h "Function 0Dh - Alternate Disk Subsystem Reset" on page 39.

5.2.2 Function 01h - Get Disk Subsystem Status

Description:

Returns the status of the last disk operation in the AH register.

Supports:

Fixed disks and floppy disks.

Passed:

Parameter	Description
AH	01h
DL	Drive number

Returns:

Parameter	Description
AH	Status of the last disk operation: See AH in "Function 00h - Reset Disk Subsystem" on page 32

Special Instructions:

The system BIOS stores the status of the last fixed disk operation in location 40:74h in the BDA. The preferable method for retrieving disk status is the INT 13h interface, that enables system software, other than the system BIOS, to provide accurate disk subsystem status.

Related Functions:

None.

5.2.3 Function 02h - Read Sectors

Description:

Reads a caller-specified number of sectors in the buffer specified by the ES:BX register pair.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	02h
AL	Sector count
CH	Cylinder bits [7:0]
CL	Bits [7:6] = Cylinder bits [9:8] Bits [5:0] = Start sector (1-based)
DH	Drive head
DL	Drive number
ES:BX	Far pointer to caller-supplied buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33
AL	Total number of sectors read

Special Instructions:

During a floppy diskette read, the caller ensures the read operation:
1) Does not cross a 64 KB DMA page boundary (e.g., 2000:0h, 3000:0h, etc.).
2) Does not extend past the end of a physical cylinder.

The IBM PC/AT technical reference manual specifies the head register as a 4-bit value; the upper four bits of DH are undefined on this type of system. Newer systems allow for a head value of 0-0FFh, or a maximum of 255 heads. The INT 13h functions in this type of system are capable of translating between physical (drive reported) and logical cylinder, head, sector geometries.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 33.
INT 13h "Function 03h - Write Sectors" on page 35.

5.2.4 Function 03h - Write Sectors

Description:

Writes a caller-specified number of sectors in the buffer specified by the ES:BX register pair.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	03h
AL	Sector count
CH	Cylinder bits [7:0]
CL	Bits [7:6] = Cylinder bits [9:8] Bits [5:0] = Start sector (1-based)
DH	Drive head
DL	Drive number
ES:BX	Far pointer to caller-supplied buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33
AL	Total number of sectors written

Special Instructions:

During a floppy diskette write, the caller ensures the write operation:
1) Does not cross a 64 KB DMA page boundary (e.g., 2000:0h, 3000:0, etc.).
2) Does not extend past the end of a physical cylinder.

The "IBM PC/AT Technical Reference Manual" specifies the head register as a 4-bit value; the upper four bits of DH are undefined on this type of system. Newer systems allow for a head value of 0-0FFh, or a maximum of 255 heads. The INT 13h functions in this type of system are capable of translating between physical (drive reported) and logical cylinder, head, sector geometries.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 33.
INT 13h "Function 02h - Read Sectors" on page 34.

5.2.5 Function 04h - Verify Sectors

Description:

Verifies the existence and integrity of the sectors specified by the caller.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	04h
AL	Sector count
CH	Bits [7:0] = Cylinder bits [7:0]
CL	Bits [7:6] = Cylinder bits [9:8] Bits [5:0] = Start sector (1-based)
DH	Drive head
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33
AL	Number of sectors successfully written

Special Instructions:

During a floppy diskette verify, the caller ensures the verify operation:
1) Does not cross a 64 KB DMA page boundary (e.g., 2000:0h, 3000:0, etc.).
2) Does not extend past the end of a physical cylinder.

The "IBM PC/AT Technical Reference Manual" specifies the head register as a 4-bit value; the upper four bits of DH are undefined on this type of system. Newer systems allow for a head value of 0-0FFh, or a maximum of 255 heads. The INT 13h functions in this type of system are capable of translating between physical (drive reported) and logical cylinder, head, sector geometries.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 33.
INT 13h "Function 02h - Read Sectors" on page 34.
INT 13h "Function 03h - Write Sectors" on page 35.

5.2.6 Function 05h - Format Track (Floppy Disk)

Description:

Performs a low level function on a single floppy diskette track. The calling application passes a far pointer to a 4-byte table specifying low level format parameters.

Supports:

Floppy disk only.

Passed:

Parameter	Description
AH	05h
AL	Number of sectors to create on this cylinder
CH	Cylinder number
CL	Starting sector (1-based)
DH	Drive head (0 or 1)
DL	Drive number
ES:BX	Far pointer to array of 4-byte parameter tables The format of a single 4-byte parameter table: BYTE Track BYTE Head BYTE Sector BYTE Bytes/sector 0 = 128, 1 = 256, 2 = 512, 3 = 1024

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33

Special Instructions:

None.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 33.

5.2.7 Function 08h - Get Drive Parameters

Description:

Returns the geometry of the caller-specified drive in terms of cylinders, heads, and sectors. If the specified drive is a "large" IDE drive whose physical cylinder count exceeds 1024, this function returns "logical" or "translated" parameters.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	08h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33
BL	Floppy drive type (AT, PS/2 only)
DL	Number of installed drives of this type
DH	Maximum head number (0-based)
CH	Bits [7:0] = Maximum cylinder number bits [7:0]
CL	Bits [7:6] = Maximum cylinder number bits [9:8] Bits [5:0] = Maximum sector number bits [5:0]
ES:DI	Far pointer to drive parameter table

Special Instructions:

The DL register returns what some manuals refer to as "the number of consecutive acknowledging drives". This means, "the number of drives of this type". For example, if your application calls this function with DL = 0, upon return, DL contains the number of installed floppy drives.

Related Functions:

None.

5.2.8 Function 0Dh - Alternate Disk Subsystem Reset

Description:

Reinitializes the fixed disk controller, resets the specified drive's parameters, and recalibrates the drive's heads (seek to track 0). Both the master drive and the slave drive respond to the reset function issued to either drive.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	0Dh
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33

Special Instructions:

None.

Related Functions:

INT 13h "Function 00h - Reset Disk Subsystem" on page 32.

5.2.9 Function 15h - Get Disk Type

Description:

Returns the type of disk that applies to the caller's DL register value.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	15h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	If CF = 0: Type of drive corresponding to caller's DL register: 00h = Disk not present 01h = Floppy disk drive without disk change detect 02h = Floppy disk drive with disk change detect 03h = Fixed disk If CF = 1: Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33
CX:DX	Number of 512 byte sectors on disk

Special Instructions:

None.

Related Functions:

INT 13h "Function 17h - Set Disk Type" on page 41.

5.2.10 Function 16h - Get Disk Change Status

Description:

Returns the value of the floppy controller disk status change line, indicating whether the user has removed or inserted a floppy diskette in the specified drive since the last read, write, or verify operation on that drive.

Supports:

Floppy disk only.

Passed:

Parameter	Description
AH	16h
DL	Drive number

Returns:

Parameter	Description
AH	Disk change status, where: 00h = No status change has occurred 06h = Diskette status has changed

Special Instructions:

The operating system issues this function before each floppy diskette read or write to determine if its current FAT (file allocation table) record is valid. The value returned by this function is valid only if the system supports the disk change status line. Operating systems first invoke INT 13h Function 15h (Get Disk Type) to determine if the installed floppy disk controller and/or BIOS supports status change detection.

Related Functions:

INT 13h "Function 15h - Get Disk Type" on page 39.

5.2.11 Function 17h - Set Disk Type

Description:

Used by older operating systems to specify the physical geometry of a floppy disk to be formatted. Modern operating systems use INT 13h, Function 18h (Set Media Type) because it allows for non-standard geometries, such as those used to support 3-mode floppies in the Japan marketplace for NEC and Toshiba systems.

Supports:

Floppy disk only.

Passed:

Parameter	Description
AH	17h
AL	Disk geometry, where: 00h = Diskette not present 01h = 360 KB disk in 360 KB drive 02h = 360 KB disk in 1.2 MB drive 03h = 1.2 MB disk in 1.2 MB drive 04h = 720 KB disk in 720 KB or 1.44 MB drive
DL	Drive number

Returns:

Parameter	Description
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 33

Special Instructions:

None.

Related Functions:

INT 13h "Function 15h - Get Disk Type" on page 39.

5.2.12 Function 18h - Set Media Type

Description:

This function is invoked by the operating system to specify the geometry of the diskette about to be formatted. It supersedes INT 13h, Function 17h, although both are still valid for standard (non 3-mode) 5 1/4” and 3 1/2” disks.

Supports:

Floppy disk only.

Passed:

Parameter	Description
AH	18h
DL	Drive number
CH	Cylinder count
CL	Sectors per track

Returns:

Parameter	Description
AH	00h = Specified geometry is not supported 01h = Function is not supported 80h = Drive is empty
ES:DI	Far pointer to 11-byte floppy diskette parameter table

Special Instructions:

None.

Related Functions:

INT 13h "Function 05h - Format Track (Floppy Disk)" on page 37.
INT 13h "Function 17h - Set Disk Type" on page 41.

6 Non-Removable Media

GeodeROM provides support for the following non-removable media devices:

- SanDisk's CompactFlash (e.g., SanDisk) devices
- Traditional, rotating media IDE drives

Note: The term "ATA Device" describes those devices that support the command protocol described in the Small Form Factor Committee's ATA-4 Specification. CompactFlash and rotating media IDE drives both belong to the family of ATA devices. This chapter uses the terminology "ATA device" to refer to IDE, CompactFlash, and any other similar devices.

GeodeROM is a fully-featured implementation of the traditional (e.g., PC/AT) and extended INT 13h functions, as described in the following documents, concerning PC/AT architecture and programming:

- Enhanced Disk Drive Specification, Revision 1.1, Phoenix Technologies, 1995
- INT 13h Extensions Reference, Revision 1.0, IBM Corporation, 1993
- IBM PC/AT Technical Reference Manual, IBM Corporation, 1984

6.1 ATA Device INT 13h Support

GeodeROM provides INT 13h runtime and boot support for as many as four ATA fixed disks. As in a traditional boot ROM, only device 80h (C: drive) is bootable. GeodeROM supports the INT 13h functions listed in Table 6-1 for each installed ATA device. Functions that do not appear in this list are not supported by GeodeROM.

Table 6-1. INT 13h Functions

Function Number/Name	Page Number
Function 00h - Reset Disk Subsystem	44
Function 01h - Get Disk Subsystem Status	46
Function 02h - Read Sectors	47
Function 03h - Write Sectors	48
Function 04h - Verify Sectors	49
Function 08h - Get Drive Parameters	50
Function 09h - Set Drive Parameters	51
Function 0Ch - Seek to Cylinder	52
Function 0Dh - Alternate Disk Subsystem Reset	53
Function 10h - Test Drive Ready	53
Function 11h - Recalibrate Drive	54
Function 14h - Perform Disk Self-Diagnostic	54
Function 15h - Get Disk Type	55
Function 41h - Check Extensions Present	57
Function 42h - Extended Read Sectors	58
Function 43h - Extended Write Sectors	58
Function 44h - Extended Verify Sectors	59
Function 47h - Extended Seek To Cylinder	59
Function 48h - Extended Get Drive Parameters	60

Note: Functions 41h-48h are INT 13h extensions and are listed in Section 6.3.3 "INT 13h Functions Extensions Descriptions" on page 57.

The format of the caller-supplied parameters and return values adheres to standard industry descriptions of the INT 13h API for floppy drives, as outlined in innumerable references, such as the “IBM PC/AT Technical Reference Manual,” “PC Interrupts”, etc. A description of each function is provided next.

6.2 INT 13h Functions Descriptions

This section describes the parameters and return values for each ATA device-specific INT 13h function in GeodeROM. This section is intended as a guide. Developers interested in extending and/or debugging the GeodeROM INT 13h interface should consult the documentation listed on the AMD Geode™ Developer Support site.

INT 13h provides the operating system with a series of functions for communicating with the system’s fixed and floppy disk drives. The INT 13h interface is a cornerstone of PC/AT compatibility because it ensures that software applications, such as DOS and Microsoft® Windows®, can read and write disk-based data in a uniform fashion, across a broad variety of architectures.

6.2.1 Function 00h - Reset Disk Subsystem

Description:

In an ATA drive-equipped system, this function toggles bit four in register six of the Control Register Block. This causes the disk(s) to recalibrate internally and seek to cylinder.

Supports:

Fixed disks and floppy disks.

Passed:

Parameter	Description
AH	00h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status of the last disk operation: 00h = Operation completed successfully (fixed, floppy) 01h = Illegal/Unrecognized command (fixed, floppy) 02h = Sector address mark not found (fixed, floppy) 03h = Attempt to write to write-protected disk (fixed, floppy) 04h = Sector not found (fixed, floppy) 05h = Reset failure (fixed only) 06h = Diskette change signal (floppy only) 07h = Parameter activity failed (fixed only) 08h = DMA overrun (floppy only) 09h = DMA operation would cross a 64 KB boundary (floppy only) 0Ah = Bad or invalid sector (fixed only) 0Bh = Bad or invalid cylinder (fixed only) 0Ch = Invalid cylinder number (fixed only) 0Dh = Invalid number of sectors supplied during format (fixed only) 0Eh = Controller detected control data address mark (fixed only) 0Fh = DMA arbitration failure (fixed only) 10h = CRC/ECC bad (fixed only) 11h = Data corrected using ECC (fixed only) 20h = Controller failed self test (fixed only) 40h = Error during seek (fixed only) 80h = Command timed out (fixed only) AAh = Drive not ready (fixed only) B0h = Volume not locked in drive B1h = Volume locked in drive B2h = Volume not removable B3h = Volume in use B4h = Lock count exceeded B5h = Valid eject request failed BBh = Unknown error (fixed only) CCh = Write error (fixed only) E0h = Status register error (fixed only) FFh = Media sense failed (fixed only)

Special Instructions:

If DL $\leq$ 80h, both the fixed disks and floppy disks reset.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 46.
INT 13h "Function 0Dh - Alternate Disk Subsystem Reset" on page 53.

6.2.2 Function 01h - Get Disk Subsystem Status

Description:

Returns the status of the last disk operation in the AH register.

Supports:

Fixed disks and floppy disks.

Passed:

Parameter	Description
AH	01h
DL	Drive number

Returns:

Parameter	Description
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

The system BIOS stores the status of the last fixed disk operation in location 40:74h in the BDA. The preferable method for retrieving disk status is the INT 13h interface that enables system software, other than the system BIOS, to provide accurate disk subsystem status.

Related Functions:

None.

6.2.3 Function 02h - Read Sectors

Description:

Reads a caller-specified number of sectors in the buffer specified by the ES:BX register pair.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	02h
AL	Sector count
CH	Cylinder bits [7:0]
CL	Bits [7:6] = Cylinder bits [9:8] Bits [5:0] = Start sector (1-based)
DH	Drive head
DL	Drive number
ES:BX	Far pointer to caller-supplied buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46
AL	Total number of sectors read

Special Instructions:

During a floppy diskette read, the caller ensures that the read operation:
1) Does not cross a 64 KB DMA page boundary (e.g., 2000:0h, 3000:0h, etc.).
2) Does not extend past the end of a physical cylinder.

The “IBM PC/AT Technical Reference Manual” specifies the head register as a 4-bit value; the upper four bits of DH are undefined on this type of system. Newer systems allow for a head value of 0-0FFh, or a maximum of 255 heads. The INT 13h functions in this type of system are capable of translating between physical (drive reported) and logical cylinder, head, sector geometries.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 46.
INT 13h "Function 03h - Write Sectors" on page 48.

6.2.4 Function 03h - Write Sectors

Description:

Writes a caller-specified number of sectors in the buffer specified by the ES:BX register pair.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	03h
AL	Sector count
CH	Cylinder bits [7:0]
CL	Bits [7:6] = Cylinder bits [9:8] Bits [5:0] = Start sector (1-based)
DH	Drive head
DL	Drive number
ES:BX	Far pointer to caller-supplied buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46
AL	Total number of sectors written

Special Instructions:

During a floppy diskette write, the caller ensures that the write operation:
1) Does not cross a 64 KB DMA page boundary (e.g., 2000:0h, 3000:0, etc.).
2) Does not extend past the end of a physical cylinder.

The “IBM PC/AT Technical Reference Manual” specifies the head register as a 4-bit value; the upper four bits of DH are undefined on this type of system. Newer systems allow for a head value of 0-0FFh, or a maximum 255 heads. The INT 13h functions in this type of system are capable of translating between physical (drive reported) and logical cylinder, head, sector geometries.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 46.
INT 13h "Function 02h - Read Sectors" on page 47.

6.2.5 Function 04h - Verify Sectors

Description:

Verifies the existence and integrity of the sectors specified by the caller.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	04h
AL	Sector count
CH	Bits [7:0] = Cylinder bits [7:0]
CL	Bits [7:6] = Cylinder bits [9:8] Bits [5:0] = Start sector (1-based)
DH	Drive head
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46
AL	Number of sectors successfully written

Special Instructions:

During a floppy diskette verify, the caller ensures the verify operation:
1) Does not cross a 64 KB DMA page boundary (e.g., 2000:0h, 3000:0, etc.).
2) Does not extend past the end of a physical cylinder.

The “IBM PC/AT Technical Reference Manual” specifies the head register as a 4-bit value; the upper four bits of DH are undefined on this type of system. Newer systems allow for a head value of 0-0FFh, or a maximum of 255 heads. The INT 13h functions in this type of system are capable of translating between physical (drive reported) and logical cylinder, head, sector geometries.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 46.
INT 13h "Function 02h - Read Sectors" on page 47.
INT 13h "Function 03h - Write Sectors" on page 48.

6.2.6 Function 08h - Get Drive Parameters

Description:

Returns the geometry of the caller-specified drive in terms of cylinders, heads, and sectors. If the specified drive is a “large” IDE drive whose physical cylinder count exceeds 1024, this function returns “logical” or “translated” parameters.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	08h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
DL	Drive number
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46
BL	Floppy drive type (AT, PS/2 only)
DL	Number of installed drives of this type (see “Special” below)
DH	Maximum head number (0-based)
CH	Bits [7:0] = Maximum cylinder number bits [7:0]
CL	Bits [7:6] = Maximum cylinder number bits [9:8] Bits [5:0] = Maximum sector number bits [5:0]
ES:DI	Far pointer to drive parameter table

Special Instructions:

The DL register returns what some manuals refer to as “the number of consecutive acknowledging drives”. This means, “the number of drives of this type”. For example, if your application calls this function with DL = 0, upon return DL contains the number of installed floppy drives.

Related Functions:

None.

6.2.7 Function 09h - Set Drive Parameters

Description:

Initializes the fixed disk controller with the parameters that correspond to the installed drive. The intent of this function was originally to allow a plug-in ISA drive controller to service many different types of drives. Since IDE drives have an integrated controller, this function is theoretically no longer necessary, as the controller is specifically designed to support the geometry of the drive it is physically attached to. However, many drive controllers still require that the BIOS issue this interrupt during POST.

Supports:

Fixed disk only.

Passed:

Parameter	Description
AH	09h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

The vectors at 0:[41h*4] (INT 41h) and 0:[46h*4] (INT 46h) point to the parameter tables for drives 80h (C:) and 81h (D:), respectively. Issuing INT 13h Function 09h with DL = 80h or 81h causes the BIOS to download those parameters pointed to by the corresponding vector to the drive's controller. In a four-drive system, there are no such interrupt vectors, and the actual location of the parameter tables for drives 82h (E:) and 83h (F:) are unknown to the caller.

Traditionally, fixed disks have a "native" cylinder/head/sector count. Ideally, it is these values that are used by the BIOS to initialize the drive during POST. This guarantees the drive's interpretation of the caller's CHS values during a Read/Write/Verify operation are always correct. Some drives behave poorly when initialized with non-native parameters and map sectors.

Related Functions:

None.

6.2.8 Function 0Ch - Seek to Cylinder

Description:

Moves the drive's read/write head to the caller-specified cylinder. In modern systems, it is used primarily for testing the performance of the drive.

Supports:

Fixed disk only.

Passed:

Parameter	Description
AH	0Ch
DL	Drive number
DH	Head number
CH	Bits [7:0] = Cylinder bits [7:0]
CL	Bits [7:6] = Cylinder bits [9:8]

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

In modern drives, a Read/Write/Verify command causes the drive to seek to the caller-specified cylinder automatically. However, this function remains a favorite of disk performance benchmark applications.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 46.

6.2.9 Function 0Dh - Alternate Disk Subsystem Reset

Description:

Reinitializes the fixed disk controller, resets the specified drive's parameters, and recalibrates the drive's heads (seek to track 0). Both the master and slave drives respond to the reset function.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	0Dh
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

None.

Related Functions:

INT 13h "Function 00h - Reset Disk Subsystem" on page 44.

6.2.10 Function 10h - Test Drive Ready

Description:

Returns whether the disk is ready.

Supports:

Fixed disk only.

Passed:

Parameter	Description
AH	10h
DL	Drive number (80h = primary HDD, 81h = secondary HDD)

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

None.

Related Functions:

None.

6.2.11 Function 11h - Recalibrate Drive

Description:

Issues a recalibrate ATA command to the fixed disk specified in the DL register and returns the status of the operation.

Supports:

XT, AT, PS/2 fixed disk only.

Passed:

Parameter	Description
AH	11h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

None.

Related Functions:

INT 13h "Function 01h - Get Disk Subsystem Status" on page 46.

6.2.12 Function 14h - Perform Disk Self-Diagnostic

Description:

Performs controller diagnostics and returns the result.

Supports:

Fixed disk only.

Passed:

Parameter	Description
AH	14h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

None.

Related Functions:

None.

6.2.13 Function 15h - Get Disk Type

Description:

Returns the type of disk that applies to the caller's DL register value.

Supports:

Fixed disk and floppy disk.

Passed:

Parameter	Description
AH	15h
DL	Drive number

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	If CF = 0: Type of drive corresponding to caller's DL register: 00h = Disk not present 01h = Floppy disk drive without disk change detect 02h = Floppy disk drive with disk change detect 03h = Fixed disk If CF = 1: Status code: S ee AH in "Function 01h - Get Disk Subsystem Status" on page 46
CX:DX	Number of 512 byte sectors on disk

Special Instructions:

None.

Related Functions:

None.

6.3 INT 13h Extensions API

The functions in this section were defined by IBM in the document entitled, “INT 13h Extensions API” as an alternate mechanism for handling large IDE drives and to provide a uniform API for devices that support removable media. The functions in this extended API share a common data structure called the Disk_Address_Packet, whose format appears here:

```
Disk_Address_Packet        STRUCT 1
       Packet_Size         db     16     ; Size of this packet in bytes
       Reserved            db     0      ; Reserved / Unused
       Block_Count         dw     0      ; Number of blocks (sectors) to transfer
       pBuffer             dd            ; SEG:OFFSET address of transfer buffer
       Block_Offset        dq            ; Starting device block number
Disk_Address_Packer ENDS
```

Packet_Size - The supporting firmware examines the Packet_Size field to determine if it can support the caller’s request. A value other than 16 indicates that the caller is requesting support for a revision of this API that does not yet exist. In this case, the BIOS would return with CF = 1 and an error code.

Block_Count - On input, Block_Count is the number of blocks (sectors) the caller wants to transfer. On output, it represents the number of blocks actually transferred. Zero is a legal value, and implies that no data be transferred.

pBuffer - The segment offset pointer to the start of the caller-supplied data transfer buffer.

Block_Offset - The absolute logical block number on the device.

6.3.1 Calling Conventions

Wherever possible, these extensions share the following register usage convention:

- DS:SI: Far pointer to Disk_Address_Packet structure
- DL: Drive number (80h = C:, 81h = D:, etc.)
- AH: On input, contains the function index. On output, contains the function return status.

The following return codes have been added to support these extensions:

- B0h: Volume not locked in drive
- B1h: Volume locked in drive
- B2h: Volume not removable
- B3h: Volume in use
- B4h: Lock count exceeded
- B5h: Valid eject request failed

6.3.2 INT 13h Extensions API Subsets

The INT 13h extensions API allows implementors to support certain subsets of the entire interface without violating that specification. Each subset is well defined, and if supported, must be done so in its entirety.

6.3.2.1 Large IDE Drive Support API Subset

This subset consists of the following functions:

- Function 41h: Check Extensions Present
- Function 42h: Extended Read Sectors
- Function 43h: Extended Write Sectors
- Function 44h: Extended Verify Sectors
- Function 47h: Extended Seek to Cylinder
- Function 48h: Extended Get Drive Parameters

6.3.2.2 Removable Media Lock/Eject API Subset

This subset consists of the following functions:

- Function 41h: Check Extensions Present
- Function 45h: Lock/Unlock Drive (not supported)
- Function 46h: Eject Drive (not supported)
- Function 48h: Extended Get Drive Parameters
- Function 49h: Extended Get Disk Change Status (not supported)
- INT 15h: Removable Media Eject Interrupt (not supported)

Note: If the system contains drives that support removable media and these drives have been assigned a drive index greater than 80h, the system firmware must support the Removable Media API subset for each of these drives.

The operating system determines API subset support by repeatedly issuing the Function 41h for each valid drive in the system.

6.3.3 INT 13h Functions Extensions Descriptions

This section lists the INT 13h function extensions supported in GeodeROM, the parameters that system software supplies to each INT 13h function, and the values that each function returns.

6.3.3.1 Function 41h - Check Extensions Present

Description:

Detects the presence or lack of INT 13h extensions support for a particular drive.

Supports:

Fixed disks only.

Passed:

Parameter	Description
AH	41h
BX	55AAh
DL	Drive index

Returns:

Parameter	Description
CF	0 if extensions are supported for this drive 1 if extensions support is not present for this drive
AX	Version of extensions (= 0100h)
BX	55AAh
CX	API subset support bitmap: Bits [15:2] = Reserved/Unused in this specification revision Bit 0 = 1 if large IDE extensions are supported Bit 1 = 1 if Removable/Lock extensions are supported
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

None.

Related Functions:

None.

6.3.3.2 Function 42h - Extended Read Sectors

Description:

Used to read zero or more blocks of data into host memory. If successful, Block_Count within the Disk_Address_Packet contains the number of sectors successfully transferred.

Supports:

Fixed disks only.

Passed:

Parameter	Description
AH	42h
DL	Drive index
DS:SI	Far pointer to caller-supplied data transfer buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46 for status.

Special Instructions:

None.

Related Functions:

None.

6.3.3.3 Function 43h - Extended Write Sectors

Description:

Used to write zero or more blocks of data into host memory. If successful, Block_Count within the Disk_Address_Packet contains the number of sectors successfully transferred.

Supports:

Fixed disks only.

Passed:

Parameter	Description
AH	43h
DL	Drive index
DS:SI	Far pointer to caller-supplied data transfer buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46.

Special Instructions:

This function fails if the BIOS does not support Write w/Verify for the caller-specified device.

Related Functions:

None.

6.3.3.4 Function 44h - Extended Verify Sectors

Description:

Used to verify zero or more blocks of data into host memory. If successful, Block_Count within the Disk_Address_Packet contains the number of sectors successfully verified.

Supports:

Fixed disks only.

Passed:

Parameter	Description
AH	44h
DL	Drive index
DS:SI	Far pointer to caller-supplied data transfer buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46.

Special Instructions:

This function fails if the BIOS does not support Write w/Verify for the caller-specified device.

Related Functions:

None.

6.3.3.5 Function 47h - Extended Seek To Cylinder

Description:

Positions disk head at a specified sector/block.

Supports:

Fixed disks only.

Passed:

Parameter	Description
AH	47h
DL	Drive index
DS:SI	Far pointer to caller-supplied Disk_Address_Packet

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46

Special Instructions:

None.

Related Functions:

None.

6.3.3.6 Function 48h - Extended Get Drive Parameters

Description:

Returns physical characteristics of the caller-specified drive.

Supports:

Fixed disks only.

Passed:

Parameter	Description
AH	48h
DL	Logical drive number (80h = drive 0, 81h = drive 1, etc.)
DS:SI	Far pointer to caller's buffer to receive drive information structure

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
DS:SI	Pointer to returned drive information structure, see Special (below).
AH	Status code: See AH in "Function 01h - Get Disk Subsystem Status" on page 46.

Special Instructions:

```
DRIVE_INFO STRUCT 1
       info_size    dw          30     ; Size of the DRIVE_INFO structure
       info_flags   dw                 ; Information flag word (see Table 6-2)
       cylinders    dw                 ; Number of drive cylinders
       heads        dw                 ; Number of drive heads
       sectors      dw                 ; Number of drive sectors per track
       sectors      dq                 ; Total number of drive sectors
       sector_size  dw                 ; Number of bytes per sector on drive
DRIVE_INFO ENDS
```

The info_size field contains the size in bytes of the buffer passed in and returned, including this field. It must be set by the caller before invoking this function, indicating the size of the buffer passed in. It is also filled in on return, indicating the size of the buffer returned. The returned size cannot be larger than the passed-in size. This mechanism allows the returned values of this function to be extended in the future with a minimum of compatibility problems. The info_flags field is used to return additional information about the disk characteristics. Currently bits [6:0] are defined, and bits [15:7] are reserved and must be set to zero by the implementor. Table 6-2 on page 61 gives the formats for bits [6:0] of the flags field.

Related Functions:

None.

Table 6-2. info_flag Field

Bit	Description
15:7	Reserved: Must be set to zero by the implementor.
6	0 if CHS values are for the media that is currently in the drive (removable media only); values must be returned for the media if the media is in the drive. 1 if CHS values are fully supported by the drive (when there is no media in the drive).
5	0 if drive is not lockable. 1 if drive is lockable. Bit 5 must be set for removable drives accessed via drive numbers 80h and above, as well as appropriate drives numbered 0-7Fh.
4	0 if drive does not have change line support. 1 if drive has change line support. Bit 4 must be set for removable drives accessed via drive numbers 80h and above, as well as appropriate drives numbered 0-7Fh.
3	0 if drive does not support write with verify. 1 if drive supports write with verify. Bit 3 indicates whether Write w/Verify (4301h) is supported on this drive.
2	0 if drive is not removable. 1 if drive is removable.
1	0 if CHS-per-track info is not supplied. 1 if CHS-per-track info is valid. Bit 1 is clear for block devices for which traditional geometry descriptions are inappropriate.
0	0 if DMA boundary errors may occur. 1 if DMA boundary conditions are handled transparently by the BIOS.

6.4 INT 13h ATA Device (Fixed Disk) Data Structures

The lower 1 MB of RAM in a PC/AT compatible system contains a hodgepodge of “compatible” locations and data structures. Several of these locations are related directly to fixed disk support.

6.4.1 BIOS Data Area (BDA)

Initially, the BIOS existed in ROM. It had no RAM to store information about the machine it was executing. For this reason, early BIOS designers chose to use a 256-byte region in lower RAM for themselves. They named this region the BIOS Data Area (BDA).

The BDA resides between 40:0h and 40:FFh. It contains a variety of dissimilar items, ranging in function from the INT 09h scan code buffer, to serial/parallel port timeout values, to installed RAM and equipment descriptors.

The BDA is a 256 byte region starting at Offset 0:400h. The BIOS creates and uses this area because the BIOS exists in ROM and has no dynamic RAM in its own address space for storing dynamic information such as device status and configuration. Table 6-3 describes the layout of the BDA.

Table 6-3. Format of the BIOS Data Area

Offset	Size	Description
00h	WORD	Base I/O address of first serial I/O port; zero if none.
02h	WORD	Base I/O address of second serial I/O port; zero if none.
04h	WORD	Base I/O address of third serial I/O port; zero if none.
06h	WORD	Base I/O address of fourth serial I/O port; zero if none. Above fields filled in by POST as it finds serial ports. POST never leaves gaps. DOS and BIOS serial device numbers may be redefined by reassigning these fields.
08h	WORD	Base I/O address of first parallel I/O port; zero if none.
0Ah	WORD	Base I/O address of second parallel I/O port; zero if none.
0Ch	WORD	Base I/O address of third parallel I/O port; zero if none.
0Eh	WORD	Segment of Extended BIOS Data Segment (see Section 6.4.2 "Extended BIOS Data Area (EBDA)" on page 66).
10h	WORD	Installed hardware: Bits [15:14] = Number of parallel devices Bits [13:12] = Unused Bits [11:9] = Number of serial devices Bits [8:7] = Unused Bit 6 = Secondary floppy installed Bits [5:4] = Initial video mode: 00 = EGA,VGA 01 = 40x25 CGA 10 = 80x25 CGA 11 = 80x25 Monochrome Bit 3 = Unused Bit 2 = PS/2 pointing device installed Bit 1 = Coprocessor install Bit 0 = Primary (boot) floppy installed
12h	BYTE	POST scratchpad byte.
13h	WORD	Base RAM (0-640 KB) size.
15h	BYTE	Reserved.
16h	BYTE	Reserved.

Table 6-3. Format of the BIOS Data Area (Continued)

Offset	Size	Description
17h	BYTE	Keyboard status byte (1 of 2): Bit 7 = INSert key active Bit 6 = CapsLock key active Bit 5 = NumLock key active Bit 4 = Scroll Lock key active Bit 3 = Either ALT key pressed Bit 2 = Either CTRL key pressed Bit 1 = Left Shift key pressed Bit 0 = Right Shift key pressed
18h	BYTE	Keyboard Status byte (2 of 2): Bit 7 = INSert key pressed Bit 6 = CapsLock key pressed Bit 5 = NumLock key pressed Bit 4 = Scroll Lock key pressed Bit 3 = Pause state is active Bit 2 = SysReq key pressed Bit 1 = Left ALT key pressed Bit 0 = Left CRTL key pressed
19h	BYTE	Keyboard Alt-<Number> Scratchpad: Used by the BIOS to build a three-digit ALT-nnn ASCII code.
1Ah	WORD	Keyboard: Offset of next character in the keyboard buffer that starts at 40:1Eh.
1Ch	WORD	Keyboard: Offset of next empty location in the keyboard buffer that starts at 40:1Eh.
1Eh	16 WORDs	16 Character keyboard buffer.
3Eh	BYTE	Diskette recalibrate status: Bit 7 = Floppy controller IRQ occurred Bits [6:4] = Unused Bit 3 = 1 if diskette 3 requires recalibration Bit 2 = 1 if diskette 2 requires recalibration Bit 1 = 1 if diskette 1 requires recalibration Bit 0 = 1 if diskette 0 requires recalibration
3Fh	BYTE	Diskette drive motor status: Bit 7 = 0 if current operation is verify or read Bit 7 = 1 if current operation is format or write Bit 6 = Unused Bits [5:4] = Currently selected diskette drive (0-3) Bit 3 = 1 if diskette 3 motor is on Bit 2 = 1 if diskette 2 motor is on Bit 1 = 1 if diskette 1 motor is on Bit 0 = 1 if diskette 0 motor is on
40h	BYTE	Number of 18.2 Hz timer ticks until floppy motor is shut off.
41h	BYTE	Status of last diskette operation (0 = No error): Bit 7 = 1 if drive not ready Bit 6 = 1 if a seek error occurred Bit 5 = 1 if a controller failure occurred Bits [4:0] = Other error conditions: 01h = Invalid command 02h = Sector address mark not found 03h = Disk write protect error 06h = Change line is active 08h = DMA overrun 09h = Attempt to DMA across 64 KB page boundary 0Ch = Unable to determine media type 0Eh = CRC error during read operation

Table 6-3. Format of the BIOS Data Area (Continued)

Offset	Size	Description
42h[1]	7 BYTEs	PC/XT only disk subsystem command/status bytes.
49h	BYTE	Current video mode.
4Ah	WORD	Number of columns in current text page.
4Ch	WORD	Size of current video page in bytes.
4Eh	WORD	Current video page start address.
50h	16 BYTEs	Row/column of cursor position in each of eight text video pages.

60h	WORD	Video cursor type, 6845 compatible:
		MSB = Startline
		LSB = Endline

62h	BYTE	Video current page number.

63h	WORD	Video CRT controller base address:
		Color = 03D4h
		Mono = 03B4h

65h	BYTE	Video current setting of mode select register 03D8h/03B8h.
66h	BYTE	Video current setting of CGA palette register 03D9h.
67h	DWORD	Real mode re-entry address for BIOS shutdown from protected mode sequences.
6Bh	BYTE	Ordinal value of last spurious interrupt.
6Ch	DWORD	Number of IRQ0 timer ticks since 12:00AM.
70h	BYTE	Date rollover flag: Non-zero if timer has overflowed (crossed midnight) since the last INT 1Ah GET_TIME call.
71h	BYTE	Ctrl-Break status: Bit 7 = 1 if Ctrl-Break key has been pressed.
72h	WORD	System reset signature: Contains 1234h during CTRL-ALT-DEL (warm) boot.
74h[1]	BYTE	Status of last fixed disk operation: 00h = No error 01h = Invalid function requested 02h = Sector address mark not found 03h = Disk is write protected 04h = Sector not found 05h = Reset operation failed 07h = Drive parameters invalid 08h = DMA overrun 09h = Attempt to DMA across 64K page boundary 0Ah = Bad sector error 0Bh = Bad cylinder 0Dh = Invalid number of sectors requested 0Eh = Control data address mark found 0Fh = DMA arbitration error 10h = Unrecoverable CRC error 11h = ECC data correction occurred 20h = General controller failure 40h = Seek operation failed 80h = Drive timed out AAh = Drive not ready error BBh = Unknown error CCh = Error during write E0h = Unknown error FFh = Media sense failed
75h[1]	BYTE	Number of installed fixed disks.

Table 6-3. Format of the BIOS Data Area (Continued)

Offset	Size	Description
76h[1]	BYTE	Head control byte (= 8 if head count > 8).
77h	BYTE	Reserved.
78h	3 BYTEs	Timeout count bytes for LPT1-LPT3.
79h	BYTE	Reserved.
7Ch	4 BYTEs	Timeout count bytes for COM1-COM3 devices.
80h	WORD	Keyboard buffer start location override (relative to 40:0h).
82h	WORD	Keyboard buffer end offset + 1 override (relative to 40:0h).
84h	BYTE	Maximum video text row.
85h	WORD	Height of EGA/MCGA/VGA character in scan lines.
87h	BYTE	Video EGA/VGA control byte.
88h	BYTE	Video EGA/VGA switches.
89h	BYTE	Reserved.
8Ah	BYTE	Video [MCGA/VGA]: index into display code table.
8Bh	BYTE	Diskette media control byte: Bits [7:6] = Data rate used during last operation: 00 = 500 KB/second 01 = 300 KB/second 10 = 250 KB/second 11 = Reserved Bits [5:4] = Diskette step rate used during last operation Bits [3:0] = Reserved
8Ch[1]	BYTE	Last BIOS read of Fixed Disk Status register.
8Dh[1]	BYTE	Last BIOS read of Fixed Disk Error register.
8Eh[1]	BYTE	INT 13h IRQ semaphore.
8Fh	BYTE	Diskette controller information byte.
90h	BYTE	Diskette drive 0 media state (used internally by INT 13h diskette drive state machine).
91h	BYTE	Diskette drive 1 media state (used internally by INT 13h diskette drive state machine).
92h	BYTE	Diskette drive 0 media state at start of operation.
93h	BYTE	Diskette drive 1 media state at start of operation.
94h	BYTE	Diskette drive 0 current track number.
95h	BYTE	Diskette drive 1 current track number.
96h	BYTE	Extended keyboard status byte (1 of 2): Bit 7 = 1 if a Read ID command is in progress Bit 6 = 1 if last byte read was first of 2 ID bytes Bit 5 = 1 force NumLock during Read ID command Bit 4 = 1 if enhanced PC/AT keyboard installed Bit 3 = 1 if right ALT key is pressed Bit 2 = 1 if right CTRL key is pressed Bit 1 = 1 if last byte read from KBC was E1h Bit 0 = 1 if last byte read from KBC was E0h

Table 6-3. Format of the BIOS Data Area (Continued)

Offset	Size	Description
97h	BYTE	Extended keyboard status byte (2 of 2): Bit 7 = 1 if a keyboard transmit error occurred Bit 6 = 1 if an LED update is in progress Bit 5 = 1 if the keyboard issued a RESEND Bit 4 = 1 if the keyboard issued an ACK Bit 3 = Reserved Bit 2 = Current status of CapsLock LED Bit 1 = Current status of NumLock LED Bit 0 = Current status of ScrollLock LED
98h	DWORD	Far pointer to user-specified elapsed time semaphore byte (see INT 15h Function 83h, Wait For Event): Bit 7 = 1 if delay is elapsed
9Ch	DWORD	User-specified wait Timer2: [AT, PS exc Mod 30] user wait count in 972 ns increments
A0h-FFh	5Fh BYTEs	Reserved for OEM-specific BIOS features.
100h	BYTE	Print Screen Status byte.

1. Reserved for use by the fixed disk subsystem.

6.4.2 Extended BIOS Data Area (EBDA)

Eventually, the 256-byte BDA proved to be too small and a second area, appropriately named the “Extended BIOS Data Area” or EBDA was created. The EBDA was originally intended for storing PS/2 pointing device data. Many current systems use this area for storing fixed disk information.

The EBDA is typically 1 KB in length. The EBDA may be larger, however it is always in multiples of 1 KB increments. The segment where the EBDA is located is a WORD value stored at 40:0Eh. Typically this value is 9FC0h, or 1 KB below the end of lower 640 KB RAM. The BYTE located at EBDA:0h describes the length of this area in 1 KB increments.

Note: A value of zero in the WORD sized EBDA start segment at 40:0Eh does not mean the EBDA starts at physical location zero. It means the system does not use an EBDA.

There is no fixed format for EBDA usage other than for those locations reserved for the PS/2 pointing device.

6.5 INT 41h/46h Vectors

INT 41h and INT 46h are not interrupt vectors in the normal sense. Attempting to execute an INT 41h or INT 46h instruction is likely to crash the system immediately. These locations hold 32-bit segment:offset pointers to physical parameter tables for fixed disks 0 and 1, respectively. If the fixed disk count in location 40:75h is one, only the pointer in the INT 41h location (0:104h) is valid. If the value in 40:75h is two, both pointers are valid.

The INT 41h and INT 46h vectors are “well-behaved” low memory locations, meaning they should contain valid information on any PC/AT or compatible system. Each of these pointers references the same type of parameter table structure, shown in Section 6.5.1 in MASM-compatible form.

6.5.1 Standard Disk Drive Parameter Table

Below is the standard IBM PC/AT style fixed disk parameter table.

```
;STRUCT FIXED_PARMS - THE ORIGINAL PC/AT FIXED DISK PARAMETER TABLE
FIXED_PARMS STRUCT 1
       FP_CYLS            WORD         ?      ; Maximum cylinder
       FP_HEADS           BYTE         ?      ; Maximum head
       FP_RES1            WORD         ?      ; Unused
       FP_WR_PRECMP       WORD         ?      ; Write pre-comp start cylinder
       FP_RES2            BYTE         ?      ; Unused
       FP_CTL             BYTE         ?      ; Extended head count flag
       FP_RES3            BYTE         ?      ; Unused
       FP_RES4            BYTE         ?      ; Unused
       FP_RES5            BYTE         ?      ; Unused
       FP_LANDING         WORD         ?      ; Head parking cylinder
       FP_SPT             BYTE         ?      ; Sectors per track
       FP_RES6            BYTE         ?
FIXED_PARMS ENDS
```

The following clarifies some of the fields in the Fixed Disk Parameter table above:

- **FP_WR_PRECMP, Write Pre-Comp:**
  — Early drives were formatted with the same number of sectors per cylinder and required the BIOS to compensate for the fact that the magnetic media near the edge of a disk is farther apart than the media located closer to the center of the disk. The Write Pre-Comp field tells the BIOS the exact cylinder at which to start compensating during write operations on older drives. Modern drives vary the number of sectors per track and automatically convert the caller’s CHS parameters to the correct physical byte on the disk and therefore do not require the information in this field.
- **FP_LANDING, Head Parking Cylinder:**
  — Early drives required BIOS or application support to seek to the landing-zone cylinder, a cylinder designated as a safe place to leave the read/write heads if the drive was to be physically moved. Modern drives automatically park their read/write heads when power is removed and the information in this field is no longer needed.
- **FP_CTL, Extended Head Count Flag**
  — On old machines, this flag signifies a drive that contains eight or more read/write heads. Although this bit is still supported, applications and utilities pay little or no attention to it anymore.

6.5.2 Enhanced Disk Drive Parameter Table

The Enhanced Disk Drive (or EDD) table is backwardly compatible with the standard parameter table (described in Section 6.5.1 "Standard Disk Drive Parameter Table" on page 67). The preceding discussion (Section 6.5 "INT 41h/46h Vectors" on page 67) applies to this type of table as well as the standard IBM drive parameter table. Modern systems support the EDD table, which is a superset of IBM’s original table.

The EDD table format was introduced by Phoenix Technologies and is valuable for a few reasons. First, because it is checksummed, an EDD table allows applications to verify that the data being examined is really a disk parameter table and not just random data in the system’s ROM or RAM. Second, the EDD table provides the BIOS scratchpad space to record geometry translation information. Lastly, the format of the EDD table allows system software to determine if and what kind of translation is currently active based on the contents of its physical vs. logical cylinder, head, and sector counts.

The format of the EDD table appears here in MASM-compatible format:

```
; STRUCT EDD_PARMS - ENHANCED DISK DRIVE TABLE
EDD_PARMS STRUCT 1
      LOGCYL       DW          ?      ; Maximum Logical Cylinder
      LOGHEAD      DB          ?      ; Maximum Logical Head
      SIGNATURE    DB          ?      ; Translation Active Signature
      PHYSPT       DB          ?      ; Physical Sector/Track Count
      WPRECOMP     DW          ?      ; Write Pre-Comp Cylinder
      RSV2         DB          ?      ; Unused/Reserved
      CTRLBYTE     DB          ?      ; Extended Head Count Flag
      PHYCYLN      DW          ?      ; Maximum Physical Cylinder
      PHYHEAD      DB          ?      ; Maximum Physical Head
      LZONE        DW          ?      ; Head Park Cylinder
      LOGSPT       DB          ?      ; Logical Sector/Track Count
      CHKSUM       DB          ?      ; Checksum Byte
EDD_PARMS ENDS
```

The difference between “physical” and “logical” parameters is a source of confusion when learning about and interfacing with IDE devices.

The physical parameters that a drive reports are a reference point shared by the drive and the system software. It is hard to imagine a 2.5” portable fixed disk actually having fifteen individual read/write heads inside a housing that stands about a half inch tall, however, this is the number of “physical” heads that many such drives report.

Logical parameters are those parameters that the system BIOS reports to the operating system. They may or may not be the same as the physical parameters reported by the drive itself. If the logical parameters differ from the physical parameters, the BIOS has some kind of translation active. To understand why translation is important and often necessary, refer to Section 6.3.2.1 "Large IDE Drive Support API Subset" on page 56, which describes the methods used by system firmware and drivers to support “Large” IDE drives.

6.5.3 Fixed Disk Parameter Table Extensions

In addition to determining the physical geometry of a fixed disk, it is useful to determine other fixed disk configuration parameters such as base I/O addresses, IRQ assignments, etc. For this reason, many newer system BIOS implementations support Fixed Disk Parameter Table Extensions (FDPTs).

Within such a system, the FDPTs take much of the guesswork out of determining the physical geometry and resources assigned to the system's fixed disks. If the system BIOS supports the INT 13h Functions Extensions, as described by IBM, there exists for each fixed disk in the system a FDPT00 that the user can retrieve by issuing INT 13h Function 48h.

Note: The FDPTs are an enhancement introduced to IBM's original INT 13h Function Extensions by Phoenix Technologies. In order to determine if the FDPTs support is present within the system, the caller should first issue INT 13h Function 41h, as shown in Section 6.3.3.1 "Function 41h - Check Extensions Present" on page 57.

The Fixed Disk Parameter Table Extension is a 16-byte table that adheres to the format described in Table 6-4. This FPDT is available only if the Check Extensions Present function described in Section 6.3.3.1 on page 57 returns a major version of 20h or greater.

Table 6-4. Fixed Disk Parameter Table (FDPT)

Offset	Size	Description
00h	WORD	Controller I/O Port Base Address (i.e., 1F0h): Contains the I/O port base address for the drive. For example, if the drive is connected to the primary IDE controller in a PC/AT compatible system, this field contains the value 1F0h.
02h	WORD	Drive Control Port Address (i.e., 3F6h): Contains the address of the control port for the drive. For example, if the drive is connected to the primary IDE controller in a PC/AT compatible system, this field contains the value 3F6h.
04h	BYTE	Status byte #1, drive head register prefix: The drive head register prefix byte serves two purposes. First, it indicates to the caller of INT 13h Function 48h if the drive is in Large Block Address (LBA) mode, and whether the drive is a master or slave drive. Second, the BIOS stores the LBA and master/slave information in the same form as the upper four bits of the drive controller's head register. This simplifies the BIOS' programming of the drive's master/slave and LBA modes because during a disk read/write operation, the BIOS merely ORs this value with the desired drive head when it programs the head register. Bit 7 = Reserved: Must be set to 1 Bit 6 = If set, the drive is in LBA mode, otherwise the drive is CHS Bit 5 = Reserved: Must be set to 1 Bit 3 = If set, the drive is an IDE master, otherwise the drive is a slave Bits [3:0] = Reserved: Must be set to 0
05h	BYTE	Reserved: Bits [7:4] are always 0.
06h	BYTE	Drive IRQ Assignment: Contains the ordinal number of the IRQ assigned to the drive.
07h	BYTE	Multi-Sector Transfer Byte Count: Contains the number of sectors the BIOS transfers during a read or write to the drive.
08h	BYTE	Drive DMA Assignment: Bits [7:4] = Specify the ATA-DMA mode in which the drive is currently operating. Bits [3:0] = Contain the ordinal number of the DMA channel currently assigned to the drive. If the drive does not support DMA, or is not currently in DMA mode, the value in this field is undefined.
09h	BYTE	Drive PIO (Programmable I/O) Timings: Contains the ordinal number of the Small Form Factor Committee-specified PIO mode in which the drive is currently operating. Legal values for this field are 1, 2, 3 and 4. The SFF Committee ATA-2 specification contains a comprehensive explanation of each PIO timing mode.

Table 6-4. Fixed Disk Parameter Table (FDPT) (Continued)

Offset	Size	Description
0Ah	BYTE	Drive Description Byte: Bit 7 = If set, the system has been configured to perform DWORD-wide transfers for this drive. Otherwise, the system performs WORD-wide transfers to and from the drive. Bit 6 = If set, the drive is a CD-ROM device. Bit 5 = If set, the drive supports removable media. Bit 4 = If set, the system has configured the drive to operate in LBA mode. Bit 3 = If set, the BIOS is currently configured to perform logical to physical translation of the drive's CHS parameters. Bit 2 = If set, the BIOS is configured to transfer data to and from the drive in multi-sector mode and the Multi-sector Transfer Count Byte data is valid. Bit 1 = If set, the system is configured to transfer data to and from the drive via DMA and the DMA Assignment Byte data is valid. Bit 0 = If set, the system has configured the drive controller to operate in a fast PIO timing mode, and the PIO Mode Type Byte is valid.
0Bh	3 BYTEs	Reserved: Must be set to 0.
0Eh	BYTE	Extension Table Revision ID (= 10h for this structure): Contains the revision ID for the extension table. Currently, the only value defined for this field is 10h. FDPTs do not replace standard drive parameter tables; the information contained in each table is mutually exclusive. Instead, these tables allow the operating system to bypass its comparatively time-consuming and inaccurate process of snooping drive capabilities on systems that do not provide these extensions. Unlike the two standard drive parameter tables in a PC/AT-compatible BIOS, that are available to applications and operating system enumeration software via the INT 41h and INT 46h vectors, only the system BIOS knows the exact location of the system's fixed disk parameter table extensions. Instead of examining drive parameters via interrupt vectors, applications and operating systems that are capable of managing more than two drives invoke INT 13h Function 48h to receive a far pointer to the fixed disk parameter table extension for each of the system's fixed disks, regardless of whether the appropriate INT 41h and INT 46h vectors are currently available for the specified drive. In addition to verifying the FDPTs are present, the calling application or device driver should retrieve all physical disk information via the extended INT 13h Function 48h. See Section 6.3.3.6 "Function 48h - Extended Get Drive Parameters" on page 60.
0Fh	BYTE	Checksum of this Extension Table.

Figure 6-1 on page 71 shows the presence of all tables in a system supporting INT 41h, INT 46h, EDD, ROM-based and FDPT Extensions.

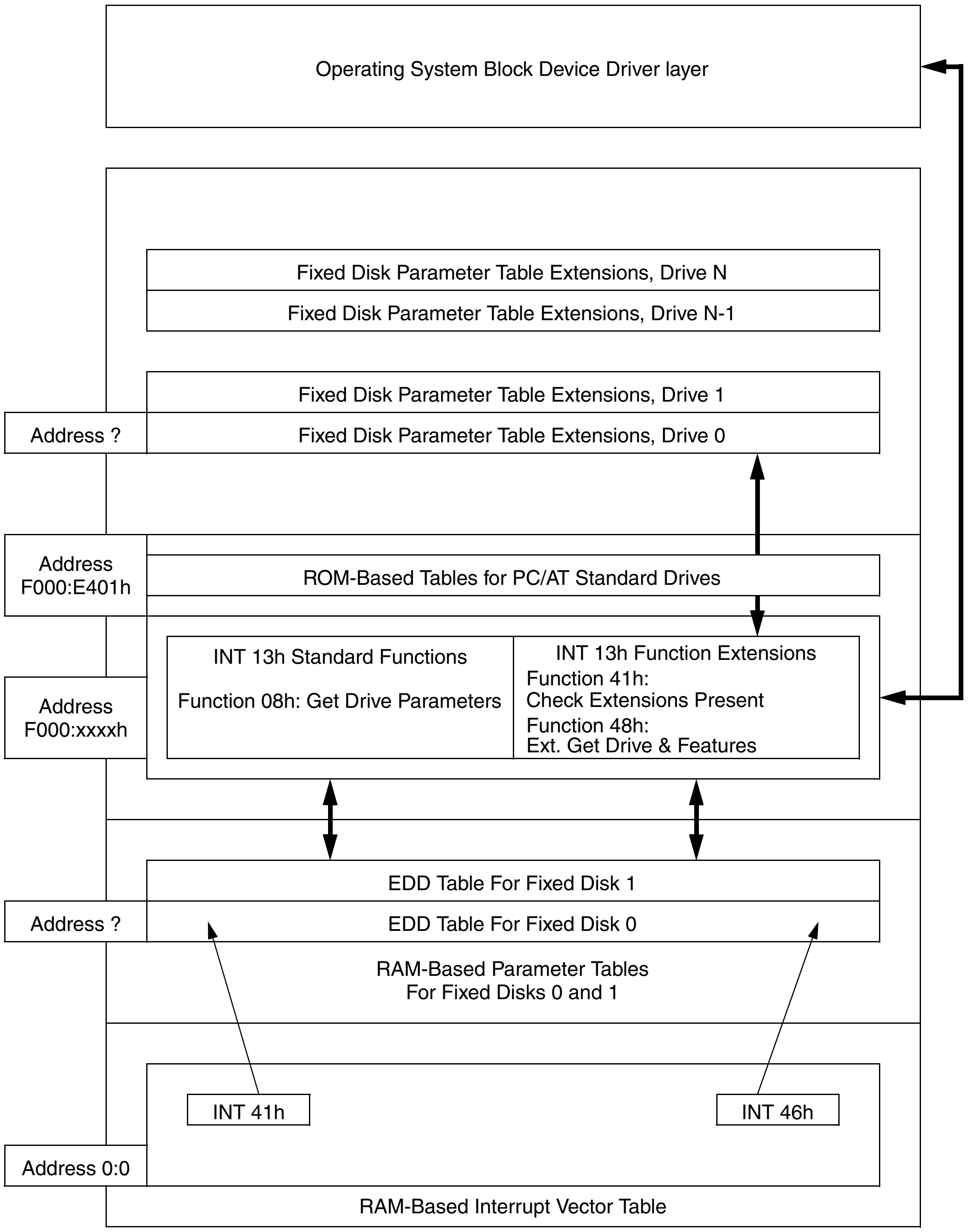

Operating System Block Device Driver layer
Fixed Disk Parameter Table Extensions, Drive N
Fixed Disk Parameter Table Extensions, Drive N-1
Fixed Disk Parameter Table Extensions, Drive 1
Address ?
Fixed Disk Parameter Table Extensions, Drive 0
Address F000:E401h
ROM-Based Tables for PC/AT Standard Drives
INT 13h Standard Functions
Function 08h: Get Drive Parameters
INT 13h Function Extensions
Function 41h: Check Extensions Present
Function 48h: Ext. Get Drive & Features
Address F000:xxxxh
EDD Table For Fixed Disk 1
Address ?
EDD Table For Fixed Disk 0
RAM-Based Parameter Tables For Fixed Disks 0 and 1
INT 41h
INT 46h
Address 0:0
RAM-Based Interrupt Vector Table

Figure 6-1. System BIOS INT 13h Interface with Enhanced IDE Data Structures

7 PCI Support

This chapter describes the support that GeodeROM provides for PCI device enumeration, configuration, and runtime access.

PCI bus architecture is outlined in detail by the following documents:

- PCI Local Bus Specification, revision 2.1 or newer
- PCI BIOS Specification, revision 2.1 or newer
- PCI IDE Specification, revision 1.0
- PCI-PCI Bridge Specification, revision 1.1 or newer

Each of these documents is available through the PCI SIG (Special Interest Group) located at http://www.pcisig.com.

GeodeROM supports all PCI 2.1 BIOS functions except those designed to support getting/setting IRQ routing options. This chapter assumes the reader is familiar with the layout and usage of PCI configuration space. GeodeROM supports the INT 1Ah, B1h PCI BIOS subfunctions listed in Table 7-1.

Table 7-1. INT 1Ah, B1h PCI BIOS Subfunctions

Subfunction Number/Name	Page Number
Subfunction 01h - PCI BIOS Present	75
Subfunction 02h - Find PCI Device	76
Subfunction 03h - Find PCI Class Code	77
Subfunction 06h - Generate Special Cycle	78
Subfunction 08h - Read Config BYTE	79
Subfunction 09h - Read Config WORD	80
Subfunction 0Ah - Read Config DWORD	80
Subfunction 0Bh - Write Config BYTE	81
Subfunction 0Ch - Write Config WORD	81
Subfunction 0Dh - Write Config DWORD	82
Subfunction 0Eh - Get PCI Interrupt Routing Options	82

Directory of 32-Bit Services

GeodeROM provides a 32-bit services table, that is characterized by the ‘_32_’ ASCII signature on a 16-byte boundary in the address range E0000h-FFFF0h.

The purpose of this table is to inform the operating system of the presence and physical location of the 32-bit PCI BIOS services entry point. The layout of this table is described in the PCI BIOS Specification.

PCI IRQ Routing Support

Currently, IRQs are assigned to each device that requires one. All devices are assigned the same IRQ (typically 11) in the Geode™ South Bridge and their INTLINE registers are programmed to reflect this assignment. Therefore, any operating systems that execute in conjunction with GeodeROM must provide drivers that are capable of sharing IRQs.

Power-On PCI Device Configuration Support

During its power-on sequence, GeodeROM assigns IRQs, I/O, and memory ranges to PCI adapters requesting such system resources. GeodeROM scans the PCI bus in ascending order. I/O and memory ranges are assigned in a "top-down" fashion, starting at FFFFh and FFE00000h, respectively.

Assignment of PCI IRQ Channels

The same IRQ channel is assigned to all PCI devices. It is expected that the operating system can share IRQ channels between devices. In a basic implementation, INTA# is routed to IRQ11. Similarly, IRQ11 is programmed to be level sensitive in the Geode South Bridge's ELCR (Edge/Level Configuration register). In cases where the operating system does not support IRQ sharing, GeodeROM can be built to steer PCI interrupt channels other than INTA# to different PC/AT IRQ channels.

Assignment of PCI I/O Ranges

PCI devices are assigned I/O ranges starting above the ISA limit of 0FFFh. Such a strategy ensures there are no resource conflicts between PCI and legacy devices. GeodeROM contains a simple resource allocation module that assigns I/O ranges in descending order as they are required by installed PCI devices.

Assignment of PCI Address Space Ranges

PCI devices are assigned address ranges starting above the ISA limit of 0FFFFFh. Such a strategy ensures there are no resource conflicts between PCI and legacy devices. Additionally, GeodeROM ensures there are no conflicts between those address ranges assigned to PCI devices and the ranges used by SMM software-related functions. GeodeROM contains a simple resource allocation module that assigns address ranges in descending order as required by installed PCI devices.

Support for PCI Option ROM

GeodeROM contains functionality to detect, shadow and initialize PCI option ROMs. As required by the PCI specification, PCI option ROMs are left writable during their initialization sequence to allow such ROMs to modify their own code space.

Support for PCI Bridges

GeodeROM does not contain PCI bridge support except to avoid corrupting a PCI bridge device.

7.1 INT 1Ah, Function B1h PCI BIOS Subfunctions Descriptions

GeodeROM supports real (INT 1Ah) and 32-bit protected mode access to the set of functions defined in revision 2.1 of the PCI BIOS Specification. This section lists those INT 16h Function B1h subfunctions supported in GeodeROM, the parameters that system software supplies to each subfunction, and the values that each function returns.

7.1.1 Subfunction 01h - PCI BIOS Present

Description:

The primary purpose of this function is to signal the presence and revision level of the system's PCI BIOS. Additionally, PCI BIOS Present reports the actual hardware mechanism the PCI BIOS uses to read and write configuration space registers, as well as what type of special cycle support exists in the chipset.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	01h (PCI BIOS Present)

Returns:

Parameter	Description
EDX	20494350h (4-byte ASCII string 'PCI ') if PCI BIOS present
AH	If 00h, and CF and EDX are correct, PCI BIOS is present
AL	Supported hardware mechanism
BH	BCD-encoded major revision of interface supported
BL	BCD-encoded minor revision of interface supported
CL	Zero-based number of last PCI bus in the system
CF	0 if PCI BIOS is present, and AH and EDX are correct 1 if PCI BIOS is not present

If the PCI BIOS Present function returns successfully (CF = 0), the AL register contains Geode South Bridge device-specific information regarding special cycle support and the programming mechanism the system's Geode South Bridge supports.

Table 7-2. AL Register Upon Return From A Successful Call to PCI_BIOS_PRESENT

Bit	Description
7:6	Reserved
5	1: Special cycles are supported via Mechanism #2
4	1: Special cycles are supported via Mechanism #1
3:2	Reserved
1	1: System chipset supports Mechanism #1
0	1: System chipset supports Mechanism #2

7.1.2 Subfunction 02h - Find PCI Device

Description:

Given a vendor ID, device ID, and an index N, the function Find PCI Device finds the Nth device or function whose vendor ID and device ID match those passed into the function. Additionally, Find PCI Device returns the bus number, device number, and function number of the device if it successfully finds a match.

This function is useful for locating all PCI devices in the system that perform the same function. The first return value of DEVICE_NOT_FOUND indicates there are no more devices of the type specified in the system.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	02h (Find PCI Device)
CX	16-Bit device ID
DX	16-Bit vendor ID
SI	Index N (Nth occurrence of PCI device)

Returns:

Parameter	Description
BH	Bus number of device (0-based)
BL	Bits [7:3] = Device number Bits [2:0] = Function number within located device
CF	Function completion status: 0 if device was located 1 if an error occurred, AH contains error code
AH	Function return status codes: 00h = Successful 81h = Unsupported function 83h = Bad vendor ID 86h = Device not found 87h = Bad PCI register number

7.1.3 Subfunction 03h - Find PCI Class Code

Description:

The function Find PCI Class Code returns the Nth occurrence of the device or device function whose class code matches the value passed in the ECX register.

The Find PCI Class Code function is useful for locating all system PCI devices that belong to the same device class. The first return value of DEVICE_NOT_FOUND indicates there are no more devices in the system with the specified class code.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	03h (Find PCI Class Code)
ECX	Class code in lower three bytes
SI	Index N (Nth occurrence of PCI device or function whose class code matches that passed in the ECX register)

Returns:

Parameter	Description
BH	Bus number of device (0-based)
BL	Bits [7:3] = Device number Bits [2:0] = Function number within located device
CF	Function completion status: 0 if device was located 1 if an error occurred, AH contains error code
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

7.1.4 Subfunction 06h - Generate Special Cycle

Description:

The PCI host controller has the ability to broadcast messages across the entire bus by issuing special cycles. When a special cycle occurs, devices on the bus can monitor the message, but must not acknowledge the message by asserting their DEVSEL# (Device Select) signal. PCI devices do not have to respond to special cycles. If a device is capable of responding to special cycles, the system configurator or PCI BIOS enables this capability in a device by setting bit three of its Configuration Space Command register to '1'.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	06h (Generate Special Cycle)
BH	Bus number on which to assert the cycle (0-FFh)
EDX	Special Cycle Data: Bits [15:0] = Special cycle message Bits [31:16] = Message specific data

Returns:

Parameter	Description
CF	Function completion status: 0 if function completed successfully 1 if an error occurred, AH contains error code
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

Special cycle messages consist of a 16-bit message field, that the host controller asserts on address/data lines AD[15:0], and a message field that is asserted in signals AD[31:16]. The meaning of each message field is determined by the PCI SIG and a list of all valid special cycles appears in the PCI Local Bus Specification. Revisions 2.0 and 2.1 of the PCI Local Bus Specification define the following special cycle messages:

- 0000h: System Shutdown
- 0001h: PCI Bus Halt
- 0002h: Intel x86 Architecture-Specific message
- 0003h-FFFFh: Reserved

One useful application of special cycle messages is to broadcast a pending system shutdown to PCI bus devices. For example, a PCI network controller should immediately abort its current network activity in the event of a system shutdown. It is the responsibility of the operating system to issue a PCI BIOS call to generate the system shutdown message (0000h).

7.1.5 Reading and Writing Configuration Space

The PCI BIOS provides applications and drivers for six subfunctions for reading and writing configuration space registers:

- Subfunction 08h: Read Config BYTE
- Subfunction 09h: Read Config WORD
- Subfunction 0Ah: Read Config DWORD
- Subfunction 0Bh: Write Config BYTE
- Subfunction 0Ch: Write Config WORD
- Subfunction 0Dh: Write Config DWORD

When reading or writing a DWORD-sized value in configuration space, the register number specified in the function WRITE_CONFIG_DWORD or READ_CONFIG_DWORD must be on a DWORD boundary, such as 00h, 04h, 08h, etc. Similarly, when reading or writing a WORD-sized value in configuration space, the register number specified in the function WRITE_CONFIG_WORD or READ_CONFIG_WORD must be on a WORD boundary, such as 00h, 02h, 04h, etc. The remaining functions, READ_CONFIG_BYTE and WRITE_CONFIG_BYTE operate correctly on any register boundary within configuration space.

If the calling program attempts an illegal I/O operation, such as a DWORD read of configuration space location 02h, the PCI BIOS returns the value 87h (BAD_REGISTER_NUMBER) in the AH register and sets the carry flag.

7.1.5.1 Subfunction 08h - Read Config BYTE

Description

Reads one BYTE from the configuration space of the caller-specified PCI device.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	08h (Read Config BYTE)
BH	Bus number on which the device resides
BL	Bits [7:3] = Device number Bits [2:0] = Device function number
DI	Register index (0-FFh) within the device’s or function’s configuration space

Returns:

Parameter	Description
CL	Byte read from configuration space
CF	Function completion status: 0 if function completed successfully 1 if an error occurred
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

7.1.5.2 Subfunction 09h - Read Config WORD

Description:

Reads one WORD from the configuration space of the caller-specified PCI device.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	09h (Read Config WORD)
BH	Bus number on which the device resides
BL	Bits [7:3] = Device number Bits [2:0] = Device function number
DI	Register index (0-FFh) within the device's or function's configuration space

Returns:

Parameter	Description
CX	WORD read from configuration space
CF	Function completion status: 0 if function completed successfully 1 if an error occurred, AH contains error code
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

7.1.5.3 Subfunction 0Ah - Read Config DWORD

Description:

Reads one DWORD from the configuration space of the caller-specified PCI device.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	0Ah (Read Config DWORD)
BH	Bus number on which the device resides
BL	Bits [7:3] = Device number Bits [2:0] = Device function number
DI	Register index (0-FFh) within the device's or function's configuration space

Returns:

Parameter	Description
CX	DWORD read from configuration space
CF	Function completion status: 0 if function completed successfully 1 if an error occurred, AH contains error code
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

7.1.5.4 Subfunction 0Bh - Write Config BYTE

Description:

Writes one BYTE to the configuration space of the caller-specified PCI device.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	0Bh (Write Config BYTE)
BH	Bus number on which the device resides
BL	Bits [7:3] = Device number Bits [2:0] = Device function number
CL	Byte value to write to configuration space
DI	Register index (0-FFh) within the device's or function's configuration space

Returns:

Parameter	Description
CF	Function completion status: 0 if function completed successfully 1 if an error occurred, AH contains error code
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

7.1.5.5 Subfunction 0Ch - Write Config WORD

Description:

Writes one WORD to the configuration space of the caller-specified PCI device.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	0Ch (Write Config WORD)
BH	Bus number on which the device resides
BL	Bits [7:3] = Device number Bits [2:0] = Device function number
CX	WORD value to write to configuration space
DI	Register index (0-FFh) within the device's or function's configuration space

Returns:

Parameter	Description
CF	Function completion status: 0 if function completed successfully 1 if an error occurred
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

7.1.5.6 Subfunction 0Dh - Write Config DWORD

Description:

Writes one DWORD to the configuration space of the caller-specified PCI device.

Passed:

Parameter	Description
AH	B1h (PCI Function ID)
AL	0Dh (Write Config DWORD)
BH	Bus number on which the device resides
BL	Bits [7:3] = Device number Bits [2:0] = Device function number
DI	Register index (0-FFh) within the device’s or function’s configuration space
ECX	DWORD value to write to configuration space

Returns:

Parameter	Description
CF	Function completion status: 0 if function completed successfully 1 if an error occurred
AH	Function return status codes: See AH in Section 7.1.2 "Subfunction 02h - Find PCI Device" on page 76.

7.1.5.7 Subfunction 0Eh - Get PCI Interrupt Routing Options

Description:

Passed:

Parameter	Description
AX	B10Eh
BX	0000h
DS	Segment/selector for PCI BIOS data (real mode: F000h; 16-bit PM: physical 000F0000h; 32-bit PM: as specified by BIOS32 services directory).
ES	(E)DI IRQ routing table header

Returns:

Parameter	Description
CF	0 = Success
AH	00h
BX	Bitmap of IRQ channels permanently dedicated to PCI
ES	(E)DISize of returned data
CF	1 = Set on error
AH	Error code
ES	[DI]Required size of buffer

8 Serial Port BIOS Support

GeodeROM supports the standard INT 14h functions listed in Table 8-1 that pertain to the operation of up to four serial ports in the system.

Table 8-1. INT 14h Functions

Function Number/Name	Page Number
Function 00h - Initialize Port	83
Function 01h - Write Character to Port	85
Function 02h - Read Character from Port	85
Function 03h - Get Port Status	86

8.1 INT 14h Serial Port BIOS Functions Descriptions

This section lists those INT 14h functions supported in GeodeROM, the parameters that system software supplies to each INT 14h function, and the values each function returns. The I/O address(es) of any port(s) in the system are stored in the BDA by POST. The WORD-length addresses begin at 40:0h and can go through 40:6h.

8.1.1 Function 00h - Initialize Port

Description:

Sets up the serial port for transmission or reception of data.

Passed:

Parameter	Description
AH	00h

AL	Port parameters: Bits [7:5] - Data rate: 000 = 110 bps 001 = 150 bps 010 = 300 bps 011 = 600 bps 100 = 1200 bps 101 = 2400 110 = 4800 111 = 9600 Bits [4:3] - Parity: 00 = None 10 = None 01 = Odd 11 = Even Bit 2 - Stop bit: 0= Clear 1= Set Bits [1:0] - Data size; character length: 00 = 5 01 = 6 10 = 7 11 = 8
DX	Port number; BDA location: 00h = 40:0h 01h = 40:2h 02h = 40:4h 03h = 40:6h

Returns:

Parameter	Description
AH	Line status: Bit 7 = Timeout error occurred Bit 6 = Transfer shift register empty Bit 5 = Transfer holding register empty Bit 4 = Break occurred Bit 3 = Framing error occurred Bit 2 = Parity error occurred Bit 1 = Overrun error occurred Bit 0 = Data ready
AL	Modem status: Bit 7 = Carrier detect Bit 6 = Ring indicator Bit 5 = Data set ready Bit 4 = Clear to send Bit 3 = Delta carrier detect Bit 2 = Trailing edge of ring indicator Bit 1 = Delta data set ready Bit 0 = Delta clear to send

8.1.2 Function 01h - Write Character to Port

Description:

Sends a character of data to the serial port.

Passed:

Parameter	Description
AH	01h
AL	ASCII code for the character
DX	Port number: See "Function 00h - Initialize Port" on page 83

Returns:

Parameter	Description
AH	00h if no error occurred 8xh indicates an error occurred x represents: 6 = Transfer shift register empty 5 = Transfer holding register empty 4 = Break occurred 3 = Framing error occurred 2 = Parity error occurred 1 = Overrun error occurred 0 = Data ready

8.1.3 Function 02h - Read Character from Port

Description:

Reads a byte of data from the serial port. Function does not return until data is available or a timeout has occurred. The caller may invoke Function 03h (Get Port Status) to check whether data is available to be read.

Passed:

Parameter	Description
AX	02h
DX	Port number: See "Function 00h - Initialize Port" on page 83

Returns:

Parameter	Description
AL	ASCII code for the character
AH	00h if no error occurred 8xh indicates an error occurred x represents: 6 = Transfer shift register empty 5 = Transfer holding register empty 4 = Break occurred 3 = Framing error occurred 2 = Parity error occurred 1 = Overrun error occurred 0 = Data ready

8.1.4 Function 03h - Get Port Status

Description:

Reports the status of the serial port. Most of the function reports errors, however, it can be used to check whether data is available for reading (Data Ready flag, AH = 0).

Passed:

Parameter	Description
AX	03h
DX	Port number: See "Function 00h - Initialize Port" on page 83

Returns:

Parameter	Description
AH	03h
DX	Encoded line status: Bit 7 = Timeout error occurred Bit 6 = Transfer shift register empty Bit 5 = Transfer holding register empty Bit 4 = Break occurred Bit 3 = Framing error occurred Bit 2 = Parity error occurred Bit 1 = Overrun error occurred Bit 0 = Data ready
AL	Encoded modem status: Bit 7 = Carrier detect Bit 6 = Ring indicator Bit 5 = Data set ready Bit 4 = Clear to send Bit 3 = Delta carrier detect Bit 2 = Trailing edge of ring indicator Bit 1 = Delta data set ready Bit 0 = Delta clear to send

9 Parallel Port BIOS Support

GeodeROM supports the standard INT 17h functions listed in Table 9-1 that pertain to the operation of up to three parallel ports in the system:

Table 9-1. INT 17h Functions

Function Number/Name	Page Number
Function 00h - Print a Character	87
Function 01h - Initialize Parallel Port	88
Function 02h - Get Port Status	88

9.1 INT 17h Parallel Port BIOS Functions Descriptions

This section lists those INT 17h functions supported in GeodeROM, the parameters that system software supplies to each INT 17h function, and the values each function returns. The I/O address(es) of any port(s) in the system are stored in the BDA by POST. The WORD-length addresses begin at 40:8h and can go through 40:Ch.

9.1.1 Function 00h - Print a Character

Description:

Sends a character to the parallel port. The function waits until the printer is not busy or until a timeout has occurred. The caller can invoke Function 02h to check whether the printer is ready to accept a character.

Passed:

Parameter	Description
AH	00h
AL	ASCII code of character to send
DX	Port number; BDA location: 00h = 40:8h 01h = 40:Ah 02h = 40:Ch

Returns:

Parameter	Description
AH	Port status: Bit 7 = Printer ready Bit 6 = Acknowledgement of last character Bit 5 = Paper empty Bit 4 = Printer selected Bit 3 = I/O error Bits [2:1] = Reserved Bit 0 = Timeout error

9.1.2 Function 01h - Initialize Parallel Port

Description:

Resets the printer and sets the top of the page to the current position of the paper by sending control codes 08h and 0Ch.

Passed:

Parameter	Description
AH	01h
DX	Port number: See "Function 00h - Print a Character" on page 87

Returns:

Parameter	Description
AH	Encoded information indicating status of the operation: Bit 7 = Printer ready Bit 6 = Acknowledgement of last character Bit 5 = Paper empty Bit 4 = Printer selected Bit 3 = I/O Error Bits [2:1] = Reserved Bit 0 = Timeout error

9.1.3 Function 02h - Get Port Status

Description:

Reads the current status of the printer. This function can be used to determine if the printer is ready to accept data.

Passed:

Parameter	Description
AX	02h
DX	Port number: See "Function 00h - Print a Character" on page 87

Returns:

Parameter	Description
AH	Encoded information indicating status of the port: Bit 7 = Printer ready Bit 6 = Acknowledgement of last character Bit 5 = Paper empty Bit 4 = Printer selected Bit 3 = I/O error Bit [2:1] = Reserved Bit 0 = Timeout error

10 Human Interface Device Support

This chapter describes GeodeROM's support for human interface devices (HID), such as keyboards and pointing devices.

GeodeROM provides full support for 101 key PC keyboards. It contains a full implementation of the INT 16h interface as described in numerous books on the subject of low level PC programming. Additionally, GeodeROM contains an IRQ1 handler and supports INT 15h Function 4Fh (Scan Code Redirect) as a means of enabling TSRs (Terminate, Stay Resident) and any other software that intercepts keystrokes.

In addition to the standard PS/2 keyboard device, the INT 16h interface transparently supports the Legacy USB Keyboard.

Table 10-1. INT 16h HID Functions

Function Number/Name	Page Number
Function 00h - Wait For Character	89
Function 01h - Check For Key Present	90
Function 02h - Get Shift Status	90
Function 03h - Set Keyboard Typematic Rate	91
Function 05h - Insert Key Code In Keyboard Buffer	91
Function 10h - Get Extended Key Code	92
Function 11h - Check For Enhanced Key Code	92
Function 12h - Get Extended Shift Status	93

10.1 INT 16h Functions Descriptions

This section lists those INT 16h functions supported in GeodeROM, the parameters that system software supplies to each INT 16h function and the values that each function returns.

10.1.1 Function 00h - Wait For Character

Description:

Returns after a keystroke occurs, ignoring any non-standard keystroke.

Passed:

Parameter	Description
AH	00h

Returns:

Parameter	Description
AH	Scan code
AL	Character

Related Functions:

INT 16h "Function 10h - Get Extended Key Code" on page 92.

10.1.2 Function 01h - Check For Key Present

Description:

Checks the keyboard buffer to determine whether a keystroke is available. The keystroke is not removed from the keyboard buffer.

Passed:

Parameter	Description
AH	01h

Returns:

Parameter	Description
AH	Scan code
AL	Character
ZF	00h if character in buffer 01h if no character in buffer

Related Functions:

INT 16h "Function 11h - Check For Enhanced Key Code" on page 92.

10.1.3 Function 02h - Get Shift Status

Description:

Returns the state of the Left Shift, Right Shift, Ctrl, and Alt keys. It also indicates the state of the ScrollLock, NumLock, CapsLock, and Insert keys.

Passed:

Parameter	Description
AH	02h

Returns:

Parameter	Description
AL	Shift status bits: Bit 7 = Insert state active Bit 6 = CapsLock active Bit 5 = NumLock active Bit 4 = ScrollLock active Bit 3 = Alt depressed Bit 2 = Ctrl depressed Bit 1 = Left Shift key depressed Bit 0 = Right Shift key depressed

Related Functions:

INT 16h "Function 12h - Get Extended Shift Status" on page 93.

10.1.4 Function 03h - Set Keyboard Typematic Rate

Description:

Operating system modifiable typematic delay and rate.

Passed:

Parameter	Description					
BH	Delay value in milliseconds: 00h = 250 msec 01h = 500 msec 02h = 750 msec 03h = 1000 msec 04h to 0FFH = Reserved					
BL	Typematic Rate (characters per second): No other values are supported.					
	00h = 30.0	06h = 17.1	0Ch = 10.0	12h = 6.0	18h = 3.7	1Eh = 2.1
	01h = 26.7	07h = 16.0	0Dh = 9.2	13h = 5.5	19h = 3.3	1Fh = 2.1
	02h = 24.0	08h = 15.0	0Eh = 8.6	14h = 5.0	1Ah = 3.0	
	03h = 21.8	09h = 13.3	0Fh = 8.0	15h = 4.6	1Bh = 2.7	
	04h = 20.0	0Ah = 12.0	10h = 7.5	16h = 4.3	1Ch = 2.5	
	05h = 18.5	0Bh = 10.9	11h = 6.7	17h = 4.0	1Dh = 2.3	

Returns:

None.

Related Functions:

None.

10.1.5 Function 05h - Insert Key Code In Keyboard Buffer

Description:

Adds a keystroke to the keyboard buffer and adjusts the pointer appropriately.

Passed:

Parameter	Description
AH	05h
CH	Scan code
CL	Character

Returns:

Parameter	Description
AL	00h if buffer not full 01h if buffer full

Related Functions:

None.

10.1.6 Function 10h - Get Extended Key Code

Description:

Returns after a keystroke (including non-standard keys) occurs.

Passed:

Parameter	Description
AH	10h

Returns:

Parameter	Description
AH	Scan code
AL	Character

Related Functions:

INT 16h "Function 00h - Wait For Character" on page 89.

10.1.7 Function 11h - Check For Enhanced Key Code

Description:

Checks the keyboard buffer to determine whether a keystroke is available. The keystroke is not removed from the keyboard buffer. This function does not ignore extended keystrokes.

Passed:

Parameter	Description
AH	11h

Returns:

Parameter	Description
AH	Scan code \ meaningless if ZF = 01h
AL	Character
ZF	00h if keystroke available 01h if keyboard scan code buffer empty

Related Functions:

INT 16h "Function 01h - Check For Key Present" on page 90

10.1.8 Function 12h - Get Extended Shift Status

Description:

Returns the state of the Left Shift, Right Shift, Ctrl, and Alt keys. It also indicates the state of the ScrollLock, NumLock, CapsLock, and Insert keys. Additionally, the states of other keys are returned.

Passed:

Parameter	Description
AH	12h

Returns:

Parameter	Description
AL	Shift flags: Bit 7 = Ins active Bit 6 = CapsLock active Bit 5 = NumLock active Bit 4 = ScrollLock active Bit 3 = Either ALT key depressed Bit 2 = Either CTRL key depressed Bit 1 = Left Shift key depressed Bit 0 = Right Shift key depressed
AH	Additional shift flag information: Bit 7 = SysReq key depressed Bit 6 = CapsLock key depressed Bit 5 = NumLock key depressed Bit 4 = ScrollLock key depressed Bit 3 = Right Alt key depressed Bit 2 = Right Ctrl key depressed Bit 1 = Left Alt key depressed Bit 0 = Left Ctrl key depressed

Related Functions:

INT 16h "Function 02h - Get Shift Status" on page 90.

10.2 PS/2 Pointing Device Support

None.

11 System Time and Date

GeodeROM supports a majority of the standard system functions listed in Table 11-1.

Table 11-1. INT 1Ah Time and Date Functions

Function Number/Name	Page Number
Function 00h - Get System Time Status	95
Function 01h - Set System Time	96
Function 02h - Get Real-Time Clock Time Status	96
Function 03h - Set Real-Time Clock Time	97
Function 04h - Get Real-Time Clock Date Status	97
Function 05h - Set Real-Time Clock Date	98
Function 06h - Set Real-Time Clock Alarm	98
Function 07h - Cancel Real-Time Clock Alarm	98
Function 09h - Get Real-Time Clock Alarm Status	99
Function 0Ah - Read System Day Counter	99
Function 0Bh - Set System Day Counter	99
Function 0Eh - Get Real-Time Clock Date/Time Alarm and Status	100
Function 0Fh - Initialize Real-Time Clock	100

11.1 INT 1Ah Time and Date Functions Descriptions

This section lists those INT 1Ah functions supported in GeodeROM, the parameters that system software supplies to each INT 1Ah function, and the values each function returns.

11.1.1 Function 00h - Get System Time Status

Description:

Returns the 4-byte count of the number of timer ticks that have occurred since midnight. The value is maintained in the BIOS Data Area (40:6C) (Refer to Section 6.4.1 “BIOS Data Area (BDA)” on page 62 for information on BDA.) It also checks whether the rollover byte has been set (stored in location 40:70) and returns appropriately.

Passed:

Parameter	Description
AH	00h

Returns:

Parameter	Description
CX	The most significant two bytes of the 4-byte count
DX	The least significant two bytes of the 4-byte count
AL	Rollover value, nonzero if midnight has passed since the last time the count was read

Related Functions:

INT 1Ah "Function 01h - Set System Time" on page 96.
INT 1Ah "Function 02h - Get Real-Time Clock Time Status" on page 96.

11.1.2 Function 01h - Set System Time

Description:

Sets the 4-byte count of the number of timer ticks that have occurred since midnight. The value is maintained in the BIOS Data Area (40:6Ch). It does not modify the rollover byte, stored at 40:70h.

Passed:

Parameter	Description
AH	01h
CX	The most significant two bytes of the 4-byte count
DX	The least significant two bytes of the 4-byte count

Returns:

None.

Related Functions:

INT 1Ah "Function 03h - Set Real-Time Clock Time" on page 97.

11.1.3 Function 02h - Get Real-Time Clock Time Status

Description:

Returns the time value stored in the system's real-time clock, in hours, minutes, and seconds.

Passed:

Parameter	Description
AH	02h

Returns:

Parameter	Description
CH	The hour of the current time, in BCD, stored in the RTC
CL	The minutes of the current time, in BCD, stored in the RTC
DH	The seconds of the current time, in BCD, stored in the RTC
DL	If 00h, the RTC ignores daylight savings time If 01h, the RTC adjusts for daylight savings time

Related Functions:

INT 1Ah "Function 01h - Set System Time" on page 96.
INT 1Ah "Function 03h - Set Real-Time Clock Time" on page 97.
INT 1Ah "Function 04h - Get Real-Time Clock Date Status" on page 97.

11.1.4 Function 03h - Set Real-Time Clock Time

Description:

Sets the time value stored in the system's real-time clock, in the form of hours, minutes, and seconds.

Passed:

Parameter	Description
AH	03h
CH	The hour of the current time, in BCD, stored in the RTC
CL	The minutes of the current time, in BCD, stored in the RTC
DH	The seconds of the current time, in BCD, stored in the RTC
DL	Set to: 00h if RTC should ignore daylight savings time 01h if RTC should adjust for daylight savings time

Returns:

None.

Related Functions:

INT 1Ah "Function 01h - Set System Time" on page 96.

11.1.5 Function 04h - Get Real-Time Clock Date Status

Description:

Returns the date that is stored in the system's real-time clock.

Passed:

Parameter	Description
AH	04h

Returns:

Parameter	Description
CH	The century of the current date, in BCD, stored in the RTC
CL	The year of the current date, in BCD, stored in the RTC
DH	The month of the current date, in BCD, stored in the RTC
DL	The day of the current date, in BCD, stored in the RTC

Related Functions:

INT 1Ah "Function 02h - Get Real-Time Clock Time Status" on page 96.
INT 1Ah "Function 05h - Set Real-Time Clock Date" on page 98.

11.1.6 Function 05h - Set Real-Time Clock Date

Description:

Sets the date that is stored in the system’s real-time clock.

Passed:

Parameter	Description
AH	05h
CH	The century of the current date, in BCD, stored in the RTC
CL	The year of the current date, in BCD, stored in the RTC
DH	The month of the current date, in BCD, stored in the RTC
DL	The day of the current date, in BCD, stored in the RTC

Returns:

None.

Related Functions:

INT 1Ah "Function 04h - Get Real-Time Clock Date Status" on page 97.

11.1.7 Function 06h - Set Real-Time Clock Alarm

Description:

Sets the alarm in the system’s real-time clock. The alarm occurs every 24 hours, causing an INT 4Ah, until it is disabled.

Passed:

Parameter	Description
AH	06h
CH	The hour for the alarm time, in BCD
CL	The minutes for the alarm time, in BCD
DH	The seconds for the alarm time, in BCD

Returns:

None.

Related Functions:

INT 1Ah "Function 07h - Cancel Real-Time Clock Alarm" on page 98.

11.1.8 Function 07h - Cancel Real-Time Clock Alarm

Description:

Disables the alarm in the system’s real-time clock.

Passed:

Parameter	Description
AH	07h

Returns:

None.

Related Functions:

INT 1Ah "Function 06h - Set Real-Time Clock Alarm" on page 98.

11.1.9 Function 09h - Get Real-Time Clock Alarm Status

Description:

Sets the alarm in the system's real-time clock. The alarm occurs every 24 hours, causing an INT 4Ah, until it is disabled.

Passed:

Parameter	Description
AH	09h

Returns:

Parameter	Description
CH	The hour for the alarm time, in BCD
CL	The minutes for the alarm time, in BCD
DH	The seconds for the alarm time, in BCD
DL	Alarm status: 00h = Alarm not enabled 01h = Alarm enabled, but will not power-up system 02h = Alarm will power-up system

Related Functions:

None.

11.1.10 Function 0Ah - Read System Day Counter

Description:

Returns the number of days since January 1, 1980, from the value stored in the BDA (40:CE).

Passed:

Parameter	Description
AH	0Ah

Returns:

Parameter	Description
CX	Number of days since 1/1/1980

Related Functions:

INT 1Ah "Function 04h - Get Real-Time Clock Date Status" on page 97.

11.1.11 Function 0Bh - Set System Day Counter

Description:

Returns the number of days since January 1, 1980, from the value stored in the BDA (40:CE).

Passed:

Parameter	Description
AH	0Bh
CX	Number of days since 1/1/1980

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

INT 1Ah "Function 05h - Set Real-Time Clock Date" on page 98.
INT 1Ah "Function 0Ah - Read System Day Counter" on page 99.

11.1.12 Function 0Eh - Get Real-Time Clock Date/Time Alarm and Status

Description:

Returns settings for the RTC alarm.

Passed:

Parameter	Description
AH	0Eh

Returns:

Parameter	Description
BH	Alarm status: 00h = Alarm not enabled 01h = Alarm enabled, but will not power-up system 02h = Alarm will power-up system
CH	The hour for the alarm time, in BCD
CL	The minutes for the alarm time, in BCD
DH	The seconds for the alarm time, in BCD
DL	The day of the month for the alarm, in BCD

Related Functions:

None.

11.1.13 Function 0Fh - Initialize Real-Time Clock

Description:

Causes the BIOS to update its century byte.

Passed:

Parameter	Description
AH	0Fh

Returns:

None.

Related Functions:

None.

12 System Services

GeodeROM supports INT 15h for certain standard system services (listed in Table 12-1). This section describes the interfaces for those services. INT 15h is used for Advanced Power Management (APM). See Section 17.0 "Power Management" on page 239 for details. It is also used for backward compatibility with AMD's Virtual System Architecture™ (VSA) technology.:

Table 12-1. INT 15h System Services Support Functions

Function	Subfunction	Page Number
Function 24h - A20 Support		103
	Subfunction 00h - Disable A20 Gate	103
	Subfunction 01h - Enable A20 Gate	104
	Subfunction 02h - Get A20 Gate Status	104
	Subfunction 03h - A20 Support	105
Function 4Fh - Key Scan Hook		105
Function 53h		106
	Subfunction 00h - APM Installation Check	106
	Subfunction 01h - APM Real Mode Interface Connect	107
	Subfunction 02h - APM Protected Mode 16-Bit Interface Connect	108
	Subfunction 03h - APM Protected Mode 32-Bit Interface Connect	109
	Subfunction 04h - APM Interface Disconnect	110
	Subfunction 05h - CPU Idle	111
	Subfunction 06h - CPU Busy	111
	Subfunction 07h - Set Power State	112
	Subfunction 08h - Enable/Disable Power Management	113
	Subfunction 09h - Restore APM BIOS Power On	114
	Subfunction 0Ah - Get Power Status	115
	Subfunction 0Bh - Get PM Event	116
	Subfunction 0Ch - Get Power State	117
	Subfunction 0Dh - Enable/Disable Device Power Management	118
	Subfunction 0Eh - APM Driver Version	119
	Subfunction 0Fh - Engage/Disengage Power Management	120
	Subfunction 10h - Get Capabilities	121
	Subfunction 11h - Get/Set/Disable Resume Timer	122
	Subfunction 12h - Enable/Disable Resume on Ring	123
	Subfunction 13h - Enable/Disable Timer Based Requests	124
Function 86h - BIOS Wait		125

Table 12-1. INT 15h System Services Support Functions (Continued)

Function	Subfunction	Page Number
Function 87h - Extended Memory Block Move		126
Function 88h - Get Extended Memory Size		127
Function 89h - Enter Protected Mode		127
Function 90h - Device Busy		128
Function 91h - Interrupt Complete		129
Function BEh - AMD OEM Functions		130
	Subfunction 00h - Read ACCESS.bus Byte	131
	Subfunction 01h - Write ACCESS.bus Byte	131
	Subfunction 02h - Write ACCESS.bus Block	132
	Subfunction 03h - Read NVRAM Data	132
	Subfunction 04h - Write NVRAM Data	133
	Subfunction 05h - Get Default NVRAM Value	134
	Subfunction 06h - Get NVRAM Checksum	134
	Subfunction 07h - Set NVRAM Checksum	135
	Subfunction 08h - Reset NVRAM Default	135
	Subfunction 09h - Get NVRAM Table Address	136
	Subfunction 0Ah - ACCESS.bus Block Read	142
	Subfunction 20h - Get SCxxxx External Clock Speed	143
	Subfunction 21h - Get SCxxxx Device Type	143
	Subfunction 31h - SCxxxx Read ACCESS.bus Device	144
	Subfunction 32h - SCxxxx Write ACCESS.bus Device	144
	Subfunction 35h - Owl Board Specific Feature Access	145
	Subfunction A0h - Wait for Key Timeout	146
	Subfunction A1h - Get ROM Data	147
	Subfunction A2h - CPU Memory Register Read Int	148
	Subfunction A3h - CPU Memory Register Write Int	148
	Subfunction A4h - Get CPU Speed	149
	Subfunction A5h - Check CMOS	149
	Subfunction A6h - Check CMOS Power	150
	Subfunction A7h - Get PCI Speed	150
	Subfunction A8h - Set Warning	151
	Subfunction A9h - Read Companion Chip DWORD	151
	Subfunction AAh - CPI Register Read	152
	Subfunction ABh - CPU Register Write	152
	Subfunction ACh - Eat Key	153
	Subfunction B0h - Get Shadow	153
	Subfunction B1h - Set Shadow	154
	Subfunction F0h through FFh - User Defined Interrupts	154
Function C0h - Get ROM Configuration		155

Table 12-1. INT 15h System Services Support Functions (Continued)

Function	Subfunction	Page Number
Function C1h - Get EBDA Address		155
Function C2h - PS/2 Mouse Support		156
	Subfunction 00h: - Enable/Disable Pointing Device	156
	Subfunction 01h - Reset Pointing Device	157
	Subfunction 02h - Set Sample Rate	157
	Subfunction 03h - Set Resolution	158
	Subfunction 04h - Read Device Type	158
	Subfunction 05h - Initialize Pointing Device Interface	159
	Subfunction 06h - Pointing Device Extended Commands	159
	Subfunction 07h - Set Pointing Device Handler Address	160
Function E8h - Memory Size and Map Support		160
	Subfunction 01h - Get System Memory Size	160
	Subfunction 20h - Get System Memory Map	161

12.1 INT 15h System Services Functions Descriptions

This section lists those INT 15h functions supported in GeodeROM, the parameters that system software supplies to each INT 15h function, and the values each function returns.

12.1.1 Function 24h - A20 Support

- GeodeROM provides three subfunctions associated with A20 Gate support:
  - — Subfunction 00h: Disable A20 Gate
  - — Subfunction 01h: Enable A20 Gate
  - — Subfunction 02h: Get A20 Gate Status
  - — Subfunction 03h: A20 Support

12.1.1.1 Subfunction 00h - Disable A20 Gate

Description:

Disables the A20 functionality.

Passed:

Parameter	Description
AH	C0h
AL	00h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	00h if successful 01h if keyboard is in secure mode

Related Functions:

None.

12.1.1.2 Subfunction 01h - Enable A20 Gate

Description:

Enables the A20 functionality.

Passed:

Parameter	Description
AH	C0h
AL	01h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	00h if successful 01h if keyboard is in secure mode

Related Functions:

None.

12.1.1.3 Subfunction 02h - Get A20 Gate Status

Description:

Retrieves the current status of A20 gate.

Passed:

Parameter	Description
AH	C0h
AL	02h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	00h if successful 01h if keyboard is in secure mode
AL	00h if A20 gate is disabled 01h if A20 gate is enabled
CX	00h

Related Functions:

None.

12.1.1.4 Subfunction 03h - A20 Support

Description:

Passed:

Parameter	Description
AH	24h
AL	03h

Returns:

Parameter	Description
CF	0
AX	0000h
BX	0002h

Related Functions:

None.

12.1.2 Function 4Fh - Key Scan Hook

Description:

Passed:

Parameter	Description
AH	4Fh

Returns:

Parameter	Description
CF	1

Related Functions:

None.

12.1.3 Function 53h

12.1.3.1 Subfunction 00h - APM Installation Check

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	00h = APM function code
BX	Power device ID: 0000h - APM BIOS All other values reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = APM is supported by BIOS
AH	01 = APM major version number (in BCD format) 02 = APM minor version number (in BCD format)
BH	ASCII P character
BL	ASCII M character
CX	APM flags
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 09h = Unrecognized device ID 86h = APM not present

Related Functions:

None.

12.1.3.2 Subfunction 01h - APM Real Mode Interface Connect

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	01h = APM function code
BX	Power device ID: 0000h - APM BIOS All other values reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = APM is supported by BIOS
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code:| 02h = Real Mode interface connection already established 05h = 16-bit protected mode interface already established 07h = 32-bit protected mode interface already established 09h = Unrecognized device ID 86h = APM not present

Related Functions:

None.

12.1.3.3 Subfunction 02h - APM Protected Mode 16-Bit Interface Connect

Description:

Establish 16-bit protected mode connection. Returns with error status if the 16-bit connect is already active or if a 16-bit protected mode entry is not supported. If not connected, set a flag in PM memory to indicate the 16-bit connect and return parameters. All general purpose registers may be modified except EBP and ESP.

Passed:

Parameter	Description
AH	53h = APM
AL	02h = APM function code
BX	Power device ID: 0000h = APM BIOS All other values reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
AX	APM 16-bit code segment (real mode segment base address)
BX	Offset of entry point into the APM BIOS
CX	APM 16-bit data segment (real mode segment base address)
SI	APM BIOS code segment length
DI	APM BIOS data segment length
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 02h = Real Mode interface connection already established 05h = 16-bit protected mode interface already established 06h = 16-bit protected mode interface not supported 07h = 16-bit protected mode interface already established 09h = Unrecognized device ID 86h = APM not present

Related Functions:

None.

12.1.3.4 Subfunction 03h - APM Protected Mode 32-Bit Interface Connect

Description:

Establish 32-bit protected mode connection. Returns with error status if the 32-bit connect is already active or if a 32-bit protected mode entry is not supported. If not connected, set a flag in PM memory to indicate the 32-bit connect and return parameters. All general purpose registers may be modified except EBP, ESP.

Passed:

Parameter	Description
AH	53h = APM
AL	03h = APM function code
BX	Power device ID: 0000h = APM BIOS All other values reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
AX	APM 32-bit code segment (real mode segment base address)
EBX	Offset of 32-bit interface entry point
CX	APM 16-bit code segment (real mode segment base address)
DX	APM data segment (real mode segment base address)
ESI	APM BIOS 32-bit code segment length in lower word of ESI APM BIOS 16-bit code segment length in upper word of ESI
DI	APM BIOS data segment length
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 02h = Real Mode interface connection already established 05h = 16-bit protected mode interface already established 07h = 32-bit protected mode interface already established 09h = Unrecognized device ID 86h = APM not present

Related Functions:

None.

12.1.3.5 Subfunction 04h - APM Interface Disconnect

Description:

Record connect/engaged status.

Passed:

Parameter	Description
AH	53h = APM
AL	04h = APM function code
BX	Power Device ID: 0000h = APM BIOS All other values reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 03h = Interface not connected 09h = Unrecognized device ID

Related Functions:

None.

12.1.3.6 Subfunction 05h - CPU Idle

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	05h = APM function code

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 03h = Interface not connected 0Bh = Interface not engaged

Related Functions:

None.

12.1.3.7 Subfunction 06h - CPU Busy

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	06h = APM function code

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry Flag set on error
AH	Error code: 03h = Interface not connected 0Bh = Interface not engaged

Related Functions:

None.

12.1.3.8 Subfunction 07h - Set Power State

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	07h = APM function code
BX	Power device ID: 0001h = All devices power managed by the BIOS 01xxh[1] = Display 02xxh[1] = Secondary storage 03xxh[1] = Parallel ports 04xxh[1] = Serial ports 05xxh[1] = Network adapters 06xxh[1] = PCMCIA sockets E000h-EFFFh = OEM defined power device IDs All other values reserved
CX	Power state: 0000h[2] = APM enabled 0001h = Standby 0002h = Suspend 0003h = Off 0004h[3] = Last request processing notification 0005h[3] = Last request rejected 0006h-001Fh = Reserved system states 0020h-003Fh = OEM defined system states 0040h-007Fh = OEM defined device states 0080h-FFFFh = Reserved device states

1. xxh = Unit number (0 based). Unit number of FFH means all devices in this class.
2. Not supported for power device ID 0001h.
3. Only supported for power device ID 0001h.

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 01h = Power management functionality disabled 03h = Interface not connected 09h = Unrecognized device ID 0Ah = Parameter value out of range 0Bh = Interface not engaged 60h = Unable to enter requested state

Related Functions:

None.

12.1.3.9 Subfunction 08h - Enable/Disable Power Management

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	08h = APM function code
BX	Power device ID: 0001h = All devices power managed by APM BIOS FFFFh[1] = All devices power managed by APM BIOS All other values reserved

1. Must be implemented for compatibility with APM 1.0.

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 03h = Interface not connected 09h = Unrecognized device ID 0Ah = Parameter value out of range (function code) 0Bh = Interface not engaged

Related Functions:

None.

12.1.3.10 Subfunction 09h - Restore APM BIOS Power On

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	09h = APM function code
BX	Power device ID: 0001h = All devices power managed by APM BIOS FFFFh[1] = All devices power managed by APM BIOS All other values reserved

1. Must be implemented for compatibility with APM 1.0.

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 03h = Interface not connected 09h = Unrecognized device ID 0Bh = Interface not engaged

Related Functions:

None.

12.1.3.11 Subfunction 0Ah - Get Power Status

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	0Ah = APM function code
BX	Power device ID: 0001h = All devices power managed by APM BIOS 80xxh = Specific battery unit number, where xx = battery unit number (1 based) All other values reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
BH	AC line status
BL	Battery status
CH	Battery Flag
CL	Remaining battery life - percentage of charge
DX	Remaining battery life - time units
BH	Power device ID/Device class. I = 80h on entry, then returns
SI	Number of battery units currently installed in the machine (0 to n)
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 09h = Unrecognized device ID 0Ah = Parameter value out of range 86h = APM not present

Related Functions:

None.

12.1.3.12 Subfunction 0Bh - Get PM Event

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	0Bh = APM function code

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
BX	PM event code
CX	PM event information
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 03h = Interface not connected 0Bh = Interface not engaged 80h = No power management events pending

Related Functions:

None.

12.1.3.13 Subfunction 0Ch - Get Power State

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	0Ch = APM function code
BX	Power device ID: 0001h = All devices power managed by APM BIOS 01xxh[1] = Display 02xxh = Secondary storage 03xxh = Parallel ports 04xxh = Serial ports 05xxh = Network adapters 06xxh = PCMCIA sockets E000h-EFFFH = OEM defined power device IDs All other values reserved

1. xxh = Unit number (0 based). Unit number of FFh means all devices in this class.

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
CX	xx Power state
If function is unsuccessful:	
AH	Error code: 01h = Power management functionality disabled 09h = Unrecognized device ID 86h = APM not present

Related Functions:

None.

12.1.3.14 Subfunction 0Dh - Enable/Disable Device Power Management

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	0Dh = APM function code
BX	Power device ID: 0001h = All devices power managed by APM BIOS 01xxh[1] = Display 02xxh = Secondary storage 03xxh = Parallel ports 04xxh = Serial ports 05xxh = Network adapters 06xxh = PCMCIA sockets E000h-EFFFH = OEM defined power device IDs All other values reserved
CX	Function code: 0000h = Disable power management 0001h = Enable power management

1. xxh = Unit number (0 based). Unit number of FFh means all devices in this class.

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 01h = Power management functionality disabled 03h = Interface not connected 09h = Unrecognized device ID

Related Functions:

None.

12.1.3.15 Subfunction 0Eh - APM Driver Version

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	0Eh = APM function code
BX	Power device ID: 0000h = All devices power managed by APM BIOS
CH	APM driver major version number (in BCD format)
CL	APM driver minor version number (in BCD format)

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
AH	APM driver major version number (in BCD format)
AL	APM driver minor version number (in BCD format)
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 03h = Interface not connected 09h = Unrecognized device ID 0Bh = Interface not engaged

Related Functions:

None.

12.1.3.16 Subfunction 0Fh - Engage/Disengage Power Management

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	0Fh = APM function code
BX	Power device ID: 0001h = All devices power managed by APM BIOS 01xxh[1] = All devices power managed by APM BIOS 02xxh = Secondary storage 03xxh = Parallel ports 04xxh = Serial ports 05xxh = Network adapters 06xxh = PCMCIA sockets E000h-EFFFH = OEM defined power device IDs All other values reserved
CX	0000h = Disengage power management 0001h = Engage power management

1. xxh = Unit number (0 based). Unit number of FFh means all devices in this class.

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 01h = Power management functionality disabled 03h = Interface not connected 09h = Unrecognized device ID 0Ah = Parameter value out of range (function code)

Related Functions:

None.

12.1.3.17 Subfunction 10h - Get Capabilities

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	10h = APM function code
BX	Power device ID: 0000h = All devices power managed by APM BIOS All other values reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
BL	Number of battery units this machine supports
CX	Capability flags: Bit 0 = One system can enter global standby state Bit 1 = One system can enter global standby suspend state Bit 2 = One resume timer will wakeup from standby state Bit 3 = One resume timer will wakeup from suspend state Bit 4 = One resume ring indicator will wakeup from standby state Bit 5 = One resume ring indicator will wakeup from suspend state Bit 6 = One PCMCIA ring indicator will wakeup from standby state Bit 7 = One PCMCIA ring indicator will wakeup from suspend state All other bits are reserved (must be set to 0)
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 09h = Unrecognized device ID 86h = APM not present

Related Functions:

None.

12.1.3.18 Subfunction 11h - Get/Set/Disable Resume Timer

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	11h = APM function code
BX	Power device ID: 0000h = All devices power managed by APM BIOS All other values reserved

CL	00h = Disable resume timer
	01h = Get resume timer
	02h = Set resume timer
	
	If CL = 02h:
	CH = Second (0 to 59 in BCD format)
	DH = Hours (0 to 23 in BCD format)
	DL = Minutes (0 to 59 in BCD format)
	SI = Month (high byte, 1 to 12 in BCD format), Day (low byte, 1 to 31 in BCD format)
	DI = Year (1995 to ... in BCD format)

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
If CL = 01h	
CH	Second (0 to 59 in BCD format)
DH	Hours (0 to 23 in BCD format)
DL	Minutes (0 to 59 in BCD format)
SI	Month (high byte, 1 to 12 in BCD format), Day (low byte, 1 to 31 in BCD format)
DI	Year (1995 to ... in BCD format)
If function is unsuccessful:	
CF	1 = Carry flag set on error
AH	Error code: 03h = Interface not connected 09h = Unrecognized device ID 0Ah = Parameter value out of range 0Bh = Interface not engaged 0Ch = Function not supported 0Dh = Resume timer disabled (valid for get resume timer value only)

Related Functions:

None.

12.1.3.19 Subfunction 12h - Enable/Disable Resume on Ring

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	12h = APM function code
BX	Power device ID: 0000h = All devices power managed by APM BIOS All other values reserved
CX	0000h = Disable resume on ring indicator 00001h = Enable resume on ring indicator 0002h = Get enabled/disabled status All other values are reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
CX	Enabled/disabled status: 0000h = Disabled 0001h = Enabled
If function is unsuccessful:	
CF	Enabled/disabled status: 0 = Disabled 1 = Enabled
AH	Error code: 03h = Interface not connected 09h = Unrecognized device ID 0Ah = Parameter value out of range 0Bh = Interface not engaged 0Ch = Function not supported

Related Functions:

None.

12.1.3.20 Subfunction 13h - Enable/Disable Timer Based Requests

Description:

Passed:

Parameter	Description
AH	53h = APM
AL	13h = APM function code
BX	Power device ID: 0000h = All devices power managed by APM BIOS All other values reserved
CX	0000h = Disable resume on ring indicator 00001h = Enable resume on ring indicator 0002h = Get enabled/disabled status All other values are reserved

Returns:

Parameter	Description
If function is successful:	
CF	0 = Successful connection
CX	Enabled/disabled status: 0000h = Disabled 0001h = Enabled
If function is unsuccessful:	
CF	Enabled/disabled status: 0 = Disabled 1 = Enabled
AH	Error code: 03h = Interface not connected 09h = Unrecognized device ID 0Ah = Parameter value out of range 0Bh = Interface not engaged

Related Functions:

None.

12.1.4 Function 86h - BIOS Wait

Description:

Passed:

Parameter	Description
AH	86h
CX	CX:DX = Interval in microseconds
DX	0000h = Disable resume on ring indicator 00001h = Enable resume on ring indicator 0002h = Get enabled/disabled status All other values are reserved

Returns:

Parameter	Description
CF	0 = Carry flag cleared

Related Functions:

None.

12.1.5 Function 87h - Extended Memory Block Move

Description:

Puts the system into protected mode and copies memory from one location to another. The intent is to move data or code into an area not easily reached by a real mode program.

Passed:

Parameter	Description
AH	87h
CX	Number of words to copy (maximum 8000h)
ES:SI	Pointer to memory move structure: **Offset / Size / Description** 00h / 16 BYTEs / Zeros (used by BIOS) 10h / WORD / Source segment length in bytes 12h / 3 BYTEs / 24-bit linear source address, low byte first 15h / BYTE / Source segment access rights (93h) 16h / WORD / Extended access rights and high byte of source address 18h / WORD / Destination segment length in bytes 1Ah / 3 BYTEs / 24-bit linear destination address, low byte first 1Dh / BYTE / Destination segment access rights (93h) 1Eh / WORD / Extended access rights and high byte of destination address 20h / 16 BYTEs / Zeros (used by BIOS)

Returns:

Parameter	Description
CF	0 if operation completed successfully 1 if operation failed, AH contains status codes
AH	Status: 00h = Successful 01h = Parity error 02h = Interrupt error 03h = Address line 20 gating failed 86h = Unsupported function

Related Functions:

None.

12.1.6 Function 88h - Get Extended Memory Size

Description:

Returns the amount of memory, above 1 MB, in the system. The nature of this interface limits it to reporting 65 MB total in the system.

Passed:

Parameter	Description
AH	88h

Returns:

Parameter	Description
CF	0 if operation completed successfully 1 if operation failed, AH contains error codes
AX	Amount of continuous memory starting at an absolute address of 100000h
AH	Status: 86h = Unsupported Function

Related Functions:

None.

12.1.7 Function 89h - Enter Protected Mode

Description:

Forces the system into protected mode. The caller must construct a GDT (Global Descriptor Table) to be used by the BIOS.

Passed:

Parameter	Description
AH	89h
BL	Interrupt number for IRQ0
BH	Interrupt number for IRQ8
ES:SI	Pointer to GDT (see Table 12-2 "Global Descriptor Table (GDT)" on page 128)

Returns:

Parameter	Description
CF	0 if operation completed successfully 1 if operation failed, AH contains status codes
AH	Status: 00h = Successful FFh = Error enabling A20
BP	May be destroyed

Related Functions:

None.

Table 12-2. Global Descriptor Table (GDT)

Offset	Size	Description
00h	8 BYTEs	Zeros (null descriptor)
08h	8 BYTEs	GDT descriptor: See Table 12-3.
10h	8 BYTEs	IDT descriptor
18h	8 BYTEs	DS descriptor
20h	8 BYTEs	ES descriptor
28h	8 BYTEs	SS descriptor
30h	8 BYTEs	CS descriptor
38h	8 BYTEs	Uninitialized, used to build descriptor for BIOS CS Descriptor

Table 12-3. GDT Descriptor Table Format

Offset	Size	Description
00h	WORD	Segment limit, low WORD
02h	3 BYTEs	Segment base address, low 24 bits
05h	BYTE	Access mode
06h	BYTE	Extended access mode
07h	BYTE	Segment base address, high 8 bits

12.1.8 Function 90h - Device Busy

Description:

Passed:

Parameter	Description
AH	90h

Returns:

Parameter	Description
CF	0 = Carry flag cleared

Related Functions:

None.

12.1.9 Function 91h - Interrupt Complete

Description:

Passed:

Parameter	Description
AH	91h
CX	CX:DX = Interval in microseconds
DX	0000h = Disable resume on ring indicator 00001h = Enable resume on ring indicator 0002h = Get enabled/disabled status All other values are reserved

Returns:

Parameter	Description
CF	0 = Carry flag cleared

Related Functions:

None.

12.1.10 Function BEh - AMD OEM Functions

The AMD OEM functions can be broadly divided into the following categories:

- **ACCESS.bus Access Functions Specific to Geode™ Devices:**
  - — GeodeROM provides the following functions to access ACCESS.bus devices installed in the system. These can be used in platform-specific modules or when writing tools and utilities.
  - — ACCESS.bus access functions specific to Geode devices, INT 15h, Function BEh:
    - – Subfunction 00h: Read ACCESS.bus Byte
    - – Subfunction 01h: Write ACCESS.bus Byte
    - – Subfunction 02h: Write ACCESS.bus Block
- **NVRAM Access Functions Specific to Geode Devices:**
  - — GeodeROM provides the following functions (specific to Geode devices) to access the installed NVRAM devices in the system. Information is accessed through a token rather than an absolute address. This eliminates the necessity of knowing specific addresses, and allows for future reorganization of the NVRAM map.
  - — **Note** that although these BIOS calls are present and functional, they are intended for forward compatibility. Currently, GeodeROM (POST) does not use information found in NVRAM. All initialization values are specified using the configurator.
  - — NVRAM access functions specific to Geode devices, INT 15h, Function BEh:
    - – Subfunction 03h: Read NVRAM Data
    - – Subfunction 04h: Write NVRAM Data
    - – Subfunction 05h: Get Default NVRAM Value
    - – Subfunction 06h: Get NVRAM Checksum
    - – Subfunction 07h: Set NVRAM Checksum
    - – Subfunction 08h: Reset NVRAM Default
    - – Subfunction 09h: Get NVRAM Table Address
- **Access Functions to a Specific Geode Platform and/or other AMD Device:**
  - — GeodeROM provides the following functions for Geode specific platforms and other AMD devices installed in the system.
  - — Access functions to a specific Geode platform and/or other AMD device:
    - – Subfunction 0Ah: ACCESS.bus Block Read
    - – Subfunction 20h: Get SCxxxx External Clock Speed
    - – Subfunction 21h: Get SCxxxx Device Type
    - – Subfunction 31h: SCxxxx Read ACCESS.bus Device
    - – Subfunction 32h: SCxxxx Write ACCESS.bus Device
    - – Subfunction 35h: Owl Board Specific Feature Access
    - – Subfunction A0h: Wait for Key Timeout
    - – Subfunction A1h: Get ROM Data
    - – Subfunction A2h: CPU Memory Register Read INT
    - – Subfunction A3h: CPU Memory Register Write INT
    - – Subfunction A4h: Get CPU Speed
    - – Subfunction A5h: Check CMOS
    - – Subfunction A6h: CMOS Check Power
    - – Subfunction A7h: Get PCI Speed
    - – Subfunction A8h: Set Warning
    - – Subfunction A9h: Read Companion Chip DWORD
    - – Subfunction AAh: CPU Register Read
    - – Subfunction ABh: CPU Register Write
    - – Subfunction ACh: Eat Key
    - – Subfunction B0h: Get Shadow
    - – Subfunction B1h: Set Shadow
    - – Subfunction F0h-FFh: User Defined Interrupts

12.1.10.1 Subfunction 00h - Read ACCESS.bus Byte

Description:

Read a byte of data from an ACCESS.bus device.

Passed:

Parameter	Description
AX	BE00h
BX	4E53h (= 'NS')
CL	Register offset
CH	ACCESS.bus address

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AL	Data read

Related Functions:

None.

12.1.10.2 Subfunction 01h - Write ACCESS.bus Byte

Description:

Write a byte of data to an ACCESS.bus device.

Passed:

Parameter	Description
AX	BE00h
BX	4E53h (= 'NS')
CL	Register offset
CH	ACCESS.bus address
DL	Data read

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.3 Subfunction 02h - Write ACCESS.bus Block

Description:

Write a byte of data to an ACCESS.bus device.

Passed:

Parameter	Description
AX	BE00h
BX	4E53h (= 'NS')
CL	Register offset
CH	ACCESS.bus address
DL	Number of bytes to transfer
DS:SI	Pointer to transfer buffer

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.4 Subfunction 03h - Read NVRAM Data

Description:

Reads data associated with a particular token from NVRAM. The data is right-justified and up to eight bits wide. GeodeROM is responsible for determining the correct location from which information is read. The caller is responsible for knowing the format of the data (see Table 12-4 on page 136).

Passed:

Parameter	Description
AX	BE03h
BX	4E53h (= 'NS')
CX	Token
DH	Media: 00h = CMOS 01h = System ROM Flash 02h = Serial EEPROM 03h-FFh = Reserved

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
DL	Value read, or error code: Error Codes: 00h = Reserved 01h = Token not supported 02h = Software support not present (e.g., not implemented) 03h = Hardware support not present (e.g., no CMOS in system) 04h = Invalid media specified 05h = Token not valid in particular media

Related Functions:

None.

12.1.10.5 Subfunction 04h - Write NVRAM Data

Description:

Write data associated with a particular token to NVRAM. The data passed to the function should be right justified and up to eight bits wide. GeodeROM is responsible for determining the correct location to which information is written. The caller is responsible for knowing the format of the data (see Table 12-4 on page 136).

Passed:

Parameter	Description
AX	BE04h
BX	4E53h (= 'NS')
CX	Token
DL	Value to write
DH	Media: See "Subfunction 03h - Read NVRAM Data" on page 132

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
DL	Error code if failure: See "Subfunction 03h - Read NVRAM Data" on page 132

Related Functions:

None.

12.1.10.6 Subfunction 05h - Get Default NVRAM Value

Description:

Retrieves the default setting for a particular token. SeeTable 12-4 on page 136 for the format of the tokens.

Passed:

Parameter	Description
AX	BE05h
BX	4E53h (= ‘NS’)
CX	Token
DH	Media: See "Subfunction 03h - Read NVRAM Data" on page 132

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
DL	Default value, or error code: See "Subfunction 03h - Read NVRAM Data" on page 132

Related Functions:

None.

12.1.10.7 Subfunction 06h - Get NVRAM Checksum

Description:

Returns currently stored checksum and attempts to calculate the correct checksum.

Passed:

Parameter	Description
AX	BE06h
BX	4E53h (= ‘NS’)
DH	Media: See "Subfunction 03h - Read NVRAM Data" on page 132

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AL	Calculated checksum
AH	NVRAM checksum value
DL	Default value, or error code: See "Subfunction 03h - Read NVRAM Data" on page 132

Related Functions:

None.

12.1.10.8 Subfunction 07h - Set NVRAM Checksum

Description:

Calculates the checksum for NVRAM and stores at the location for the checksum token.

Passed:

Parameter	Description
AX	BE07h
BX	4E53h (= 'NS')
DH	Media: See "Subfunction 03h - Read NVRAM Data" on page 132

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
DL	Error code if failure: See "Subfunction 03h - Read NVRAM Data" on page 132

Related Functions:

None.

12.1.10.9 Subfunction 08h - Reset NVRAM Default

Description:

Resets all tokens in a particular type of media to the default values.

Passed:

Parameter	Description
AX	BE08h
BX	4E53h (= 'NS')
DH	Media: See "Subfunction 03h - Read NVRAM Data" on page 132

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
DL	Error code if failure: See "Subfunction 03h - Read NVRAM Data" on page 132. Note that errors 02h, 03h, and 04h only apply.

Related Functions:

None.

12.1.10.10 Subfunction 09h - Get NVRAM Table Address

Description:

Returns the address for the NVRAM and media type tables, and is intended for internal usage.

Passed:

Parameter	Description
AX	BE09h
BX	4E53h (= ‘NS’)

Returns:

Parameter	Description
SI	Address of NVRAM map
CX	Number of entries in NVRAM map
DI	Address of media table
DX	Number of entries in NVRAM (see Table 12-4 "NVRAM Table")

Related Functions:

None.

Table 12-4. NVRAM Table

Token[1]	Description	Width	Definition
PM	Power management enable	1 Bit	0 = Disable 1 = Enable
PS	Suspend state	2 Bits	00 = Stop Clock 01 = 3V Suspend 10 = Suspend-to-Disk 11 = Suspend-to-RAM
TY	Standby timeout	1 Byte	0000 = Disable 0001 = 5 seconds 0010 = 10 seconds 0011 = 15 seconds 0100 = 30 seconds 0101 = 45 seconds 0110 = 1 minute 0111 = 2 minutes 1000 = 5 minutes 1001 = 10 minutes 1010 = 15 minutes 1011 = 30 minutes 1100 = 45 minutes 1101 = 60 minutes 1110 = 90 minutes 1111 = 120 minutes
TS	Suspend timeout	1 Byte	See “Standby timeout” (TY, this table)
TI	Idle timeout	1 Byte	See “Standby timeout” (TY, this table)
TK	Keyboard/mouse timeout	1 Byte	See “Standby timeout” (TY, this table)
T1	HDD1 timeout	1 Byte	See “Standby timeout” (TY, this table)
T2	HDD2 timeout	1 Byte	See “Standby timeout” (TY, this table)
TF	FDD timeout	1 Byte	See “Standby timeout” (TY, this table)

Table 12-4. NVRAM Table (Continued)

Token[1]	Description	Width	Definition
TV	Video timeout	1 Byte	See “Standby timeout” (TY, this table)
TU	Serial port timeout	1 Byte	See “Standby timeout” (TY, this table)
TP	Parallel port timeout	1 Byte	See “Standby timeout” (TY, this table)
W1	Wakeup mask PIC1	1 Byte	Bit mask: Bit 0 = IRQ0, etc.
W2	Wakeup mask PIC2	1 Byte	Bit mask: Bit 0 = IRQ8, etc.
WC	Wakeup century	1 Bit	0 = 1999 1 = 2000
WY	Wakeup year	1 Byte	BCD value for year mod 100 (0-99)
WM	Wakeup month	1 Byte	BCD value for month (0-12)
WD	Wakeup day	1 Byte	BCD value for day (0-31)
WH	Wakeup hour	1 Byte	BCD value for hour (0-23)
WT	Wakeup minute	1 Byte	BCD value for minute (0-59)
WS	Wakeup second	1 Byte	BCD value for second (0 - 59)
WE	Wakeup enable	3 Bits	Not implemented: 000 = Disable
PS	Suspend-to-Disk or Suspend-to-RAM (S2D / S2R)	1 Bit	0 = Normal boot 1 = Wake from S2D or S2R
U1	UART1 configuration	3 Bits	000 = Disable 001 = 3F8, IRQ4 010 = 2F8, IRQ3 011 = 3E8, IRQ4 100 = 2E8, IRQ3 101-111 = Reserved
U2	UART2 configuration	3 Bits	000 = Disable 001 = 3F8, IRQ4 010 = 2F8, IRQ3 011 = 3E8, IRQ4 100 = 2E8, IRQ3 101-111 = Reserved
U3	UART3 configuration	3 Bits	000 = Disable 001 = 3F8, IRQ4 010 = 2F8, IRQ3 011 = 3E8, IRQ4 100 = 2E8, IRQ3 101-111 = Reserved
U4	UART4 configuration	3 Bits	000 = Disable 001 = 3F8, IRQ4 010 = 2F8, IRQ3 011 = 3E8, IRQ4 100 = 2E8, IRQ3 101-111 = Reserved
LA	LPT1 I/O port	2 Bits	00 = Disable 01 = 378 10 = 278 11 = 3BC
LI	LPT1 IRQ (only used when necessary, depending on port mode)	2 Bits	00 = IRQ5 01 = IRQ7 10-11 = Reserved

Table 12-4. NVRAM Table (Continued)

Token[1]	Description	Width	Definition
LD	LPT1 mode	3 Bits	000 = Compatible 001 = PS/2 bidirectional 010 = EPP 1.7 011 = EPP 1.9 100 = ECP 101-111 = Reserved
LB	LPT2 I/O port	2 Bits	00 = Disable 01 = 378 10 = 278 11 = 3BC
LQ	LPT2 IRQ (only used when necessary, depending on port mode)	2 Bits	00 = IRQ5 01 = IRQ7 10-11 = Reserved
LO	LPT2 mode	3 Bits	000 = Compatible 001 = PS/2 bidirectional 010 = EPP 1.7 011 = EPP 1.9 100 = ECP 101-111 = Reserved
ID	IDE controller enable	1 Bit	0 = Disable 1 = Enable
I1	Primary IDE enable (may not be available for all controllers)	1 Bit	0 = Disable 1 = Enable
I2	Secondary IDE enable (may not be available for all controllers)	1 Bit	0 = Disable 1 = Enable
FD	FDD enable	1 Bit	0 = Disable 1 = Enable
AU	Audio enable	1 Bit	0 = Disable 1 = Enable
AA	Audio base address	2 Bits	00 = 220 01 = 240 10 = 260 11 = 280
AI	Audio IRQ	2 Bits	00 = IRQ5 01 = IRQ7 10 = IRQ9 11 = IRQ10
A1	Audio 8-bit DMA	2 Bits	00 = DMA0 01 = DMA1 10 = Reserved 11 = DMA3
A2	Audio 16-bit DMA	2 Bits	00 = Reserved 01 = DMA5 10 = DMA6 11 = DMA7
US	USB Enable (may mean the device is present or not)	1 Bit	0 = Disable 1 = Enable
UL	Legacy USB on/off	1 Bit	0 = Disable 1 = Enable

Table 12-4. NVRAM Table (Continued)

Token[1]	Description	Width	Definition
CA	Cache on/off	1 Bit	0 = Disable 1 = Enable
CM	Cache mode	1 Bit	0 = Write-back 1 = Write-through
B1	Boot device 1	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100-111 = Reserved
B2	Boot device 2	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100-111 = Reserved
B3	Boot device 3	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100 – 111 = Reserved
B4	Boot device 4	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100-111 = Reserved
B5	Boot device 5	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100-111 = Reserved
B6	Boot device 6	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100-111 = Reserved
B7	Boot device 7	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100-111 = Reserved
B8	Boot device 8	3 Bits	000 = None 001 = HDD1 010 = FDD 011 = Network 100-111 = Reserved
MO	Memory optimization	1 Bit	0 = Automatic optimization 1 = Manual settings

Table 12-4. NVRAM Table (Continued)

Token[1]	Description	Width	Definition
MR	SDRAM clock ratio	3 Bits	000 = Reserved 001 = 2.0 010 = 2.5 011 = 3.0 100 = 3.5 101 = 4.0 110 = 4.5 111 = 5.0
MD	SDRAM drive/slew	3 Bits	000 = Lowest drive strength 001… 111 = Highest drive strength
MS	SDRAM shift SDCLK	3 Bits	000 = No shift 001 = Shift 0.5 core clocks 010 = Shift 1.0 core clocks 011 = Shift 1.5 core clocks 100 = Shift 2.0 core clocks 101 = Shift 2.5 core clocks 110 = Shift 3.0 core clocks 111 = Reserved
MC	CAS latency	3 Bits	000 = Reserved 001 = Reserved 010 = 2 CLKs 011 = 3 CLKs 100 = 4 CLKs 101 = 5 CLKs 110 = 6 CLKs 111 = 7 CLKs
M1	tRC	4 Bits	0000 = Reserved 0001 = 2 CLKs 0010 = 3 CLKs 1111 = 16 CLKs All other decodes = Reserved
M2	tRAS	4 Bits	0000 = Reserved 0001 = 2 CLKs 0010 = 3 CLKs 1111 = 16 CLKs All other decodes = Reserved
M3	tRP	3 Bits	000 = Reserved 001 = 1 CLK 010 = 2 CLKs 111 = 7 CLKs All other decodes = Reserved
M4	tRCD	3 Bits	000 = Reserved 001 = 1 CLK 010 = 2 CLKs 111 = 7 CLKs All other decodes = Reserved
M6	TDPL	3 Bits	000 = Reserved 001 = 1 CLK 010 = 2 CLKs 111 = 7 CLKs All other decodes = Reserved

Table 12-4. NVRAM Table (Continued)

Token[1]	Description	Width	Definition
VO	TV-out	2 Bits	00 = Disabled 01 = S-Video 10 = Composite 11 = Both
VF	TV format	2 Bits	00 = NTSC 01 = PAL 10 = Reserved 11 = Reserved
VM	TV Mode	2 Bits	00 = 640x480 01 = 800x600 10 = 1024x768 11 = Reserved
VH	TV horizontal position	1 Byte	0-255 Pixels
VV	TV vertical position	1 Byte	0-255 Lines

1. In general, tokens have been named by category:
   Px = Power related
   Tx = Timeouts
   Wx = Wakeup related
   Ux = UART and USB
   Lx = LPT values
   I x = IDE
   Fx = FDD
   Ax = Audio
   Cx = Cache
   Bx = Boot devices
   Mx = Memory controller

12.1.10.11 Subfunction 0Ah - ACCESS.bus Block Read

Description:

Reads a block of data from an ACCESS.bus device. Sends an offset/command byte so it only works with devices that expect an address followed by an offset/command followed by a read of data. For devices that do not require an offset/command, use the special procedure (BE31h).

Not valid for none ACCESS.bus systems (i.e., AMD Geode™ SC1100, SC1200, SC1201, SC2200, and SC3200 processors with ACCESS.bus)

Passed:

Parameter	Description
AX	BE0Ah
BX	4E53h (= ‘NS’)
BP	Number of the ACCESS.bus to use
CH	Chip Address
CL	Register
DL	Number of bytes to transfer
ES:DI	Pointer to data to write to device

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

Requires SPDI2C.ASM

12.1.10.12 Subfunction 20h - Get SCxxxx External Clock Speed

Description:

Returns the value of the single chip device’s clock speed in MHz.

Passed:

Parameter	Description
AX	BE20h
BX	4E53h (= ‘NS’)

Related Functions:

None.

Returns:

Parameter	Description
AX	Clock speed (MHz)
CF	0 = Success 1 = Failure

12.1.10.13 Subfunction 21h - Get SCxxxx Device Type

Description:

Returns the value of the single chip device’s number in the system (i.e., SC1100, SC1200, SC1201, SC2200, SC3200).

Passed:

Parameter	Description
AX	BE21h
BX	4E53h (= ‘NS’)
CX	00h = Returns CPU type that GeodeROM was built with 01h = Returns CPU type reported by F5 60h 02h = Returns CPU type reported by CPU straps

Returns:

Parameter	Description
EBX	Chip ID
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.14 Subfunction 31h - SCxxxx Read ACCESS.bus Device

Description:

Read a byte of data from an ACCESS.bus device when a single chip device is used in the system (i.e., SC1100, SC1200, SC1201, SC2200, SC3200).

Passed:

Parameter	Description
AX	BE31h
BX	4E53h (= ‘NS’)
CH	Chip Address
CL	Number of bytes
ES:DI	Pointer to buffer (if CL > 04h)

Returns:

Parameter	Description
EAX	Data read if CL <= 04h
ES:DI	Data read if CL > than 04h
CF	0 if operation completed successfully 1 if operation failed; error reported in AH
AH	Error code: 01h = Invalid size 02h = ACCESS.bus COM error 03h = Buffer address wrap

Related Functions:

None.

12.1.10.15 Subfunction 32h - SCxxxx Write ACCESS.bus Device

Description:

Write a byte of data from an ACCESS.bus device when a single chip device is used in the system (i.e., SC1100, SC1200, SC1201, SC2200, SC3200).

Passed:

Parameter	Description
AX	BE32h
BX	4E53h (= ‘NS’)
CH	Chip address
CL	Number of bytes
EDX	Data written if CL <= 04h
ES:DI	Pointer to buffer (if CL > 04h)

Returns:

Parameter	Description
CF	0 if operation completed successfully 1 if operation failed; error reported in AH
AH	Error code: 01h = Invalid size 02h = ACCESS.bus COM error 03h = Buffer address wrap

Related Functions:

None.

12.1.10.16 Subfunction 35h - Owl Board Specific Feature Access

Description:

Provides access to the features on the Owl board.

Passed:

Parameter	Description
AX	BE35h
BX	4E53h (= ‘NS’)
CH	Function: 00h = Read Owl data (returns AX) 05h = Get backlight value (returns AL) 06h = Set backlight data (requires CL)
CL	Data

Returns:

Parameter	Description
AX	Data
CF	0 if operation completed successfully 1 if operation failed; error reported in AH
AH	Error code: 01h = Invalid function 02h = Owl COM error 03h = Invalid data 04h = NVRAM error

Related Functions:

None.

12.1.10.17 Subfunction A0h - Wait for Key Timeout

Description:

Calls waitForKeyTimeout. Does not EAT the key. Use I15EatKey (BEAC).

Passed:

Parameter	Description
AX	BEA0h
BX	4E53h (= 'NS')
ECX	Contains maximum number of mSec to wait for a key press before continuing.

Returns:

Parameter	Description
AX	Holds key pressed or 0 if timeout.
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.18 Subfunction A1h - Get ROM Data

Description:

Returns a pointer to the ROM data. The address is returned in DX:AX.

Passed:

Parameter	Description
AX	BEA1h
BX	4E53h (= ‘NS’)
CL	GeodeROM version number: 00h = GeodeROM version number 01h = GeodeROM build time 02h = GeodeROM build date 03h = Engineering release string 04h = Copyright string 05h = Platform name 06h = User string 07h = First configuration string generated by the Configurator 08h = Second string generated by the Configurator 09h = List of overrides 0Ah = NVRAM map length 0Bh = NVRAM map 0Ch = Video memory size 0Dh = Summary screen buffered in DRAM (data is subject to overwriting prior to call) 0Eh = End of summary screen buffered in DRAM 0Fh = Warnings buffer 10h and higher = Reserved

Returns:

Parameter	Description
AX	Offset of data item
DX	Segment of data item (address is DX:AX)
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.19 Subfunction A2h - CPU Memory Register Read Int

Description:

Read a memory mapped offset from GX_BASE. This function is not defined in the Geode GX processor BIOS and returns a 0 (success) in CF.

Passed:

Parameter	Description
AX	BEA2h
BX	4E53h (= ‘NS’
ECX	Register offset from GX_BASE

Returns:

Parameter	Description
EDX	Register data
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.20 Subfunction A3h - CPU Memory Register Write Int

Description:

Write a memory mapped offset from GX_BASE. This function is not defined in the Geode GX processor BIOS and returns a 0 (success) in CF.

Passed:

Parameter	Description
AX	BEA3h
BX	4E53h (= ‘NS’)
ECX	Register offset from GX_BASE
EDX	Register data

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.21 Subfunction A4h - Get CPU Speed

Description:

Calculate and return the speed of the CPU.

Passed:

Parameter	Description
AX	BEA4h
BX	4E53h (=’NS’)

Returns:

Parameter	Description
AX	CPU Speed in MHz
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.22 Subfunction A5h - Check CMOS

Description:

Check for the presence of CMOS by writing test pattern to b[1:0] of the diagnostic byte.

Passed:

Parameter	Description
AX	BEA5h
BX	4E53h (=’NS’)

Returns:

Parameter	Description
CF	0 = CMOS present 1 = CMOS absent

Related Functions:

None.

12.1.10.23 Subfunction A6h - Check CMOS Power

Description:

Check whether CMOS has lost power.

Passed:

Parameter	Description
AX	BEA6h
BX	4E53h (= ‘NS’)

Returns:

Parameter	Description
CF	0 = Power good 1 = Power lost

Related Functions:

None.

12.1.10.24 Subfunction A7h - Get PCI Speed

Description:

Detect and return the PCI bus speed.

Passed:

Parameter	Description
AX	BEA7h
BX	4E53h (= ’NS’)

Returns:

Parameter	Description
AX	PCI bus speed in MHz
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.25 Subfunction A8h - Set Warning

Description:

Set a summary screen warning with a string located at CX:DX. The system may contain up to three warning messages. If three already exist, this function places the warning in the third location.

Passed:

Parameter	Description
AX	BEA8h
BX	4E53h (= ’NS’)
CX	Segment of warning string
DX	Offset of warning string

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.26 Subfunction A9h - Read Companion Chip DWORD

Description:

Read a DWORD register from the PCI configuration space of any device in the companion chip.

Passed:

Parameter	Description
AX	BEA9h
BX	4E53h (= ’NS’)
EDX	PCI function address of register: b[31] = 1 b[30:24] = reserved = 0 b[23:16] = bus number = 0 b[15:11] = device number = 12 b[10:8] = function number b[7:2] = register number b[1:0] = 00h

Returns:

Parameter	Description
EDX	Register contents
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.27 Subfunction AAh - CPI Register Read

Description:

Read a Geode GX1 processor configuration register from the index/data pair at 22h/23h. Executing this interrupt has no function on a Geode GX processor but will return success. See the *AMD Geode™ GX1 Processor Data Book* for a list of configuration registers that may be read.

Passed:

Parameter	Description
AX	BEAAh
BX	4E53h (= ‘NS’)
CL	Register to read

Returns:

Parameter	Description
AL	Register contents
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.28 Subfunction ABh - CPU Register Write

Description:

Write a Geode GX1 processor configuration register from the index/data pair at 22h/23h. Executing this interrupt has no function on a Geode GX processor but will return success. See the *AMD Geode™ GX1 Processor Data Book* for a list of configuration registers that may be written.

Passed:

Parameter	Description
AX	BEABh
BX	4E53h (= ‘NS’)
CX	Register to write
DL	Data to write

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.29 Subfunction ACh - Eat Key

Description:

Calls EatKey. Not used in Geode GX processor.

Passed:

Parameter	Description
AX	BEACh
BX	4E53h (= ‘NS’)

Returns:

Parameter	Description
AX	Keystroke
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.30 Subfunction B0h - Get Shadow

Description:

Read the shadow information for each of the 16 KB regions from C0000h through FC000h. This call is only supported on Geode GX processor systems. On anything else, it returns with an indication of unsuccessful.

Passed:

Parameter	Description
AX	BEB0h
BX	4E53h (= ‘NS’)

Returns:

Parameter	Description
EDX	Read and write enables: b[31:16] = bitwise write enables for FC000h-C0000h b[15:0] = bitwise read enables for FC000h-C000h
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.31 Subfunction B1h - Set Shadow

Description:

Write the shadow information for each of the 16 KB regions from C0000h through FC0000h. This call is only supported on Geode GX processor systems. On anything else it returns with an indication of unsuccessful.

Passed:

Parameter	Description
AX	BEB1h
BX	4E53h (=’NS’)
EDX	Read and write enables: b[31:16] = bitwise write enables for FC000h-C0000h b[15:0] = bitwise read enables for FC000h-C000h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure

Related Functions:

None.

12.1.10.32 Subfunction F0h through FFh - User Defined Interrupts

Description:

Passed:

Parameter	Description
AX	BEF0h - BEFFh
BX	4E53h (= ‘NS’)

Returns:

None.

Related Functions:

None.

12.1.11 Function C0h - Get ROM Configuration

Description:

The ROM holds information about the system's design. This function retrieves a pointer to the data.

Passed:

Parameter	Description
AX	C0h

Returns:

Parameter	Description
CF	0 if operation completed successfully 1 if operation failed, AH contains error code
AH	Error code: 86h = Unsupported function
ES:BX	Pointer to the ROM table:

Offset	Size	Description	Value
00h	WORD	Number of bytes following	08h
02h	BYTE	Model	FCh
03h	BYTE	Submodel	01h
04h	BYTE	BIOS version	00h
05h	BYTE	Feature byte 1	74h
06h	BYTE	Feature byte 2	00h
07h	BYTE	Feature byte 3	00h
1Dh	BYTE	Feature byte 4	00h

Related Functions:

None.

12.1.12 Function C1h - Get EBDA Address

Description:

Returns a pointer to the system's Extended BIOS Data Area.

Passed:

Parameter	Description
AH	C1h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
ES	Segment of the EBDA

Related Functions:

None.

12.1.13 Function C2h - PS/2 Mouse Support

GeodeROM provides support for detecting, initializing and handling PS/2 mouse activity. For information on PS/2 mouse support, refer to the IBM Mouse Technical Reference Manual.

- **PS/2 Mouse Support Functions, INT 15h, Function C2h:**
  - — Subfunction 00h: Enable/Disable Pointing Device
  - — Subfunction 01h: Reset Pointing Device
  - — Subfunction 02h: Set Sample Rate
  - — Subfunction 03h: Set Resolution
  - — Subfunction 04h: Read Device Type
  - — Subfunction 05h: Initialize Pointing Device Interface
  - — Subfunction 06h: Pointing Device Extended Commands
  - — Subfunction 07h: Set Pointing Device Handler Address

12.1.13.1 Subfunction 00h: - Enable/Disable Pointing Device

Description:

Enables the pointing device, allowing its use, or disables the device so it can no longer be used.

Passed:

Parameter	Description
AX	C200h
BH	00h = Disable 01h = Enable

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: 00h = Successful 01h = Invalid function 02h = Invalid input 03h = Interface error 04h = Need to resend 05h = No device handler installed

Related Functions:

None.

12.1.13.2 Subfunction 01h - Reset Pointing Device

Description:

Resets the pointing device: IRQ 12 is unmasked, the interface is disabled, the pointing device is reset (command FFh), and if found successfully, bit 4 of the equipment determination WORD in the BDA (40:10) is set.

Passed:

Parameter	Description
AH	C201h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
BH	Device ID
BL	Value returned by pointing device (AAh if device is a mouse)
AH	Status code: See "Subfunction 00h: - Enable/Disable Pointing Device" on page 156

Related Functions:

None.

12.1.13.3 Subfunction 02h - Set Sample Rate

Description:

Sets the sample rate for the pointing device. Note that if an invalid sample rate is passed, the return status reflects invalid input. Sending the F3h command to the device, followed by the rate value sets the sample.

Passed:

Parameter	Description
AH	C202h
BH	Sample rate: 00h = 10 samples/second 01h = 20/second 02h = 40/second 03h = 60/second 04h = 80/second 05h = 100/second 06h = 200/second

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See "Subfunction 00h: - Enable/Disable Pointing Device" on page 156

Related Functions:

None.

12.1.13.4 Subfunction 03h - Set Resolution

Description:

Sets the resolution for the pointing device. Sending the E8h command to the device, followed by the resolution value, sets the resolution.

Passed:

Parameter	Description
AH	C203h
BH	Resolution: 00h = One count per mm 01h = Two counts per mm 02h = Four counts per mm 03h = Eight counts per mm

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See "Subfunction 00h: - Enable/Disable Pointing Device" on page 156

Related Functions:

None.

12.1.13.5 Subfunction 04h - Read Device Type

Description:

Reads the device type of the pointing device. Sending the F2h command to the device causes the device to return its ID. The ID for a mouse should be 00h.

Passed:

Parameter	Description
AH	C204h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
BH	Device ID
AH	Status code: See "Subfunction 00h: - Enable/Disable Pointing Device" on page 156

Related Functions:

None.

12.1.13.6 Subfunction 05h - Initialize Pointing Device Interface

Description:

Initializes the pointing device interface flags by clearing the Acknowledge bit (bit 5) in the Extended BDA (offset 26h) and setting the package size (bits 0-3 in the EBDA offset 27h).

Passed:

Parameter	Description
AH	C205

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See "Subfunction 00h: - Enable/Disable Pointing Device" on page 156

Related Functions:

None.

12.1.13.7 Subfunction 06h - Pointing Device Extended Commands

Passed:

Parameter	Description
AH	C206h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See "Subfunction 00h: - Enable/Disable Pointing Device" on page 156

Related Functions:

None.

12.1.13.8 Subfunction 07h - Set Pointing Device Handler Address

Description:

Allows the caller to set the address for the handler. The vector is stored in the Extended BDA at offset 22h, and the driver flag is set in Offset 27h.

Passed:

Parameter	Description
AH	C207h
ES:BX	Far pointer to the handler, or 0000:0000 to cancel

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Status code: See "Subfunction 00h: - Enable/Disable Pointing Device" on page 156

Related Functions:

None.

12.1.14 Function E8h - Memory Size and Map Support

- **Memory Size and Map Support Functions, INT 15h, Function E8h:**
  - — Subfunction 01h: Get System Memory Size
  - — Subfunction 20h: Get System Memory Map

12.1.14.1 Subfunction 01h - Get System Memory Size

Description:

Reports the amount of system memory present and configured.

Passed:

Parameter	Description
AX	E801h

Returns:

Parameter	Description
CF	0 = Success 1 = Failure
AH	Extended memory between 1 MB and 16 MB (in KB blocks)
BX	Extended memory above 16 MB (in 64 KB blocks)
CX	Configured memory between 1 MB and 16 MB (in KB blocks)
DX	Configured memory above 16 MB (in 64 KB blocks)

Related Functions:

None.

12.1.14.2 Subfunction 20h - Get System Memory Map

Description:

Reports a memory map of the memory installed in the system. Data is in the form of table entries.

Passed:

Parameter	Description
EAX	E820h
EDX	534D4150h (‘SMAP’)
EBX	Continuation value, or 00000000h the first time
ECX	Size of buffer for result, in bytes (must be >= 20 bytes)
ES:DI	Buffer for result

Returns:

Parameter	Description
EAX	534D4150h (‘SMAP’)
ES:DI	Buffer is filled
EBX	Continuation value (=00000000h if no more entries)
ECX	Actual length of data written to buffer (maximum of 20): **Offset** **Size** **Description** 00h QWORD Base Address 08h QWORD Length, in Bytes 0Ch DWORD Type of Address Range: 01h = Memory Available for OS 02h = Reserved/Not Available (e.g., for System ROMs, etc.) 03h = ACPI Reclaim Memory (not used by GeodeROM firmware) 04h = ACPI NVS Memory (not used by GeodeROM firmware)

Related Functions:

None.

13 Video BIOS Support

GeodeROM's supports the INT 10h video BIOS functions listed in Table 13-1 and VESA BIOS Extension in Section 13.2 on page 192.

Table 13-1. INT 10h Video BIOS Functions

Function	Subfunction	Page Number
Function 00h - Set Video Mode		165
Function 01h - Set Cursor Type		166
Function 02h - Set Cursor Position		166
Function 03h - Get Cursor Position		167
Function 04h - Read Light Pen		167
Function 05h - Set Active Display Page		168
Function 06h - Scroll Up		168
Function 07h - Scroll Down		169
Function 08h - Read Character and Attribute		169
Function 09h - Write Character and Attribute		170
Function 0Ah - Write Character		170
Function 0Bh - Set CGA Palette		171
Function 0Ch - Write Dot		171
Function 0Dh - Read Dot		172
Function 0Eh - Write TTY		172
Function 0Fh - Get Mode		173
Function 10h - Palette Handler		173
	Subfunction 00h: Set Individual Palette Register	173
	Subfunction 01h: Set Overscan Register	173
	Subfunction 02h: Set All Palette and Overscan Registers	174
	Subfunction 03h: Toggle Intensity/Blinking Bit	174
	Subfunction 07h: Read Individual Palette Register	174
	Subfunction 08h: Read Overscan Register	175
	Subfunction 09h: Read All Palette and Overscan Registers	175
	Subfunction 10h: Read Individual RAMDAC Register	175
	Subfunction 12h: Set Block of RAMDAC Registers	176
	Subfunction 13h: Select Color Page	176
	Subfunction 15h: Get Individual RAMDAC Register	176
	Subfunction 17h: Get Block of RAMDAC Registers	177

Table 13-1. INT 10h Video BIOS Functions

Function	Subfunction	Page Number
	Subfunction 1Ah: Get Color Page	177
	Subfunction 1Bh: Sum RAMDAC to Gray Scale	178
Function 11h - Font Functions		178
	Subfunction 00h: Load User Font	178
	Subfunction 01h: Load 8x14 Font	179
	Subfunction 02h: Load 8x8 Font	179
	Subfunction 03h: Set Font Block	179
	Subfunction 04h: Load 8x16 Font	180
	Subfunction 10h: Load User Font with Fixup	180
	Subfunction 11h: Load 8x14 Font with Fixup	181
	Subfunction 12h: Load 8x8 Font with Fixup	181
	Subfunction 14h: Load 8x16 Font with Fixup	181
	Subfunction 20h: Load Upper 8x8 Graphics Character Set	182
	Subfunction 21h: Load User Graphics Character Set	182
	Subfunction 22h: Load 8x14 Graphics Character Set	183
	Subfunction 23h: Load 8x8 Graphics Character Set	183
	Subfunction 24h: Load 8x16 Graphics Character Set	184
	Subfunction 30h: Get Font Information	184
Function 12h: Alternate Select Functions		185
	Subfunction 10h: Return Video Information	185
	Subfunction 20h: Alternate Print Screen	185
	Subfunction 30h: Select Scan Lines	186
	Subfunction 31h: Enable/Disable Palette Loading	186
	Subfunction 32h: Enable/Disable Video Subsystem	187
	Subfunction 33h: Enable/Disable Summing to Gray Scales	187
	Subfunction 34h: Enable/Disable Cursor Emulation	187
	Subfunction 35h: Display Switch	188
	Subfunction 36h: Enable/Disable Video Screen	188
Function 13h - Write String		189
Function 1Ah - Get DCC Information		190
Function 1Bh - Get Functionality Information		191
Function 1Ch - Save Restore State		191

13.1 INT 10h Functions Descriptions

This section lists those INT 10h functions supported in GeodeROM, the parameters that system software supplies to each INT10h function, and the values that each function returns.

13.1.1 Function 00h - Set Video Mode

Description:

Sets the VGA into one of several enumerated modes. A “normal” mode set includes clearing the display memory; however, by setting bit 7 of AL to a “1” allows the mode set to occur without clearing video memory. Note that even if bit 7 is set, a font still gets loaded in text modes.

On a mode set, these events occur:

1) As determined by the parameter table, all VGA registers are placed into a known state.
2) The cursor position changes to 0, 0.
3) The BIOS variables for mode number, number of rows and columns, CRTC address, etc. are updated.
4) The screen is cleared (if bit 7 of AL = 0 on entry to this function).
5) The RAMDAC is loaded based on mode type.
6) In text modes, the appropriate size font is loaded.
7) Alternate palettes and alternate fonts may be loaded based on the save pointer table.

The font size used in the text mode is based on the number of scan lines on the display. The BIOS saves the last setting of Function 12h, Subfunction 30h (Select Scan Lines) for this purpose. The fonts used in each text mode are shown in Table 13-2.

Table 13-2. Text Mode Fonts

Mode/Scan Lines	200	350	400
0/1	8x8	8x14	9x16
2/3	8x8	8x14	9x16
7	N/A	9x14	9x16

Passed:

Parameter	Description
AH	00h = Function number
AL	Mode number
DS	Seg0

Returns:

None.

13.1.2 Function 01h - Set Cursor Type

Description:

Changes the shape of the text mode cursor to a new start and end scan line shape. By setting the cursor start scan line greater than the cell height on the screen, the text cursor is disabled (hidden). The standard method of disabling the cursor is to pass a 20h as the start scan line value. This function has no effect in graphics mode.

In order to maintain compatibility with the CGA and EGA, the BIOS emulates an 8x8 cursor cell. In other words, when the cell height is 16 scan lines (standard mode 3), calling this with a start of 06h and an end of 07h actually sets the start and end to 0Dh and 0Eh. This emulation functionality can be disabled by calling Alternate Select Function (12h), Subfunction 34h.

When emulated, the cursor follows these general rules:

- Bit 5 = 1: No cursor
- Start scan < end scan<= 3: Overbar cursor
- Start scan + 2 >= end scan: Underline cursor
- Start >= 2: Half block cursor
- Start <= 2: Full block cursor
- End < Start: Full block cursor

Passed:

Parameter	Description
AH	01h
AL	Mode number
DS	Seg0
CL	Cursor end scan line
CH	Cursor start scan line

Returns:

Parameter	Description
AX	Last value programmed into CRTC

13.1.3 Function 02h - Set Cursor Position

Description:

Moves the current cursor position. All character read/write functions depend on the cursor position to determine where to read or write the next character. In graphics mode, this text position is still maintained even though there is no actual blinking cursor. In modes that can have more than one video page, the cursor position can be changed even when the current screen page is different from that passed into this function.

Passed:

Parameter	Description
AH	02h
BH	Page number (0 for graphics modes)
DS	Seg0
DL	Column
DH	Row

Returns:

None.

13.1.4 Function 03h - Get Cursor Position

Description:

Returns the current cursor start and end scan line as well as the current cursor position. Note that the cursor position is based on the page passed, but the cursor type (start and end scan lines) is global across all video pages.

Passed:

Parameter	Description
AH	03h
BH	Page number (0 for graphics modes)
DS	Seg0

Returns:

Parameter	Description
DH	Column
DL	Row

13.1.5 Function 04h - Read Light Pen

Description:

The VGA hardware does not support the light pen and therefore always returns AH = 0.

Passed:

Parameter	Description
AH	04h
DS	Seg0

Returns:

Parameter	Description
AX	0 = Function not supported. Always returns 0.

13.1.6 Function 05h - Set Active Display Page

Description:

Sets the displayable video memory to a new page. The number of video pages available are mode dependent. The higher resolution and extended modes use only one video page (page 0).

Mode	**Pages**
00h/01h	8
02h/03h	8
07h	8
0Dh	8
0Eh	4
0Fh/10h	2
All others	0

Passed:

Parameter	Description
AH	05h
DS	Seg0
AL	xxh = Page to set to

Returns:

None.

13.1.7 Function 06h - Scroll Up

Description:

Causes a specified rectangular area of the screen to move up a given number of lines. The remaining rows at the bottom of the area are cleared with a given fill attribute. The data outside of this area is unaffected. This function only operates on the active page.

Setting the number of lines to scroll to a zero (“0”) causes the entire area to be cleared with the fill attribute. In text mode, this fill attribute is a text attribute (part of the character/attribute pair that define characters in text mode). The rectangular area is filled with a space character (ASCII 20h) and the fill attribute is used as the attribute in that region. The standard fill attribute in text modes is a 07h.

In planar graphics mode, the fill attribute is actually the color to fill with. For example, a fill attribute of 02h actually fills the area with a green rectangle. The standard fill attribute for graphics modes is a 00h.

Passed:

Parameter	Description
AH	06h
DS	Seg0
AL	Number of lines: 0 = Blank entire window
BH	Attribute used to blank line
CL	Upper left column
CH	Upper left row
DL	Lower right column
DH	Lower right row

Returns:

None.

13.1.8 Function 07h - Scroll Down

Description:

Causes a specified rectangular area of the screen to move down a given number of lines. The remaining rows at the top of the area are cleared with a given fill attribute. The data outside of this area is unaffected. This function only operates on the active page.

Setting the number of lines to scroll to a zero (“0”) causes the entire area to be cleared with the fill attribute. In text mode, this fill attribute is a text attribute (part of the character/attribute pair that define characters in text mode). The rectangular area is filled with a space character (ASCII 20h) and the fill attribute is used as the attribute in that region. The standard fill attribute in text modes is a 07h.

In planar graphics mode, the fill attribute is actually the color to fill with. For example a fill attribute of 02h actually fills the area with a green rectangle. The standard fill attribute for graphics modes is a 00h.

Passed:

Parameter	Description
AH	07h
DS	Seg0
AL	Number of lines: 0 = Blank entire window
BH	Attribute used to blank line
CL	Upper left column
CH	Upper left row
DL	Lower right column
DH	Lower right row

Returns:

None.

13.1.9 Function 08h - Read Character and Attribute

Description:

Returns the character and attribute at the current cursor position. In graphics modes, only the character code is returned and then only if the background data is 0 (black).

Passed:

Parameter	Description
AH	08h
DS	Seg0

Returns:

Parameter	Description
AL	Character read
AH	Attribute read

13.1.10 Function 09h - Write Character and Attribute

Description:

Writes a character with a given attribute at the location specified by the current cursor position. In graphics mode, the attribute is actually the foreground color (background is always black). Also in graphics modes, if bit 7 of BL is set to a "1", then the character is XORed into memory.

The number of characters written (specified by CX) should not exceed the screen length. No error checking or clipping is provided by the BIOS on this value.

Passed:

Parameter	Description
AH	09h
DS	Seg0
AL	Character to write
AH	Attribute of character
BH	Display page to write to
CX	Number of times to write character

Returns:

None.

13.1.11 Function 0Ah - Write Character

Description:

Writes a character only (not the attribute) at the location specified by the current cursor position. In graphics mode, this function actually maps to Function 09h and therefore requires the foreground color information. Just like Function 09h, in graphics modes, if bit 7 of BL is set to a "1", then the character is XORed into memory.

The number of characters written (specified by CX) should not exceed the screen length. No error checking or clipping is provided by the BIOS on this value.

Passed:

Parameter	Description
AH	0Ah
DS	Seg0
AL	Character to write
BL	Graphics mode: character color (if bit 7=1: XOR char)
BH	Display page to write to
CX	Number of times to write character

Returns:

None.

13.1.12 Function 0Bh - Set CGA Palette

Description:

Sets the VGA palette as if the 6845 palette existed. It is provided for backward compatibility with the CGA. Applications aware of the EGA or VGA should use Function 10h to access the palette.

When BH = 0, the background color and overscan is set. When BH = 1, the palette is set to one of these two palettes:

Pixel Value	**BL = 0**	**BL = 1**
0	Background	Background
1	Green	Cyan
2	Red	Magenta
3	Brown	White

Passed:

Parameter	Description
AH	0Bh
DS	Seg0
BH	Color ID to set: 0 = Set background 1 = Set palette
BL	Color value

Returns:

None.

13.1.13 Function 0Ch - Write Dot

Description:

Writes a colored pixel at the specified location in graphics mode. The number of colors available is determined by the current graphics mode. For example, mode 4h (320x200x2) can only use colors from 0 to 3, while mode 12h (640x480x4) can use colors from 0 to 15. This function has no effect in text modes.

In non-256 color modes, bit 7 of the color value is used as an XOR flag. If bit 7 is set to a “1”, then the pixel is XORed into memory. In 256 color modes, all eight bits are used as pixel data.

Passed:

Parameter	Description
AH	0Ch
DS	Seg0
AL	Pixel color
BH	Page
CX	Column
DX	Row

Returns:

None.

13.1.14 Function 0Dh - Read Dot

Description:

Returns the color of the pixel at the specified location in graphics mode. This function has no effect in text mode.

Passed:

Parameter	Description
AH	0Dh
DS	Seg0
AL	Pixel color
BH	Page
CX	Column
DX	Row

Returns:

None.

13.1.15 Function 0Eh - Write TTY

Description:

Writes a character to the display at the current cursor position. The cursor position is updated to the next available position. If the cursor is at the end of the line, then the cursor is placed at the beginning of the next line. If the cursor is at the end of the screen, then the entire display is scrolled up one line and the cursor is placed at the beginning of the last line.

Several control characters have an effect on the cursor position without writing an actual character to the display. The bell character (ASCII 07h) beeps the speaker once without changing the cursor position. The backspace character (ASCII 08h) moves the cursor back one position on the line unless the cursor is already at the beginning of the line. At that point the backspace has no effect. The line feed character (ASCII 0Ah) moves the cursor down one row without changing the column position. If the cursor is already at the bottom of the screen, the display is scrolled up one line. The carriage return (ASCII 0Dh) moves the cursor position to the beginning of the current line.

Passed:

Parameter	Description
AH	0Eh
DS	Seg0
AL	Character to write to TTY device
BL	Foreground color in graphics mode

Returns:

None.

13.1.16 Function 0Fh - Get Mode

Description:

Returns the current mode number, the number of columns on the screen, and the active display page. Bit 7 of AL returns the memory clear flag as passed to the previous call to set mode.

Passed:

Parameter	Description
AH	0Fh

Returns:

None.

Returns:

Parameter	Description
AL	Current mode
AH	Number of columns
BH	Active page

13.1.17 Function 10h - Palette Handler

Operates the interface to the internal palette and RAMDAC.

13.1.17.1 Subfunction 00h: Set Individual Palette Register

Description:

Sets an attribute of a single internal palette register to a given value.

Passed:

Parameter	Description
AH	10h
AL	00h
BH	Value to set
BL	Register index

Returns:

None.

13.1.17.2 Subfunction 01h: Set Overscan Register

Description:

Sets the overscan (border) to a specified value. Overscan is the small border around the edge of the screen between display end and blank start.

Passed:

Parameter	Description
AH	10h
AL	01h
BH	Value to set

Returns:

None.

13.1.17.3 Subfunction 02h: Set All Palette and Overscan Registers

Description:

Sets the palette to the values pointed to by ES:DX. The first 16 bytes in the buffer are the palette and the last byte is the overscan value.

Passed:

Parameter	Description
AH	10h
AL	02h
ES:DX	Pointer to 17 byte table: Byte 16 = Overscan Bytes[15:0] = Palette

Returns:

None.

13.1.17.4 Subfunction 03h: Toggle Intensity/Blinking Bit

Description:

Changes the meaning of bit 7 of the attribute for text modes. By default, bit 7 of text attributes signals blinking. However, this can be changed so that the background color in the attribute byte can be expanded to 16 colors instead of the default 8 + blinking.

Passed:

Parameter	Description
AH	10h
AL	03h
BL	Blinking Flag: 0 = Intensity 1 = Blinking

Returns:

None.

13.1.17.5 Subfunction 07h: Read Individual Palette Register

Description:

Returns the current value of a given single internal palette register.

Passed:

Parameter	Description
AH	10h
AL	07h
BL	Register to read

Returns:

Parameter	Description
BH	Value read

13.1.17.6 Subfunction 08h: Read Overscan Register

Description:

Returns the current value of the Overscan register. Overscan is the small border around the edge of the screen between display end and blank start.

Passed:

Parameter	Description
AH	10h
AL	08h

Returns:

Parameter	Description
BH	Value read

13.1.17.7 Subfunction 09h: Read All Palette and Overscan Registers

Description:

Returns all 16 internal palette registers as well as the Overscan register into a buffer pointed to by ES:DX. The first 16 bytes of the buffer contain the Palette registers (Index 00h-0Fh) and the last byte contains the Overscan register.

Passed:

Parameter	Description
AH	10h
AL	09h
ES:DX	Pointer to 17 byte table for return data: Byte[16] = Overscan Bytes[15:0] = Palette

Returns:

None.

13.1.17.8 Subfunction 10h: Read Individual RAMDAC Register

Description:

Sets a specified, individual RAMDAC register to the given R, G, B value. Each of the 256 RAMDAC locations contain three 6-bit values for red, green, blue. Values above 3Fh are truncated (masked).

Passed:

Parameter	Description
AH	10h
AL	10h
BX	Index
CH	Green value
CL	Blue value
DH	Red value

Returns:

None.

13.1.17.9 Subfunction 12h: Set Block of RAMDAC Registers

Description:

Sets a block of RAMDAC registers to the values pointed to by ES:DX. This buffer should contain a sequence of red, green, and blue values to be placed in the RAMDAC, starting at the specified index. The value in CX is not the length of the buffer, but the number of registers to set. The buffer is actually three times the number of bytes specified in CX. Each of the 256 RAMDAC locations contains three 6-bit values each for red, green, and blue. Values above 3Fh are truncated (masked).

Passed:

Parameter	Description
AH	10h
AL	12h
BX	Starting index
CX	Number of registers to set
ES:DX	Pointer to buffer containing RGB values <R,G,B ... R,G,B> for CX number of entries

Returns:

None.

13.1.17.10 Subfunction 13h: Select Color Page

Description:

Calling this subfunction changes the block of RAMDAC registers used by non-256 color modes. Depending on the color page mode (BL = 0), the RAMDAC is divided into either 4 or 16 different pages.

BX	**Color Page Mode**
0000h	4 pages of 64 registers
0100h	16 pages of 16 registers

Passed:

Parameter	Description
AH	10h
AL	13h
BX	Starting index
CX	Number of registers to set
ES:DX	Pointer to buffer containing RGB values <R,G,B ... R,G,B> for CX number of entries.

Returns:

None.

13.1.17.11 Subfunction 15h: Get Individual RAMDAC Register

Description:

Gets a specified, individual RAMDAC register's R,G,B value. Each of the 256 RAMDAC locations contain three 6-bit values each for red, green, and blue.

Passed:

Parameter	Description
AH	10h
AL	15h
BX	Index

Returns:

Parameter	Description
CH	Green value
CL	Blue value
DH	Red value

13.1.17.12Subfunction 17h: Get Block of RAMDAC Registers

Description:

Gets a block of RAMDAC registers into a buffer pointed to by ES:DX. After the call, this buffer contains a sequence of red, green, and blue values from the RAMDAC, starting at the specified index. The value in CX is not the length of the buffer, but the number of registers to get. The buffer is actually three times the number of bytes specified in CX. Each of the 256 RAMDAC locations contains three 6-bit values each for red, green, and blue.

Passed:

Parameter	Description
AH	10h
AL	17h
BX	Starting index
CX	Number of registers to get
ES:DX	Pointer to buffer to save RGB values <R,G,B ... R,G,B> for CX number of entries

Returns:

None.

13.1.17.13Subfunction 1Ah: Get Color Page

Description:

Returns information about the block of RAMDAC registers used by non-256 color modes. Depending on the color page mode, the RAMDAC is divided into either 4 or 16 different pages.

BX	Color Page Mode
0000h	4 pages of 64 registers
0100h	16 pages of 16 registers

Passed:

Parameter	Description
AH	10h
AL	1Ah

Returns:

Parameter	Description
BH	Current color page
BL	Current color page mode

13.1.17.14Subfunction 1Bh: Sum RAMDAC to Gray Scale

Description:

Converts a range of color registers into a gray scale. The shade of gray is based on 30% red, 59% green, and 11% blue.

Passed:

Parameter	Description
AH	10h
AL	1Bh
BX	Starting index
CX	Number of registers to sum

Returns:

None.

13.1.18 Function 11h - Font Functions

Operates the interface to the VGA loadable fonts.

13.1.18.1 Subfunction 00h: Load User Font

Description:

Loads the font for a range of characters without changing the cell height and cursor size. If the cell height needs to be changed, use Subfunction 10h to adjust the CRTC values. Eight different font blocks can be loaded, but only two can be displayed at any one time. The pointer to the font points to character 0 even if the starting character is non-zero.

Passed:

Parameter	Description
AH	11h
AL	00h
BH	Number of bytes per character (character height)
BL	Font block
CX	Number of characters to load
DX	Starting character
ES:BP	Pointer to font

Returns:

None.

13.1.18.2 Subfunction 01h: Load 8x14 Font

Description:

Loads the ROM 8x14 font into the specified block. The font is loaded without changing the cell height or cursor size. If the cell height needs to be changed, use Subfunction 11h to adjust the CRTC values. Eight different font blocks can be loaded, but only two can be displayed at any one time.

Passed:

Parameter	Description
AH	11h
AL	01h
BL	Font block

Returns:

None.

13.1.18.3 Subfunction 02h: Load 8x8 Font

Loads the ROM 8x8 font into the specified block. The font is loaded without changing the cell height or cursor size. If the cell height needs to be changed, use Subfunction 12h to adjust the CRTC values. Eight different font blocks can be loaded, but only two can be displayed at any one time.

Passed:

Parameter	Description
AH	11h
AL	02h
BL	Font block

Returns:

None.

13.1.18.4 Subfunction 03h: Set Font Block

Specifies the font block(s) to be displayed on the screen. Eight different font blocks can be loaded, but only two can be displayed at any one time. The two fonts displayed are defined by the bit fields passed in BL. Bits 5, 3, 2 identify the block displayed when text attribute bit 3 is a one. Bits 4, 1, 0 identify the block displayed when text attribute bit 3 is a zero.

Data Bit	Block # Bit
D7	Unused
D6	Unused
D5	Block 0, bit 0
D4	Block 1, bit 0
D3	Block 0, bit 2
D2	Block 0, bit 1
D1	Block 1, bit 2
D0	Block 1, bit 1

Passed:

Parameter	Description
AH	11h
AL	03h
BL	Font block

Returns:

None.

13.1.18.5 Subfunction 04h: Load 8x16 Font

Loads the ROM 8x16 font into the specified block. The font is loaded without changing the cell height or cursor size. If the cell height needs to be changed, use Subfunction 14h to adjust the CRTC values. Eight different font blocks can be loaded, but only two can be displayed at any one time.

Passed:

Parameter	Description
AH	11h
AL	04h
BL	Font block

Returns:

None.

13.1.18.6 Subfunction 10h: Load User Font with Fixup

Loads the font for a range of characters and adjusts the cell height, cursor size, and vertical resolution. If the cell height does not need to be changed, use Subfunction 00h. Eight different font blocks can be loaded, but only two can be displayed at any one time. The pointer to the font points to character 0 even if the starting character is non-zero.

The following rules must be followed:

1) No CRTC adjustments have been made since the previous mode set for the following calculations to be accurate.

2) Page zero must be active.

The BIOS variables are changed as follows:

Character height will be updated from BH	Word variable at 0:485h
Display rows will be: INT ((200, 350, 400)/(char height) – 1	Byte variable at 0:484h
Regen length will be: (rows + 1) * columns * 2	Word variable at 0:44Ch

The CRTC adjustments are made as follows:

CRTC[09h] = Character height – 1	Max scan line
CRTC[0Ah] = Character height – 2	Cursor start
CRTC[0Bh] = Character height – 1	Cursor end
CRTC[12h] = (Rows + 1) *(character height) – 1	Vertical display end (single scanned modes)
CRTC[12h] = (Rows + 1) * (character height) * 2) – 1	Vertical display end (double scanned modes)
CRTC[14h] = Character height – 1	Underline location (monochrome modes only)

Passed:

Parameter	Description
AH	11h
AL	10h
BH	Number of bytes per character (character height)
BL	Font block
CX	Number of characters to load
DX	Starting character
ES:BP	Pointer to font

Returns:

None.

13.1.18.7 Subfunction 11h: Load 8x14 Font with Fixup

Loads the 8x14 font and adjusts the cell height, cursor size, and vertical resolution. If the cell height does not need to be changed, use Subfunction 01h. Eight different font blocks can be loaded, but only two can be displayed at any one time.

Passed:

Parameter	Description
AH	11h
AL	11h
BL	Font block

Returns:

None.

13.1.18.8 Subfunction 12h: Load 8x8 Font with Fixup

Loads the 8x8 font and adjusts the cell height, cursor size, and vertical resolution. If the cell height does not need to be changed, use Subfunction 02h. Eight different font blocks can be loaded, but only two can be displayed at any one time.

Passed:

Parameter	Description
AH	11h
AL	12h
BL	Font block

Returns:

None.

13.1.18.9 Subfunction 14h: Load 8x16 Font with Fixup

Loads the 8x16 font and adjusts the cell height, cursor size, and vertical resolution. If the cell height does not need to be changed, use Subfunction 04h. Eight different font blocks can be loaded, but only two can be displayed at any one time.

Passed:

Parameter	Description
AH	11h
AL	14h
BL	Font block

Returns:

None.

13.1.18.10Subfunction 20h: Load Upper 8x8 Graphics Character Set

Sets the INT 1Fh vector to the pointer passed in ES:BP. This font pointer is only used in modes 4, 5 and 6 for the upper half (character 128-255) of the character set. The font pointer at the INT 1Fh vector is valid until the next mode set or the next call to this subfunction.

Passed:

Parameter	Description
AH	11h
AL	20h
ES:BP	Pointer to font

Returns:

None.

13.1.18.11Subfunction 21h: Load User Graphics Character Set

Sets the INT 43h vector to the pointer passed in ES:BP. This font pointer is used to draw all characters in graphics modes, except modes 4, 5, 6, which only use the lower 128 characters of this table. The pointer to the upper half of the font for modes 4, 5, 6 is located at the INT 1Fh vector. The font pointer at the INT 43h vector is valid until the next mode set or the next call to load a graphics character set.

Passed:

Parameter	Description
AH	11h
AL	21h
BL	Row specifier: 0 = User 1 = 14 2 = 25 3 = 43
CX	Character height (bytes per character)
DL	Rows: Passes the number of rows if BL is set to 0 on entry. Otherwise, BL contains a row specifier.
ES:BP	Pointer to font

Returns:

None.

13.1.18.12Subfunction 22h: Load 8x14 Graphics Character Set

Sets the INT 43h vector to a pointer to the 8x14 ROM font. This font pointer is used to draw all characters in graphics modes except modes 4, 5, 6 which only use the lower 128 characters of this table. The pointer to the upper half of the font for modes 4, 5, 6 is located at the INT 1Fh vector. The font pointer at the INT 43h vector is valid until the next mode set or the next call to load a graphics character set.

Passed:

Parameter	Description
AH	11h
AL	22h
BL	Row specifier: 0 = User 1 = 14 2 = 25 3 = 43
CX	Character height (bytes per character)
DL	Rows: Passes the number of rows if BL is set to 0 on entry. Otherwise, BL contains a row specifier.

Returns:

None.

13.1.18.13Subfunction 23h: Load 8x8 Graphics Character Set

Sets the INT 43h vector to a pointer to the 8x8 ROM font. This font pointer is used to draw all characters in graphics modes except modes 4, 5, 6 which only use the lower 128 characters of this table. The pointer to the upper half of the font for modes 4, 5, 6 is only located at the INT 1Fh vector. The font pointer at the INT 43h vector is valid until the next mode set or the next call to load a graphics character set.

Register DL passes the number of rows only if BL is set to 0 on entry. Otherwise, BL contains a row specifier:

Passed:

Parameter	Description
AH	11h
AL	23h
BL	Row specifier: 0 = User 1 = 14 2 = 25 3 = 43
DL	Rows: Passes the number of rows if BL is set to 0 on entry. Otherwise, BL contains a row specifier.

Returns:

None.

13.1.18.14Subfunction 24h: Load 8x16 Graphics Character Set

Sets the INT 43h vector to a pointer to the 8x16 ROM font. This font pointer is used to draw all characters in graphics modes except modes 4, 5, 6 which only use the lower 128 characters of this table. The pointer to the upper half of the font for modes 4, 5, 6 is located at the INT 1Fh vector. The font pointer at the INT 43h vector is valid until the next mode set or the next call to load a graphics character set.

Passed:

Parameter	Description
AH	11h
AL	24h
BL	Row specifier: 0 = User 1 = 14 2 = 25 3 = 43
DL	Rows: Passes the number of rows if BL is set to 0 on entry. Otherwise, BL contains a row specifier.

Returns:

None.

13.1.18.15Subfunction 30h: Get Font Information

Returns a pointer to a specific font as well as the current character height and number of rows on the screen. The BIOS stores the number of rows as one less than the total rows - this is the number that is returned, not the actual number (add one to get the number of rows).

BH	**Font Pointer**
0	Current INT 1Fh Vector
1	Current INT 43h Vector
2	ROM 8x14 Font Pointer
3	ROM 8x8 Font Pointer
4	ROM 8x8 Font Pointer (Top)
5	ROM 9x14 Font Fixup Pointer
6	ROM 8x16 Font Pointer
7	ROM 9x16 Font Fixup Pointer

Passed:

Parameter	Description
AH	11h
AL	30h
BH	Font specifier

Returns:

Parameter	Description
CX	Current character height
DL	Current number of rows – 1
ES:BP	Pointer to font

13.1.19 Function 12h: Alternate Select Functions

Operates the interface to a variety of miscellaneous functions.

13.1.19.1 Subfunction 10h: Return Video Information

Returns additional information about the adapter mode that is not available in Function 0Fh. This function was introduced with the EGA, and was a common method of detecting an EGA in the system. For compatibility reasons, all VGAs return a memory size of 256 KB in this function no matter how much more memory may be installed. Also, since very few VGAs have dip switches, the value returned in CX is meaningless and is actually an emulated EGA switch setting value.

Passed:

Parameter	Description
AH	12h
BL	10h

Returns:

Parameter	Description
BH	Color flag: 0 = Color mode 1 = Mono mode
BL	Memory: 0 = 64 KB 1 = 128 KB 2 = 192 KB 3 = 256 KB
CH	Feature Bits
CL	Switch settings

13.1.19.2 Subfunction 20h: Alternate Print Screen

Replaces the print screen handler at INT 05h with one that recognizes more than 25 rows. The original PC/AT motherboard BIOS assumed all modes use 25 rows, something that can not be assumed with EGA or VGA adapters.

Passed:

Parameter	Description
AH	12h
BL	20h

Returns:

None.

13.1.19.3 Subfunction 30h: Select Scan Lines

Sets the number of scan lines to be used in text mode to either 200, 350, or 400 lines. This setting takes effect on the next mode set. Only text modes are affected by this function; graphics modes remain at the same resolution regardless of this setting. Only modes 0, 1, 2, 3 can set a 200 scan line mode; mode 7 can only be set to 350 or 400 scan lines.

Scan Lines	Default Color Font	Default Monochrome Font
200	8x8 (double scanned)	N/A
350	8x14	9x14
400	9x16	9x16

Passed:

Parameter	Description
AH	12h
AL	Scan lines: 0 = 200 1 = 350 2 = 400 lines
BL	30h

Returns:

Parameter	Description
AL	12h

13.1.19.4 Subfunction 31h: Enable/Disable Palette Loading

Enables or disables the loading of the attribute controller palette registers, the Overscan register, and the RAMDAC registers during mode sets.

Passed:

Parameter	Description
AH	12h
AL	Enable palette load flag: 0 = Enable 1 = Disable
BL	31h

Returns:

Parameter	Description
AL	12h

13.1.19.5 Subfunction 32h: Enable/Disable Video Subsystem

Enables or disables the video subsystem. All I/O and memory accesses are affected.

Passed:

Parameter	Description
AH	12h
AL	Enable subsystem flag: 0 = Enable 1 = Disable
BL	32h

Returns:

Parameter	Description
AL	12h

13.1.19.6 Subfunction 33h: Enable/Disable Summing to Gray Scales

Causes all RAMDAC operations to load “as is” or to sum the color values to a shade of gray. Setting this flag has an effect the next time the RAMDAC is loaded (includes mode sets). The relative shade of gray is based on 30% red, 59% green, and 11% blue.

Passed:

Parameter	Description
AH	12h
AL	Enable gray scale flag: 0 = Enable 1 = Disable
BL	33h

Returns:

Parameter	Description
AL	12h

13.1.19.7 Subfunction 34h: Enable/Disable Cursor Emulation

Calling this subfunction enables or disables the cursor type emulation for Function 01h (Set Cursor Type on page 166). The default is for emulation to be enabled. When emulated, the cursor follows these general rules:

- Bit 5 = 1: No cursor
- Start scan < end scan < = 3: Overbar cursor
- Start scan + 2 > = end scan: Underline cursor
- Start > = 2: Half block cursor
- Start < = 2: Full block cursor
- End < Start: Full block cursor

Passed:

Parameter	Description
AH	12h
AL	Enable emulation flag: 0 = Enable 1 = Disable
BL	34h

Returns:

Parameter	Description
AL	12h

13.1.19.8 Subfunction 35h: Display Switch

Switches between an adapter VGA and a motherboard (planar) VGA on the IBM PS/2 Model 30. Subfunctions 02h and 03h are valid only after Functions 00h and 01h have been called. The same buffer (pointed to by ES:DX) must be used in all calls to this function since the BIOS calls Function 1Ch to save/restore the video state into this buffer.

Note that most motherboards that have a VGA on them do ***NOT*** support this call and in fact can only be disabled with either jumpers/dip switches or through the CMOS setup.

Passed:

Parameter	Description
AH	12h
AL	Display switch subfunction: 00h = Initial switch off adapter VGA 01h = Initial switch on motherboard VGA 02h = Switch off active VGA 03h = Switch on inactive VGA
BL	35h
ES:DX	Pointer to 128-byte buffer

Returns:

Parameter	Description
AL	12h

13.1.19.9 Subfunction 36h: Enable/Disable Video Screen

Enables or disables the video screen. Unlike Subfunction 32h, all I/O and memory accesses are still valid. In fact, blanking the screen has the effect of giving full memory bandwidth to the CPU, since the CRTC does not require memory fetches.

Passed:

Parameter	Description
AH	12h
AL	Enable video flag: 0 = Enable 1 = Disable
BL	36h

Returns:

Parameter	Description
AL	12h

13.1.20 Function 13h - Write String

Description:

Sends a string to the display using the same TTY side-effects as Function 0Eh. With string types of AL = 2 and AL = 3, the TTY control commands are not followed by an attribute since they are not printable characters.

Several control characters have an effect on the cursor position without writing an actual character to the display. The bell character (ASCII 07h) beeps the speaker once without changing the cursor position. The backspace character (ASCII 08h) moves the cursor back one position on the line unless the cursor is already at the beginning of the line. At that point the backspace has no effect. The line feed character (ASCII 0Ah) moves the cursor down one row without changing the column position. If the cursor is already at the bottom of the screen, then the display scrolls up one line. The carriage return (ASCII 0Dh) moves the cursor position to the beginning of the current line.

String Types (AL = ?)	**Descriptions**
00h	Write character string without moving the cursor. Attribute is in BL.
01h	Write character string and update the cursor position. Attribute is in BL.
02h	Write character string without moving the cursor. Attributes are embedded in string.
03h	Write character string and update the cursor position. Attributes are embedded in string.

Passed:

Parameter	Description
AH	13h = Function number
AL	String Type: 0 = Constant attribute, cursor not moved 1 = Constant attribute, cursor moved 2 = String includes attributes, cursor not moved 3 = String includes attributes, cursor moved
BL	Attribute (for string types 0 and 1)
BH	Page Number
CX	Character Count
DL	Cursor column to start
DH	Cursor row to start
DS	Seg0
ES:BP	Pointer to character string

Returns:

None.

13.1.21 Function 1Ah - Get DCC Information

Description:

Sets or returns the display combination code (DCC). A DCC is used to indicate a combination of two monitors in the system. For example, a common combination is VGA color with a co-resident monochrome display adapter. This function was not on the EGA and therefore has been used as a test for the existence of a VGA in the system.

Display Type	Description
00h	No Display
01h	Monochrome Display Adapter (MDA)
02h	Color Graphics Adapter (CGA)
03h	Reserved
04h	Monochrome Enhanced Graphics Adapter (Mono EGA)
05h	Color Enhanced Graphics Adapter (Color EGA)
06h	Professional Graphics Adapter (PGA)
07h	Monochrome Video Graphics Array (Mono VGA)
08h	Color Video Graphics Array (Color VGA)
09h	Reserved
0Ah	Reserved
0Bh	Monochrome MCGA
0Ch	Color MCGA

Passed:

Parameter	Description
AH	1Ah = Function number
AL	DCC subfunction: 0 = Get DCC 1 = Set DCC
BL	Active display code (when AL = 1)
BH	Secondary display code (when AL = 1)

Returns:

Parameter	Description
AL	1Ah
BL	Active display code (when AL = 0)
BH	Secondary display code (when AL = 0)

13.1.22 Function 1Bh - Get Functionality Information

Description:

Returns a wealth of information about the VGA's capabilities and about the current mode setting.

Passed:

Parameter	Description
AH	1Bh = Function number
DS	Seg0
BX	0
ES:DI	Point to target buffer (size = 40h bytes)

Returns:

Parameter	Description
AL	1Bh

13.1.23 Function 1Ch - Save Restore State

Description:

Video BIOS functionality/state information.

Passed:

Parameter	Description
AH	1Ch = Function number
AL	Subfunction code: 00h = Return size of save/restore buffer 01h = Save state 02h = Restore state
CX	Requested states
ES:Di	Pointer to target buffer (for AL = 1 and AL = 2)

Returns:

Parameter	Description
AL	1Ch

13.2 VESA BIOS Extended Functions

This subsection is based on the VESA BIOS Extensions (VBE) Specification Version 2.0. Applications use VBEs to get information about a video controller and then setup an environment in which the application program can work. For example, an application may call Function 00h to get a list of modes that “may” be supported and then call Function 01h to see if the mode is supported and to get information about that mode, such as video memory address. The application would then call Function 02h to set the video mode. When writing to display memory, it may be necessary to “bank” the correct memory aperture at the video memory address. This is handled by Function 05h.

VBE functions exist as Function 4Fh in addition to the INT 10h vector standard VGA BIOS function. The VBE function code is placed in the AL register and 4Fh is placed in the AH register. Any additional registers used are dependent on the VBE function. If the VBE function exists, AL is set to 4Fh on return. The completion code is returned in the AH register, see Table 13-3. Table 13-4 listed the supported VBE functions.

Table 13-3. VBE Completion Codes

Return Value	Description
AL = 4Fh	Function is supported
AL != 4Fh	Function is not supported
AH = 00h	Function call successful
AH = 01h	Function call failed
AH = 02h	Software supports this function, but hardware does not
AH = 03h	Function not available in current video mode

Table 13-4. Supported VBE Functions

Function	Subfunction	Page Number
Function 00h: Return VBE Controller Information		194
Function 01h: Return VBE Mode Information		194
Function 02h: Set VBE Mode		194
Function 03h: Get VBE Mode		194
Function 04h: VBE Save/Restore State		195
	Subfunction 00h: Return Buffer Size in BX	195
	Subfunction 01h: Save State	195
	Subfunction 02h: Restore State	196
Function 05h: VBE Set/Get Bank		196
	Subfunction 00h: Set Bank	196
	Subfunction 01h: Get Bank	197
Function 06h: VBE Set/Get Logical Scan Line Length		197
	Subfunction 00h: Set Scan Line Length in Pixels	197
	Subfunction 01h: Get Scan Line Length	197
	Subfunction 02h: Set Scan Line Length in Bytes	198
	Subfunction 03h: Get Maximum Scan Line Length	198
Function 07h: VBE Set/Get Display Start		199
	Subfunction 00h: Set Display Start	199
	Subfunction 01h: Get Display Start	199
	Subfunction 80h: Set Display Start during Vertical Retrace	199

Table 13-4. Supported VBE Functions

Function	Subfunction	Page Number
Function 08h: VBE Set/Get RAMDAC Palette Format		200
	Subfunction 00h: Set Format	200
	Subfunction 01h: Get Format	200
Function 09h: VBE Set/Get RAMDAC Palette Data		201
	Subfunction 00h: Set RAMDAC Data	201
	Subfunction 01h: Get RAMDAC Data	201
	Subfunction 02h: Set Secondary RAMDAC Data	202
	Subfunction 03h: Get Secondary RAMDAC Data	202
	Subfunction 80h: Set RAMDAC Data During Vertical Retrace with Blanking Enabled	202
Function 0Ah: Return VBE Protected Mode Information		203
Function 10h: VBE Display Power Management Signaling (DPMS)		204
	Subfunction 00h: Version Number/Supported Power State	204
	Subfunction 01h: Requested Power State	204
	Subfunction 02h: Controller’s Currently Requested Power State	205
Function 11h: Flat Panel Interface Extensions (FP)		205
Function 12h: Cursor Interface Extensions (CI)		205
Function 13h: Audio Interface Extensions (AI)		205
Function 14h: OEM Extensions		206
	Subfunction 00h: Refresh Rate Select	206
	Subfunction 02h: Set Display Enable	206
	Subfunction 03h: Set Fixed Timings	207
	Subfunction 07h: Get Version Numbers	207
Function 15h: VBE Display Data Channel		208
Function 16h: Graphics System Configuration (GC)		208

13.2.1 Function 00h: Return VBE Controller Information

Description:

Returns information about the graphics controller. This is stored as the **VBEInfoBlock** data structure.

Note: For compatibility with older VBE-aware applications, the upper half of the 512 byte area (the last 256 bytes) and the VBE 2.0 information are available ***ONLY*** if the application fills in the first four bytes of this data structure with the characters “VBE2” ***BEFORE*** calling this function.

Passed:

Parameter	Description
AH	4Fh
AL	00h
ES:DI	Pointer to 512-byte buffer

Returns:

Parameter	Description
AX	VBE return status

13.2.2 Function 01h: Return VBE Mode Information

Description:

Returns information about the specified video mode. The information is stored in the VBEModeInfoBlock data structure.

Passed:

Parameter	Description
AH	4Fh
AL	01h
CX	Mode number
ES:DI	Pointer to 256-byte buffer

Returns:

Parameter	Description
AX	VBE return status

13.2.3 Function 02h: Set VBE Mode

Description:

Sets an extended video mode. If bit 14 is set, then the frame buffer is set to the physical address specified by the PhysBasePtr field of the VBEModeInfoBlock data structure returned by VBE Function 01h. If bit 15 is set, then the mode is set, but video memory is not cleared. For text modes, a font will still be loaded.

Note: If the function is not supported with the current hardware, then the mode is not set and AH is set to 01h on exit. (see the ModeAttributes field of the VBEModeInfoBlock data structure returned by VBE Function 01h).

Passed:

Parameter	Description
AH	4Fh
AL	02h
BX	Mode: Bits[13:0] = Mode number Bit[14] = Linear frame buffer flag Bit[15] = Don’t clear memory flag

Returns:

Parameter	Description
AX	VBE return status

13.2.4 Function 03h: Get VBE Mode

Description:

Returns the current video mode. See Function 02h: Set VBE Mode for a description of bits 14 and bit 15.

Passed:

Parameter	Description
AH	4Fh
AL	03h

Returns:

Parameter	Description
AX	VBE return status
BX	Mode: Bits[13:0] = Mode number Bit[14] = Linear frame buffer flag Bit[15] = Don’t clear memory flag

13.2.5 Function 04h: VBE Save/Restore State

This function saves or restores the state of the video controller. Note that this function call is a superset of the Standard VGA BIOS Function 1Ch. Just like Function 1Ch, there are three subfunctions:

13.2.5.1 Subfunction 00h: Return Buffer Size in BX

Passed:

Parameter	Description
AH	4Fh
AL	04h
DL	00h

Returns:

Parameter	Description
AX	VBE return status
BX	Number 64-byte blocks

13.2.5.2 Subfunction 01h: Save State

Description:

Saves the state of the video controller. The value in CX is a bit field where each bit corresponds to a section of the video controller to save.

Passed:

Parameter	Description
AH	4Fh
AL	04h
DL	01h
CX	Save/Restore flags: Bit 0 = Standard VGA register/hardware state Bit 1 = BIOS data state Bit 2 = RAMDAC state Bit 3 = Extended register/hardware state
ES:BX	Pointer to save buffer

Returns:

Parameter	Description
AX	VBE return status

13.2.5.3 Subfunction 02h: Restore State

Description:

Restores the state of the video controller. The value in CX is a bit field where each bit corresponds to a section of the video controller to restore. Note that on a restore state, this value must be the same as the save state that originally filled the save buffer.

Passed:

Parameter	Description
AH	4Fh
AL	04h
DL	02h
CX	Save/Restore flags: Bit 0 = Standard VGA register/hardware state Bit 1 = BIOS data state Bit 2 = RAMDAC state Bit 3 = Extended register/hardware state
ES:BX	Pointer to save buffer

Returns:

Parameter	Description
AX	VBE return status

13.2.6 Function 05h: VBE Set/Get Bank

The subfunctions position video memory into the memory aperture based on the granularity of the aperture (Set Bank) or return the current bank number (Get Bank). The WinFuncPtr field of the VBEModeInfoBlock data structure returned by VBE Function 01h can be used to call this function directly without the overhead of the INT 10h call. Note that each mode may have a different window function. If these subfunctions are called while linear frame buffer addressing is set, they will fail and return AH set to 03h.

13.2.6.1 Subfunction 00h: Set Bank

Passed:

Parameter	Description
AH	4Fh
AL	05h
DL	00h
BL	Window number: 0 = Window A 1 = Window B
DX	Bank number

Returns:

Parameter	Description
AX	VBE return status

13.2.6.2 Subfunction 01h: Get Bank

Passed:

Parameter	Description
AH	4Fh
AL	05h
DL	01h
BL	Window number: 0 = Window A 1 = Window B

Returns:

Parameter	Description
AX	VBE return status
DX	Bank number

13.2.7 Function 06h: VBE Set/Get Logical Scan Line Length

The subfunctions either set or get the logical scan line length (sometimes referred to as “row offset”). The logical scan line length can be set greater than or equal to the displayed scan line length. For example, a 640x480, 24-bit, graphics mode has a displayed scan line length of 640*3 or 1920 bytes. It is fairly typical to set this mode to 2048 bytes so that a 64K bank boundary does not cross in the middle of a pixel (an R, G, B triplet).

On a Set Scan Line Length subfunction call, if the desired width is larger than the maximum available, then this function will fail and AH will be set to 02h on exit.

13.2.7.1 Subfunction 00h: Set Scan Line Length in Pixels

Passed:

Parameter	Description
AH	4Fh
AL	06h
BL	00h
CX	Desired width in pixels

Returns:

Parameter	Description
AX	VBE return status
BX	Bytes per scan line
CX	Actual pixels per scan line (truncated to nearest)
DX	Maximum number of scan lines

13.2.7.2 Subfunction 01h: Get Scan Line Length

Passed:

Parameter	Description
AH	4Fh
AL	06h
BL	01h

Returns:

Parameter	Description
AX	VBE return status
BX	Bytes per scan line
CX	Actual pixels per scan line (truncated to nearest)
DX	Maximum number of scan lines

13.2.7.3 Subfunction 02h: Set Scan Line Length in Bytes

Passed:

Parameter	Description
AH	4Fh
AL	06h
BL	02h
CX	Desired width in bytes

Returns:

Parameter	Description
AX	VBE return status
BX	Bytes per scan line
CX	Actual pixels per scan line (truncated to nearest)
DX	Maximum number of scan lines

13.2.7.4 Subfunction 03h: Get Maximum Scan Line Length

Passed:

Parameter	Description
AH	4Fh
AL	06h
BL	03h

Returns:

Parameter	Description
AX	VBE return status
BX	Bytes per scan line
CX	Actual pixels per scan line (truncated to nearest)
DX	Maximum number of scan lines

13.2.8 Function 07h: VBE Set/Get Display Start

The subfunctions either set the display start to a specific pixel location (Set Display Start) or return the current starting address (Get Display Start). When setting the display start address, it is possible that all pixel positions are not available. In this case, the functions will fail and the display start will not change.

13.2.8.1 Subfunction 00h: Set Display Start

Passed:

Parameter	Description
AH	4Fh
AL	07h
BH	Reserved and set to 00h
BL	00h
CX	First display pixel in line
DX	First displayed scan line

Returns:

Parameter	Description
AX	VBE return status

13.2.8.2 Subfunction 01h: Get Display Start

Passed:

Parameter	Description
AH	4Fh
AL	07h
BH	Reserved and set to 00h
BL	01h

Returns:

Parameter	Description
AX	VBE return status
BH	Reserved and set to 00h
CX	First displayed pixel in line
DX	First displayed scan line

13.2.8.3 Subfunction 80h: Set Display Start during Vertical Retrace

Passed:

Parameter	Description
AH	4Fh
AL	07h
BH	Reserved and set to 00h
BL	80h
CX	First display pixel in line
DX	First displayed scan line

Returns:

Parameter	Description
AX	VBE return status

13.2.9 Function 08h: VBE Set/Get RAMDAC Palette Format

These subfunctions either change the number of bits per primary (Set RAMDAC Format) or return the current number of bits per primary (Get RAMDAC Format). Note that some hardware is only capable of 6 bits per gun, also note that for strict VGA compatibility, the standard modes (modes 00h through 13h) usually only operate with a RAMDAC width of 6 bits per gun.

On a mode set, the BIOS always sets the mode to 6 bits per gun. If this function is called in a YUV or in a direct color (16-bit or 24-bit) mode, then this function will fail and AH will be set to 03h on exit.

13.2.9.1 Subfunction 00h: Set Format

Passed:

Parameter	Description
AH	4Fh
AL	08h
BH	Desired bits per gun
BL	00h

Returns:

Parameter	Description
AX	VBE return status

13.2.9.2 Subfunction 01h: Get Format

Passed:

Parameter	Description
AH	4Fh
AL	08h
BL	01h

Returns:

Parameter	Description
AX	VBE return status
BH	Current number of bits per gun

13.2.10 Function 09h: VBE Set/Get RAMDAC Palette Data

The subfunctions either load the RAMDAC registers (Set RAMDAC Data) or retrieve the values currently loaded in the RAMDAC registers (Get RAMDAC Data). Though the specification includes references to a “secondary palette”, this portion of Function 09h is actually reserved for future VBE expansion.

The RAMDAC data is stored in a different format than the standard VGA BIOS functions:

Byte 0 = Ignored
Byte 1 = Red Value
Byte 2 = Green Value
Byte 3 = Blue Value

13.2.10.1 Subfunction 00h: Set RAMDAC Data

Passed:

Parameter	Description
AH	4Fh
AL	09h
BL	00h
CX	Number of palette registers
DX	First palette register
ES:DI	Pointer to palette values

Returns:

Parameter	Description
AX	VBE return status

13.2.10.2 Subfunction 01h: Get RAMDAC Data

Passed:

Parameter	Description
AH	4Fh
AL	09h
BL	01h
CX	Number of palette registers
DX	First palette register
ES:DI	Pointer to palette values

Returns:

Parameter	Description
AX	VBE return status

13.2.10.3 Subfunction 02h: Set Secondary RAMDAC Data

Passed:

Parameter	Description
AH	4Fh
AL	09h
BL	02h
CX	Number of palette registers
DX	First palette register
ES:DI	Pointer to palette values

Returns:

Parameter	Description
AX	VBE return status

13.2.10.4 Subfunction 03h: Get Secondary RAMDAC Data

Passed:

Parameter	Description
AH	4Fh
AL	09h
BL	03h
CX	Number of palette registers
DX	First palette register
ES:DI	Pointer to palette values

Returns:

Parameter	Description
AX	VBE return status

13.2.10.5 Subfunction 80h: Set RAMDAC Data During Vertical Retrace with Blanking Enabled

Passed:

Parameter	Description
AH	4Fh
AL	09h
BL	80h
CX	Number of palette registers
DX	First palette register
ES:DI	Pointer to palette values

Returns:

Parameter	Description
AX	VBE return status

13.2.11 Function 0Ah: Return VBE Protected Mode Information

Description:

Calling this function returns a real mode pointer (segment:offset) to the protected mode interface table. The table points to code that can be copied into an application's memory space for execution from a 32-bit code segment. These functions execute a near return ("retn") when returning to the calling application.

Table Offset	**Description**
00h	Offset to code for Set Bank Function (05h), Subfunction 00h
02h	Offset to code for Set Display Start Function (07h), Subfunctions 00h and 80h
04h	Offset to code for Set Primary RAMDAC Data (09h), Subfunction 00h
06h	Offset to table of ports and memory locations sub-table

Applications must still set the registers the same way they would for an INT 10h call, including the AX register. The Display Start Function (07h) is slightly different when called from the protected mode function. Instead of specifying the pixel and scan line position, DX:CX specifies the display start address in bytes.

The ports and memory locations sub-table provides a list of I/O addresses and memory locations that may be needed by an application for I/O privilege or read/write permission. The sub-table is an array of WORD values terminated by 0FFFFh for the I/O locations immediately followed by a second array of DWORD values for memory locations and a WORD value for the length of memory needed. The second array is also terminated by the WORD 0FFFFh for the memory locations. Note that a memory location CAN NOT use 0FFFFh as the low order WORD in its address. If no addresses are needed then the table will contain two entries, each a WORD of 0FFFFh.

Passed:

Parameter	Description
AH	4Fh
AL	0Ah
BL	00h

Returns:

Parameter	Description
AX	VBE return status
CX	Length of table
ES:DI	Real mode pointer to table

13.2.12 Function 10h: VBE Display Power Management Signaling (DPMS)

Controls the power state of the attached display device or monitor.

The VESA committee defined a method of signalling a monitor to shutdown or to go into standby mode. The sync signals are used in the following manner:

H Sync	**V SyncResult**
Pulses	PulsesMonitor is Active
None	PulsesMonitor is in “Standby” mode
Pulses	NoneMonitor is in “Suspend” mode
None	NoneMonitor is in “Shutdown” mode

13.2.12.1 Subfunction 00h: Version Number/Supported Power State

Passed:

Parameter	Description
AX	4F10h
BL	00h
ES:DI	Null pointer
DS	Seg0

Returns:

Parameter	Description
AX	VBE return status
BL	VBE/PM version number: Bits[7:4] = Major version number Bits[3:0] = Minor version number (0)
BH	States supported: Bit 0 = Standby Bit 1 = Suspend Bit 2 = Off Bit 3 = Reduced On Bits[7:4] = Reserved

13.2.12.2 Subfunction 01h: Requested Power State

Passed:

Parameter	Description
AX	4F10h
BL	01h
BH	Requested power state: 0 = On 1 = Standby 2 = Suspend 4 = Off 8 = Reduced On
ES:DI	Null pointer
DS	Seg0

Returns:

Parameter	Description
AX	VBE return status

13.2.12.3 Subfunction 02h: Controller's Currently Requested Power State

Passed:

Parameter	Description
AX	4F10h
BL	02h
ES:DI	Null pointer
DS	Seg0

Returns:

Parameter	Description
AX	VBE return status
BH	Power state currently requested by controller: 0 = On 1 = Standby 2 = Suspend 4 = Off 8 = Reduced On

13.2.13 Function 11h: Flat Panel Interface Extensions (FP)

The video BIOS does not implement this function.

13.2.14 Function 12h: Cursor Interface Extensions (CI)

The video BIOS does not implement this function.

13.2.15 Function 13h: Audio Interface Extensions (AI)

The video BIOS does not implement this function.

13.2.16 Function 14h: OEM Extensions

Operates AMD specific extensions to the video BIOS.

13.2.16.1 Subfunction 00h: Refresh Rate Select

This function is used to indicate the desired refresh rate for successive mode switches. It does not change the refresh rate of the current mode. Therefore, this function should be called before calling Function 02h to set a video mode.

The number of possible refresh rates is limited by tables in the video BIOS. Table 13-5 gives the supported frequencies for the specified resolutions.

This function has no effect when setting the standard VGA modes.

Table 13-5. Refresh Rates

Resolution	Frequency (Hz)				
640x480		60	72	75	85
800x600	56	60	72	75	85
1024x768		60	70	75	85
1280x1024		60	75	85	

Passed:

Parameter	Description
AX	4F14h
BL	00h
DL	Refresh rate

Returns:

None.

13.2.16.2 Subfunction 02h: Set Display Enable

Description:

This routine is called by the system BIOS during POST to set the initial display configuration (flat panel, CRT, or both). This routine does not affect TV output, which is handled by separate system BIOS routines. If TV output is enabled, however, this function should still be used to enable the fixed timings.

Passed:

Parameter	Description
AX	4F14h
BL	02h
BH	Display enable: Bit 0 = Flat panel output enable Bit 1 = CRT output enable Bit 2 = Enable fixed timings

Returns:

None.

13.2.16.3 Subfunction 03h: Set Fixed Timings

Description:

The system BIOS uses this function to load the resolution and timings.

Passed:

Parameter	Description
AX	4F14h
BL	03h
ES:DI	Pointer to fixed timings

Returns:

None.

13.2.16.4 Subfunction 07h: Get Version Numbers

Description:

This subfunction returns the version numbers for the video BIOS and SMI handler.

Passed:

Parameter	Description
AX	4F14h
BL	07h

Returns:

Parameter	Description
BH	Video BIOS major version number
BL	Video BIOS minor version number
CH	SMI handler major version number
CL	SMI handler minor version number

13.2.17 Function 15h: VBE Display Data Channel

Description:

This optional function provides a mechanism to extract data from attached display devices on the VESA communication channel.

Passed:

Parameter	Description
AH	4F14h
AL	15h
BL	Subfunction
CX	Controller ID (00h = Primary controller)
DX	Block number (00h in version)
ES:DI	Pointer to 128-byte buffer (if BL = 01h, 02h)

Returns:

Parameter	Description
AX	VBE Return Status
BH	Approximate time in seconds to transfer EDID
BL	DDC level supported

13.2.18 Function 16h: Graphics System Configuration (GC)

The video BIOS does not implement this function.

13.2.19 VBE Data Structures

```
VbeinfoBlock struc
VbeSignature            db      'VESA'  ;VBE Signature
Vbe Version             dw      0200h   ;VBE Version
OemStringPtr            dd      ?       ;Pointer to OEM String
Capabilities            db      4 dup (?);Capabilities of graphics controller
VideoMode Ptr           dd      ?       ;Pointer to Video Mode List
TotalMemory             dw      ?       ;Number of 64 KB memory blocks
                                        ;Added for VBE 2.0
OemSoftwareRev          dw      ?       ;VBE implementation Software revision
OemVendorNamePtr        dd      ?       ;Pointer to Vendor Name String
OemProductNamePtr       dd      ?       ;Pointer to Product Name String
OemProductRevPtr        dd      ?       ;Pointer to Product Revision String
Reserved                db      222 dup (?);Reserved for VBE implementation scratch area
OemData                 db      256 dup (?);Data Area for OEM Strings
VbeInfoBlock ends
```

14 Miscellaneous Services

GeodeROM contains support for the miscellaneous software interrupts in Table 14-1.

Table 14-1. Miscellaneous Software Interrupts

Function Number/Name	Page Number
INT 09h - Keyboard	209
INT 10h - Video BIOS	209
INT 11h - Equipment List	210
INT 12h - Get Memory Size	210

14.1 Miscellaneous Services Functions Descriptions

14.1.1 INT 09h - Keyboard

Description:

Keyboard service required:

– Reads Port 60h.
– Calls INT 15, function 47.
– Calls C_INT09H, passing value from Port 60h.

Passed:

None.

Returns:

None.

Related Functions:

None.

14.1.2 INT 10h - Video BIOS

Description:

Immediately calls INT 6Dh without changing any registers either in or out.

Passed:

None.

Returns:

None.

Related Functions:

INT 6Dh. Note that all INT 10h calls are dispatched immediately to INT 6Dh.

14.1.3 INT 11h - Equipment List

Description:

Returns a bit mask describing the devices installed in the system.

Passed:

None.

Returns:

Return	Description
AX	BIOS equipment list WORD: Bits [15:14] = Number of parallel ports installed Bit 13 = Reserved Bit 12 = Set if game adapter is present Bits [11:9] = Number of serial ports installed Bit 8 = DMAC present Bits [7:6] = If bit 0 is set (1), this is the number of FDD(s): 00 = 1 FDD 01 = 2 FDDs 10 = 3 FDDs 11 = 4 FDDs Bits [5:4] = Initial video mode Bits [3:2] = Number of 64 KB banks of RAM Bit 1 = 80x87 coprocessor installed Bit 0 = FDD(s) installed, number specified in bits [7:6]

Related Functions:

None.

14.1.4 INT 12h - Get Memory Size

Description:

Returns the amount of RAM present in the system (up to 640 KB).

Passed:

None.

Returns:

Parameter	Description
AX	Amount of usable RAM, in units of 1 KB

Related Functions:

None.

15 System Management Mode Software

The System Management Mode (SMM) software for AMD Geode™ solutions has unique properties that allow for nontraditional features. The SMM software, along with specialized hardware, allows the System Management Interrupt (SMI) handler to simulate functionality normally associated with discrete devices (e.g., VGA, audio, UARTs, etc.). This is enhanced by the Geode processor's ability to enter SMM mode very quickly, and also the ability to service nested SMIs. In addition, the SMM software controls power management, much like a traditional system.

There are several types of events that generate an SMI, thereby invoking the SMI handler.

- Configurable I/O Traps:
  — The Geode device(s) support configuration of an I/O trap, range, and attributes; all of which can generate an SMI.
- Special Traps:
  — The hardware contains specialized trapping ability, such as the occurrence of audio and video events, and the reading and writing of UART or LPT I/O addresses.
- General Purpose Timers:
  — The Geode device(s) contain several configurable timers. When a timer expires, the companion device generates an SMI.
- Inactivity Timers:
  — The hardware contains function-specific timers for power management. These are reset when user-activity occurs, such as keyboard use. When the timer expires, an SMI is generated.
- GPIO Activity:
  — The Geode device(s) contain some number of General Purpose I/O pins. The pins are configurable, to generate an SMI if there is activity on a GPIO pin.
- PCI Configuration Cycle:
  — The Geode device(s) can be configured to generate an SMI upon access to a select address in the PCI configuration space.

The VSA2 software determines the cause of the SMI, generally by checking status registers. Then the System Manager software dispatches control to the appropriate VSM.

15.1 Architecture

The SMI handler is designed so no changes to the existing firmware are required. Individual binary components, called Virtual Support Modules (VSM), provide specific pieces of functionality. Each VSM is isolated from every other VSM in terms of functionality and code. VSA2 technology is architected using a client-server model. The VSM dispatcher is called the System Manager and acts as the server. The System Manager code executes as soon as an SMI occurs. It saves the state of the system and prepares the VSA2 technology system to run. Figure 15-1 "VSM Client-Server Model Example" on page 212 shows an example of the VSM client-server methodology.

Each of the remaining VSMs (clients) is an endless message-processing loop. For example, in the course of processing an “initialization” message, a VSM may register to be notified upon the occurrence of various types of events (traps, timers, etc.). After processing the initialization message, the VSM retrieves the next message out of its queue via a system-call macro. The macro allows control to return to the System Manager, that is then free to call any VSM, or cause the system to exit the SMI handler.

VSA2 technology is Geode hardware-specific. The System Manager contains the hardware-dependent implementation.

Two mechanisms for communication exist with and within VSA2 technology, and are implemented within the System Manager VSM.

1) VR (virtual registers) (see Section 15.9 “Virtual Registers” on page 219) are used for interprocess or module communication between VSMs. They are also the means of communication between external application or driver software and VSA2 software.

2) VSA2 software messages are used to communicate with other VSMs and the System Manager.

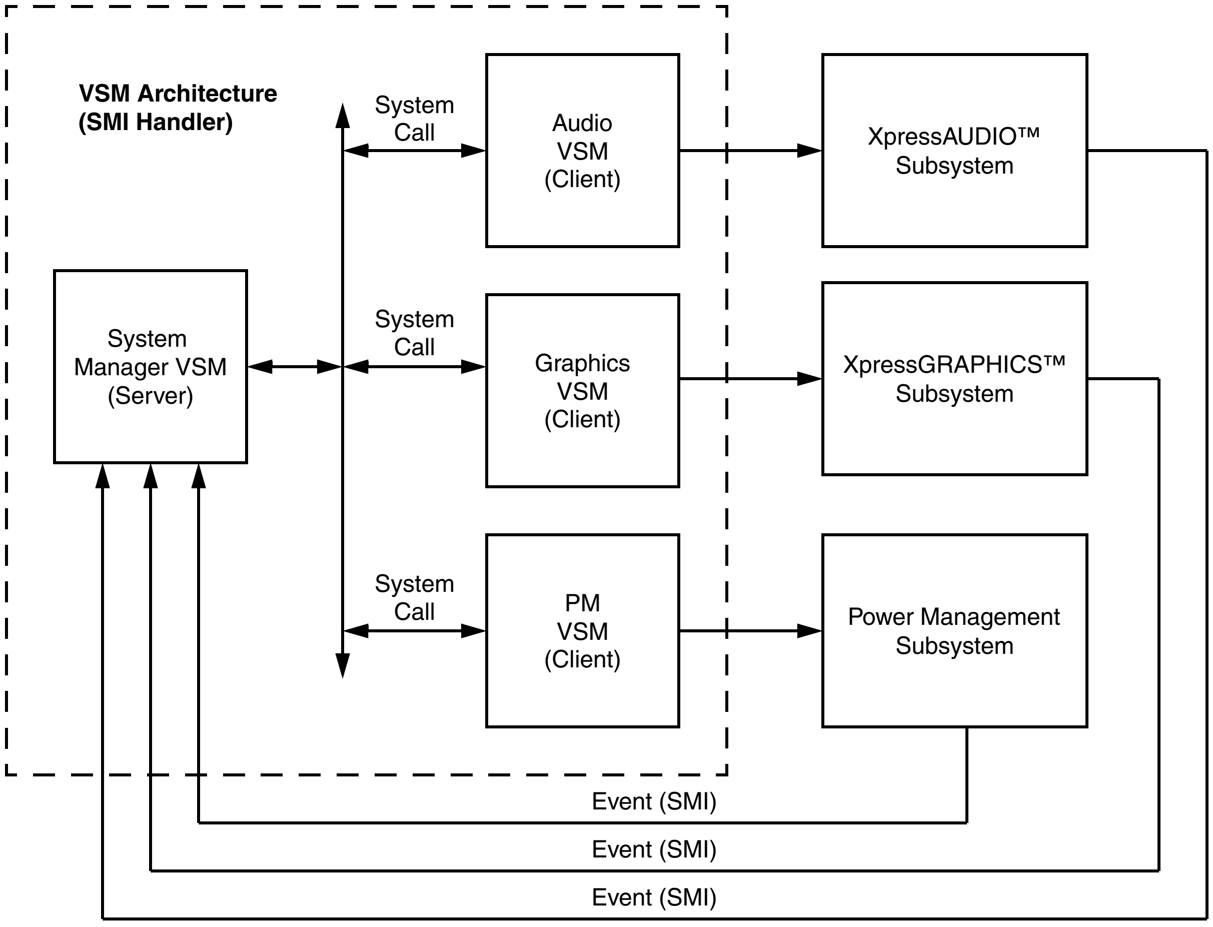


Figure 15-1. VSM Client-Server Model Example

15.2 GeodeROM Requirements

During POST, GeodeROM copies the VSA2 software image to a location below 640 KB, then executes a far call to the initialization code (Offset 20h). At the end of POST, GeodeROM notifies VSA2 software (via S/W SMI 5000h) so that any final initialization can take place.

15.3 System Manager

When an SMI occurs, the processor micro-code saves minimal amount of processor state into an SMM header. The processor is placed into real mode and execution is vectored to the physical address determined by the SMAR (SMM Address Region) registers. VSA2 software initialization code sets these registers to the location of the System Manager entry point. The code at the entry point:

1) Saves the CPU state not already saved by the Geode processor.

2) Initializes the processor to the SMM software environment.

3) Determines the source(s) of the SMI and enters the event(s) into message queue(s).

4) Dispatches to the VSMs that have pending messages.

5) Restores the interrupted task's state and resumes execution.

The System Manager provides the following services to VSMs:

- Manages inter-module message delivery.
- Allows chipset and/or processor dependency abstraction.
- Provides a mechanism for guarding critical sections of code.
- Handles memory allocation of stack and data segments.
- Ensures proper ordering of event handling.

15.4 Events

Events are SMIs. A VSM may register as a handler of one or more SMI event(s). This normally occurs at VSM initialization, but dynamic registration is also allowed. Multiple VSMs may register for the same event. The order that VSMs are invoked is determined by the priority specified at registration time. When the event occurs, the VSM registered with the highest priority for the event is invoked. If a VSM chooses to handle the event, nothing extra needs to be done. In the Geode GX1 processor, if a VSM chooses not to handle the event, it must pass the event back to the System Manager via the SYS_PASS_EVENT macro. The System Manager then sends a message to the next highest priority VSM, and so on until the event is handled. In the Geode GX processor and later processors, each VSM gets the message no matter the priority, so the SYS_PASS_EVENT macro is not needed.

15.5 Messaging

All event notification occurs via System Manager messages. The code at the entry point of each VSM is a message-handling loop. A VSM is called only to respond to a message from the System Manager. The message queue for a VSM is stored in the VSM header. The SYS_GET_NEXT_MSG macro is provided for accessing the message queue. When the message queue is empty, the SYS_GET_NEXT_MSG macro automatically returns control to the System Manager. Control is returned to the VSM when there is another message in its queue. The supported messages are enumerated in Section 15.11 “Messages” on page 225.

15.6 System Calls

One of the design goals of GeodeROM VSA2 technology is to hide the implementation details. System calls and macros provide control mechanisms and access to sensitive system values and structures. Although VSMs could directly perform certain tasks, they should call the System Manager to perform these functions. This allows hardware bug fixes as well as Geode South Bridge details to be abstracted from the VSM. Because most chipset programming is performed at initialization, where performance is not critical, the slight loss in performance due to system overhead is more than made up by readability, portability, and the handling of shared resources. The available system calls are discussed in detail in Section 15.10 “System Calls and Macros” on page 220.

Another “tool” that supports source code maintainability is the use of a set of pre-defined macros. These macros perform their specified functionality using the best possible method, and again, abstracting the implementation details. The use of these macros facilitates portability when system call interfaces are changed or when better system call implementations are developed. The available macros are discussed in detail in Section 15.13 “Macros” on page 232.

15.7 Resource Management

The System Manager owns the top level SMI source registers. A VSM owns its second level source registers and all resources related to the functional component that it controls. For example, the XpressAUDIO™ subsystem VSM does not poll the top level SMI source register directly. It receives an EVENT_AUDIO message from the System Manager when there is an audio-related event, and then reads the audio SMI source register(s) to determine the specific audio event.

When resources are accessed through index/data pairs, the code that uses the resources saves and restores the index/ data within a critical section. The PCI configuration address register is an exception because it is part of the VSM state. When a VSM uses floating-point instructions, the VSM is responsible for saving and restoring the floating-point state. A VSM must not write to global resources (e.g., CPU configuration registers).

15.7.1 Reentrancy

VSM code is not required to be reentrant. While it is possible for a VSM to be executing when another registered event occurs, the System Manager's scheduler does not preempt the executing VSM to allow processing of a more recent SMI event. Rather, the System Manager services the SMI, and records the event by entering the appropriate message into the message queue of the VSM(s) registered to handle that event. It then returns control to the interrupted VSM.

15.7.2 Event Registration

A VSM can register as a handler of SMI event(s). This occurs at VSM initialization, but dynamic registration is also allowed. Multiple VSMs can register for the same event. In the Geode GX1 processor, the order that VSMs are invoked is determined by the priority specified at the time of event registration. If a VSM chooses to handle the event, nothing extra is done. If a VSM chooses not to handle the event, it must pass the event back to the System Manager via the SYS_PASS_EVENT macro. The System Manager then sends a message to the next highest priority VSM that registered for the event, and so on, until a VSM handles the event. In the Geode GX processor and later processors, each VSM gets the message no matter the priority, so the SYS_PASS_EVENT macro is not needed.

The architecture supports the assignment of a 16-bit priority to each registered event. These priorities are used to control the order that an event is serviced. Bits [16:8] specify the order an SMI is processed relative to other VSMs. Bits [7:0] specify the order an SMI event message is inserted relative to other messages within the VSM's message queue. Higher numbers indicate a more important priority. For example, assume VSM X registers an event with priority 0x10000, and VSM Y registers an event with priority 0x20000. If VSM X's event is being processed and VSM Y's event occurs, then VSM Y preempts VSM X. VSM X is not given control until the next message in VSM Y's queue is of lower priority than the priority of the message being handled by VSM X.

A value of 00h in bits [7:0] means the event message will be inserted at the end of a VSM’s queue. If an event message is already in the queue with the same priority as a new event, the original event message is inserted first. The event queue is sorted with the first key being priority and the second key being time of event.

Note: Some combinations of events may not be supported by the underlying hardware, but may be simulated by the System Manager. For example, a VSM may register as a handler of a GPIO falling and rising edge events. The hardware only supports generation of an SMI on one or the other GPIO edge. The System Manager detects such situations and dynamically reprograms the hardware in order to simulate the desired effect. A list of events is found in Table 15-7 "Events" on page 228.

15.7.3 Nested SMIs

VSA2 makes full use of nested SMIs. SMI nesting is enabled at all times, with the following exceptions:

- Within a critical section of a VSM
- Within the System Manager
- While handling virtual register accesses from VSMs

The effect of SMI nesting is largely transparent to a VSM. Except for the small time-slice taken to record the event in the appropriate message queue, the interrupted VSM is unaffected. Control is normally returned to the interrupted VSM immediately. The two exceptions are event priorities and virtual registers.

Since it is possible for a VSM to be interrupted, it must guard certain sections of code as a critical section. The most common example is when a VSM accesses an index/data I/O pair. It is possible for the VSM to be interrupted after writing the index, but before writing the data. If an interrupting VSM accesses the same index/data pair, it corrupts the index from the first VSM. To prevent this, BEGIN_CRITICAL_SECTION and END_CRITICAL_SECTION macros must surround such sections of code.

A VSM that accesses a virtual register expects the effects of that access to occur immediately. In order for this to happen, the VSM handling the accessed virtual register must be dispatched immediately. This dispatch occurs as follows: An EVENT_VIRTUAL_REGISTER message is entered at the beginning of the VSM message queue. That VSM is given control until the message is retrieved and serviced. Control is then returned to the VSM that accessed the virtual register.

15.8 Virtual Support Modules

Each major functional component of the SMM software is implemented as a separately compiled VSM. This architectural feature is the key to the adaptability of GeodeROM VSA2 technology. Concatenating the modules with the desired functionality produces a customized VSA2 image. For example, if a platform does not require the XpressAUDIO subsystem, the XpressAUDIO subsystem VSM is excluded from the VSA2 image. Furthermore, if VSA2 functionality is dependent on a platform-specific feature, the VSM writer has the freedom to implement these details in a custom VSM without requiring support from AMD.

A VSM consists of three major components: VSM header, VSM library, and a message handler. The first two components are supplied by AMD. The third, the message handler, is the code that determines the functionality of a VSM.

Typically, a VSM writer modifies only three fields in the VSM header file: VSM_Type, VSM_Version, and EntryPoint; fields that are unique to each VSM. The default values for the other fields are sufficient for most applications and are initialized by the VSA2 installation code.

Each VSM must be linked to the VSM library file. This library contains the code for the system calls that comprise the API to the System Manager.

The VSM message handler implements the functionality of the VSM with respect to messages sent by the System Manager. It typically consists of an infinite loop that receives messages, parses each message and any parameter(s), and dispatches to routines within the VSM to handle the messages. When there are no more messages waiting for the VSM, control is returned to the System Manager via the process of retrieving the next message. The VSM then goes dormant until an event occurs that results in a message being entered into its queue. A sample message handler is as follows:

Sample VSM Message Handler

```
        unsigned char               temp;
        unsigned short              Msg;
        unsigned long               Param[MAX_MSG_PARAM];
        unsigned short              VirtualRegs[10];
        unsigned char               Index;

do {
        Msg = GET_NEXT_MSG(&Param);
        switch (Msg) {
        case MSG_INITIALIZE:
                // Register as handler of Power Management virtual registers
                SYS_REGISTER_EVENT(EVENT_VIRTUAL_REGISTER, VRC_PM, 0, 0);
                break;
        case MSG_EVENT:
                switch (Param[0]) {
                case EVENT_VIRTUAL_REGISTER:
                        Index = (unsigned char) Param[1];
                        if (Param[2] = = 0) {             // I/O read
                                SET_AX(VirtualRegs[Index]);
                        } else {                          // I/O write
                                if (Index!= 0 && Index < 10)// Version register is Read-Only
                                        VirtualRegs[Index] = (unsigned short) Param[3];
                        }
                        break;
                } // end switch(Param[0])
                break;
        } // end switch(Msg)
} while (1);
```

15.8.1 Memory Model

VSMs run in real mode using the “tiny” mode (i.e., CS = DS = SS). There are descriptor fields in the VSM header, but these are for use by the System Manager and should not be modified by the VSM. VSMs written in C must comply with the following rules:

- Must not have a main() routine
- Must not use ‘C’ library functions (e.g. malloc, printf)

15.8.2 Initialization

VSA2 software initialization code scans the binary image on paragraph (16-byte) boundaries for the signature “VSM”. Each signature marks the beginning of a VSM header. The VSA2 initialization code calls each VSM entry point with a MSG_INITIALIZE message in the VSM’s message queue. In response to this message, the VSM performs its own module specific initialization, including, but not limited to:

- Data initialization
- Registering events with the System Manager

15.8.3 VSM Header

The VSM header encapsulates all data specific to a VSM. This design frees the System Manager from having to size its data structures based on a maximum number of VSMs. The only fields that need modifying in the header are the VSM_Type, VSM_Version, and EntryPoint. The VSM_Type field is only used for display purposes. The currently defined types, their values, and their use are listed in Table 15-1. Use VSM_NULL if a type matching the VSM's primary functionality cannot be found.

Table 15-1. VSM Types

Name	Value	Type
VSM_SYS_MGR	00h	System Manager
VSM_AUDIO	01h	XpressAUDIO™ subsystem handler
VSM_VGA	02h	SMI handler
VSM_VG	02h	SMI handler
VSM_LEGACY	03h	Standard AT peripheral handler
VSM_PM	04h	Legacy Power Management handler
VSM_OHCI	05h	USB OHCI
VSM_I8042	06h	8042 emulator
VSM_DEBUGGER	07h	SMI-based debugger
VSM_ACPI	08h	Virtual ACPI handler
VSM_APM	09h	APM 1.2 handler
VSM_OEM_ACPI	10h	OEM ACPI customizations
VSM_SMB	11h	System management bus handler
VSM_BATTERY	12h	Battery controller
VSM_RTC	13h	Virtual RTC
VSM_S2D	14h	Save-to-Disk handler
VSM_EXT_AMP	15h	External audio amplifier handler
VSM_PCMCIA	16h	PCMCIA handler
VSM_SPY	17h	Spy. Receives ALL messages first
VSM_NETWORK	18h	Network handler
VSM_GPIO	19h	GPIO handler
VSM_KEYBOARD	20h	USB keyboard to PC/AT emulation
VSM_MOUSE	21h	USB mouse to PS/2 emulation
VSM_USB	22h	Universal Serial Bus handler
VSM_FLASH	23h	Flash programmer
VSM_INFRARED	24h	Infrared handler
VSM_THERMAL	25h	Thermal monitor
VSM_NULL	26h	Unspecified (e.g., SAMPLE.VSM)
VSM_MPEG	27h	MPEG video decoder
VSM_VIP	28h	Video processor (VIDEC)
VSM_LPC	29h	Low Pin Count bus handler
VSM_VUART	30h	Virtual UART handler
VSM_CONT	31h	Microcontroller handler
VSM_USER1	32h	Place holder for additional VSM
VSM_USER2	33h	Place holder for additional VSM
VSM_USER3	34h	Place holder for additional VSM

15.8.3.1 Sample VSM Header Format

A sample VSM header format is as follows:

```
typedef struct {
       unsigned long       Signature;          // 'VSM '
       unsigned char       VSM_Type;           // Type of VSM (e.g. Legacy, PM, Audio)
       unsigned char       ForCPU;
       unsigned short      ForChipset;
       unsigned short      VSM_Version;        // Version of VMS header format
       unsigned long       VSM_Length;         // Length of VSM module in bytes
       unsigned short      EntryPoint;         // Offset of initial VSM entry point
       unsigned long       DS_Limit;
       Requirements        Flag;               // Special requirements/capabilities
       unsigned short      VSA_Version;
       USHORT              AlignSystem         DWORD alignment adjustment
       System              SysStuff            Reserved for System Manager use.
} VSM_Header;
```

15.8.3.2 Sample VSM Header Structures

The required VSM header structure is a 16-bit flag value.

```
typedef struct {
       unsigned short      Alignment: 5;       // 2^(n+5) (e.g. 00000 = 32-byteph)
       unsigned short      CodeHi: 1;          // 1 = Must load Code above DRAM_TOP
       unsigned short      CodeLo: 1;          // 1 = Must load Code below 1 MB
       unsigned short      DataHi: 1;          // 1 = Must load Data above DRAM_TOP
       unsigned short      DataLo: 1;          // 1 = Must load Data below 1 MB
       unsigned short      SmallModel: 1;      // 1 = If Small memory model
       unsigned short      NoPreempt: 1        // 1 = VSM may be not be preempted
       unsigned short      SkipMe: 1           // 1 = Skip this VSM (normally set by the
                                                       BIOS)
       unsigned short      Reserved: 4;
} Requirements;
```

The Descriptor structure has the format used by the SVDC and RSDC instructions.

```
typedef struct {
       unsigned short      limit_15_0;
       unsigned short      base_15_0;
       unsigned char       base_23_16;
       unsigned char       attr;
       unsigned char       limit_19_16;
       unsigned char       base_31_24;
       unsigned short      selector;
} Descriptor;
```

15.9 Virtual Registers

Virtual registers (VR) are I/O locations accessed with 16-bit index/data operations. The Geode hardware can be configured to trap I/O accesses. VSA2 interprets the data values and either treats the data as parameters (e.g., PM time-outs) or performs some function (e.g., change the TV encoder brightness).

VRs provide a uniform method for the BIOS or third-party software to customize VSA2 software parameters and features (e.g., PM time-outs). They are also the mechanism by which one VSM communicates with another.

WARNING: The effects of accessing the VR should appear to occur immediately to the VSM. Accessing a VR from within a VSA critical section produces unpredictable results.

VRs may be used to read or write information to or from VSA2 software. The registers consist of an index/data pair of I/O locations (AC1Ch, AC1Eh). The System Manager is responsible for setting up the I/O trapping to support VRs. A VSM should use the SET_VIRTUAL_REGISTER and GET_VIRTUAL_REGISTER macros rather than directly executing the I/O cycle.

An unlock cycle is required prior to accessing a VR and must be executed upon every access. This feature protects the I/O space from undesirable probing by various operating systems.

Index Value:

Parameter	Description
AH	Class
AL	Parameter_ID

Data Value:

Parameter	Description
AX	Data

The index is a WORD, consisting of a VR class and parameter ID. The data is also a WORD. Below is sample code for writing the Standby timeout.

```
MOV    AX, 0FC53h    ; unlock code
MOV    DX, 0AC1Ch

OUT    DX, AX        ;
MOV    AH, 4         ; power management class
MOV    AL, 3         ; standby timeout
OUT    DX, AX
ADD    DX, 2         ; point to data register
MOV    AX, 60        ; set to 1 minute
OUT    DX, AX
```

15.10 System Calls and Macros

System calls preclude the need for a VSM to access a system structure directly. However, access to system data outside a VSM's data segment is occasionally necessary. The most common examples are fields within the SMI header and interrupted process registers. Macros are provided to access (read and write) these fields, and allow the System Manager to enforce access restrictions. For example, a VSM responding to an asynchronous event is prevented from modifying an SMI header or trapped registers, since to do so is a programming error. Furthermore, since there may be several contexts active due to nesting of SMIs, the System Manager ensures the correct structure instance is accessed.

All processor states associated with an interrupted context are stored either in the VSM's header or on its stack. This design simplifies the management of multiple VSM contexts.

There are no system call functions directly accessible to the programmer. System calls are always invoked by a corresponding macro. This provides the flexibility to change the implementation of a macro without changing the programming interface. Minimally, a VSM must invoke SYS_GET_NEXT_MSG to retrieve messages. Most VSMs also invoke SYS_REGISTER_EVENT one or more times, typically at initialization time. The other system calls are used in specialized cases.

Table 15-2. System Calls

System Call	Meaning
SYS_REGISTER_EVENT	Associates an event to a VSM
SYS_UNREGISTER_EVENT	Disassociates an event from a VSM
SYS_GET_NEXT_MSG	Retrieves the next message from the VSM’s message queue
SYS_INSERT_MSG	Inserts a message into the message queue
SYS_BROADCAST_MSG	Sends a message to one or more VSMs
SYS_PASS_EVENT[1]	Sends unhandled event to next registered VSM
SYS_SW_INTERRUPT	Performs a software interrupt call to the system BIOS
SYS_YIELD_CONTROL	Gives other VSMs a chance to run
SYS_GET_SYSTEM_INFO	Gets information about the system on which the VSM is currently executing

1. Geode GX1 processor only. Not applicable to Geode GX processor or later processors.

15.10.1 SYS_REGISTER_EVENT

Unless a VSM is written specifically to perform an action at initialization with no runtime processing requirements, it must invoke SYS_REGISTER_EVENT to request notification of desired events. Otherwise, the only events the VSM receives are those broadcast by the System Manager or other VSMs.

The SYS_REGISTER_EVENT macro is used to control a VSM's access to the specified event. The parameters passed are dependent on the event being registered. Reissuing the SYS_REGISTER_EVENT request, with Parameter0-Parameter2 containing the same values as the prior event registration, may change the priority of an event. Parameter3 would contain the new priority. Event codes and parameters are listed in Table 15-3.

- Parameter0: Event Code
- Parameter1: Dependent on the event
- Parameter2: Dependent on the event
- Parameter3: Priority

Table 15-3. Event Registration Parameters

Event Code	Parameter1	Parameter2
EVENT_TIMER	Interval	Handle (optional)
EVENT_AUDIO[1]		
EVENT_GRAPHICS		
EVENT_EXT_VBLANK[1]		
EVENT_USB		
EVENT_ACPI_TIMER[1]		
EVENT_ACPI		
EVENT_IRQ[1]	IRQ (3 or 4 only)	
EVENT_A20		
EVENT_GAMEPORT[1]		
EVENT_NMI		
EVENT_IO_TRAP	I/O base	Length of range (bytes)
EVENT_IO_TIMEOUT	I/O base	16 MSBs = Range (bytes) 16 LSBs = Interval (sec.)
EVENT_MEMORY_TRAP[1]	Memory base	Length of range (bytes)
EVENT_MEMORY_TIMEOUT[1]	Memory base	16 MSBs = Range (bytes) 16 LSBs = Interval (sec.)
EVENT_VIDEO_INACTIVE	Interval (seconds)	
EVENT_GPIO	GPIO pin number	0 = Falling edge 1 = Rising edge
EVENT_SOFTWARE_SMI	S/W SMI code (EAX)	Mask for AL (e.g., FFh = xx)
EVENT_GT1[1]	Interval (seconds)	Mask of reload events
EVENT_PCI_TRAP	PCI Address	Address mask
EVENT_VIRTUAL_REGISTER	Virtual register class	

1. Geode GX1 processor only. Not applicable to Geode GX processor or later processors.

The EVENT_IO_TRAP and EVENT_IO_TIMEOUT events are not completely general-purpose in the Geode GX1 processor and single chip (SC1100, SC1200, SC1201, SC2200, and SC3200) processors. The intention is to provide a common interface to the variety of I/O traps and timers supported by the hardware. If the I/O base does not match one of the traps or time-outs directly supported by the South Bridge, the System Manager attempts to use the user-defined trap hardware. However, the user-defined traps are a limited resource and there are range restrictions, so it is possible for a registration request to be rejected. The traps and time-outs for which there is direct hardware support (in Geode GX1 processor and single chip processors) are listed in Table 15-4. In the Geode GX processor and later processors, I/O trapping is general-purpose and Table 15-4 does not apply.

Example of usage:

```
SYS_REGISTER_EVENT(EVENT_IO_TRAP, 0x1F6,0x02, Priority);   // Trap Primary IDE
```

Table 15-4. Hardware Supported Traps and Time-outs[1]

Device	I/O Base Address	Range (Bytes)	Timeout Units
Port B (A20M/reset)	92h	1	N/A
Game port	200h	2	N/A
Audio	220h/240h/260h/280h 300h/330h (MIDI) 00h/C0h (DMA)	10h 2 10h each	N/A
LPT1 & LPT2	378h/278h	8 each	
COM2	2F8h	8	N/A
COM4	2E8h	8	N/A
Primary IDE	1F6h	2	Seconds
Secondary IDE	176h	2	Seconds
Floppy	3F5h or 375h	1	Seconds
LPT1/LPT2/COM1-4	Standard PC/AT addresses	8 each	Seconds
Keyboard/Mouse	60h/64h (62h/66h)	N/A	Seconds
PCI	0CFCh	4	N/A

1. Applies to Geode GX1 processor and single chip processors only.

15.10.2 SYS_UNREGISTER_EVENT

The SYS_UNREGISTER_EVENT macro cancels a prior event registration. The parameters passed are the same values passed when the event was registered. See Table 15-3 on page 221.

- Parameter0: Event Code
- Parameter1: Dependent on the event
- Parameter2*:* Dependent on the event

15.10.3 SYS_GET_NEXT_MSG

The SYS_GET_NEXT_MSG macro retrieves the next message from a VSM's message queue. The macro returns an unsigned short message code. The macro takes one argument, a buffer to receive the message parameters. The parameter buffer address must be relative to the DS segment. Therefore, the buffer must not be a local variable, unless the VSM's memory model is such that DS = SS.

If the message queue is empty, the macro returns control to the System Manager. The VSM regains control when there is a new message in its message queue.

- No Parameters

Example of usage:

```
       unsigned short      Message;
       unsigned long       Params[6];    Message = SYS_GET_NEXT_MSG(&Params);
```

15.10.4 SYS_BROADCAST_MSG

The SYS_BROADCAST_MSG macro inserts a message into one or more VSM message queue(s). Parameter2 specifies the type of VSM into whose message queue the message is inserted. If there are multiple VSMs of that type, the highest priority VSM receives the message. If that VSM chooses not to handle the message, it may invoke SYS_PASS_EVENT (in the Geode GX1 processor only) to notify the next highest priority VSM. A special type VSM, VSM_ANY, specifies that the message is to be sent to all VSMs. This system call is typically used to notify VSMs of a change in the system state, such as power management level or an imminent warm/cold boot. The other main usage is to instruct VSMs to save state in preparation for a Suspend-to-Disk.

- Parameter0: Message code
- Parameter1: Offset of parameter buffer
- Parameter2: VSM type

Example of usage:

```
// Tell all VSMs to save the state of their associated hardware.
       SYS_BROADCAST_MSG(MSG_SAVE_STATE, &ParamsBuffer, VSM_ANY);
```

15.10.5 SYS_PASS_EVENT (Geode GX1 processor only)

In the Geode GX1 processor, if an event retrieved from the message queue is not handled by a VSM, SYS_PASS_EVENT instructs the System Manager to pass the event along to the next VSM that registered for this event. This scenario typically occurs when multiple VSMs register for the same event. When that event occurs, the VSM polls a status register and determines if the event is for that VSM. If not, the VSM should pass the event in order to give other VSMs an opportunity to handle the event. If a VSM fails to do so, the event is effectively ignored, which may result in unintended behavior.

- Parameter0: Event Code
- Parameter1: Original parameter1 from message
- Parameter2: Original parameter2 from message
- Parameter3: Original parameter3 from message

Example of usage:

```
SYS_PASS_EVENT(MSG_IO_TRAP, Param1, Param2, Param3);
```

15.10.6 SYS_SW_INTERRUPT

The SYS_SW_INTERRUPT system call performs a software interrupt. Some interrupts may not be supported. Typical interrupts are INT 13h and INT 15h. The interrupt vector to which control is transferred depends on when the system call is executed. The System Manager snapshots the interrupt vector once when VSA2 is installed (early POST), and again at the end of POST. Caution must be used if this system call is used in response to a MSG_INITIALIZE with the parameter indicating "early POST'. Some vectors may not exist since the BIOS may not have initialized the interrupt vector yet. Also, some interrupts perform INT instructions so those vectors must be initialized too.

- Parameter0: INT number
- Parameter1: Offset of a register structure

Examples of usage:

```
Regs Registers;
Registers.R_AH = 0x88;
SYS_SW_INTERRUPT(0x15, &Registers); // Perform INT 15h function 0x88
```

15.10.7 SYS_YIELD_CONTROL

The SYS_YIELD_CONTROL system call returns control to the System Manager in order to give other VSMs with lower priority events a chance to execute. This is typically used in cases where a VSM is performing a lengthy procedure, such as waiting for an IDE drive to become ready. Rather than continually poll, other work can be done by scheduling another VSM.

- Parameter0: Maximum number of milliseconds to yield

Note: If Parameter0 = 00000000h, then no particular preemption interval is guaranteed.

Example of usage:

```
SYS_YIELD(500);    // Yield control for up to 500 ms
```

15.10.8 SYS_GET_SYSTEM_INFO

The SYS_GET_SYSTEM_INFO system call is used to get information about the system on which the VSM is currently executing. This allows a VSM to tailor its behavior to execute on a variety of platforms.

- Parameter0: Offset to a hardware structure

```
typedef struct {
       ULONG Chipset_Base;         //South Bridge's PCI address (e.g. 0x80009000)
       USHORT Chipsete_ID;         //South Bridge's PCI device ID (see DEVICE_ID_55x0 below)
       USHORT Chipset_Rev;         //South Bridge's revision
       USHORT CPU_ID;              //CPU's PCI device ID
       USHORT CPU_Revision;        //CPU's version DIR0::DIR1
       USHORT CPU_MHz;             //Units = MHz
       ULONG SystemMemory;         //Units = bytes
```

Example of usage:

```
Hardware SysInfo;
SYS_GET_SYS_INFO(&SysInfo);
```

15.11 Messages

The GET_NEXT_MSG macro retrieves messages from the VSM message queue. The GET_NEXT_MSG macro takes one parameter, the address of an array of unsigned longs. Messages may have zero to MAX_MSG_PARAM parameters associated with them, depending on the message. The GET_NEXT_MSG macro fills the array with the parameters, if any, associated with the retrieved message. The macro returns an unsigned short, which is the next highest priority message pending for the VSM.

Note that a VSM receives most of the following messages at some time during its execution. The only message a VSM has control over is MSG_EVENT. A VSM receives MSG_EVENT only for events it registers. A VSM is free to ignore some messages. For example, a VSM may not have hardware state to save or restore, so it would ignore the MSG_SAVE_STATE and MSG_RESTORE_STATE messages.

Table 15-5. Messages

Message	Meaning
MSG_INITIALIZE	Performs initialization (called at SMM initialization and end of POST)
MSG_SHUTDOWN	Prepares for system shutdown
MSG_SAVE_STATE	Saves entire state of device(s) controlled by VSM
MSG_RESTORE_STATE	Restores saved state of device(s) controlled by VSM
MSG_SET_POWER_STATE	Sets device(s) to specified power state
MSG_EVENT	A registered event has occurred
MSG_QUEUE_OVERFLOW	The message queue is full
MSG_WARM_BOOT	Prepares for a warm boot
MSG_SET_POWER_MODE[1]	Sets the current PM mode (APM, ACPI, Disabled, etc.)

1. Geode GX processor only. Not applicable to the Geode GX1 processor.

15.11.1 MSG_INITIALIZE

This message is sent to each VSM twice. The first message (with Parameter0 = 0) is sent when the SMM software is initialized early, when VSA is first installed. Examples of initialization types performed in early POST are:

- Registration of events
- Hardware initialization
- Initialization of virtual register values

The system BIOS signals the end of POST immediately before booting the operating system. In response to this signal, the System Manager sends a second MSG_INITIALIZE message (with Parameter0 = 1) to each VSM. This allows each VSM to perform initialization that may not have been appropriate during earlier initialization.

- Parameter 0:
  — 0 if "early POST" initialization
  — 1 if "end of POST" initialization

15.11.2 MSG_SHUTDOWN

This message is sent to each VSM immediately before the system is reset. It provides the opportunity to shutdown the system hardware gracefully by disabling hardware or waiting for an activity to complete. In particular, all SMI sources should be disabled. Processing for this event is typically the same as that for MSG_WARM_BOOT.

- No Parameters

15.11.3 MSG_SAVE_STATE

This message is sent to each VSM in preparation for Save-to-Disk or Save-to-RAM. All information required for restoring the device(s) controlled by the VSM must be saved to the VSM's data segment. This message is sent one time by the Save-to-Disk or Save-to-RAM VSM.

- No Parameters

15.11.4 MSG_RESTORE_STATE

This message is sent to each VSM during a Resume-from-Disk or Resume-from-RAM. All devices handled by the VSM should be restored using the state information saved during the handling of the MSG_SAVE_STATE message. This message is sent at most one time by the Save-to-Disk or Save-to-RAM VSM, and is only sent if a prior MSG_SAVE_STATE has been issued.

- No Parameters

15.11.5 MSG_SET_POWER_STATE

This message is sent to each VSM when the power level of the device(s) controlled by the VSM is to be changed. For example, before the system enters Standby, all VSMs are sent the MSG_SET_POWER_STATE message with Parameter0 set to PM_STANDBY. Valid power states are shown in Table 15-6.

- Parameter0: Power State

Table 15-6. Power States

ACPI	APM/Legacy	Description
S0/C0	Full on	Full ON
S0/C1		HLTed with interrupts enabled; cache(s) maintained
S0/C2		Same as S0/C1
S0/C3		Same as S0/C2 but cache(s) don't snoop
S1	Standby	CPU and RAM context preserved
S2	Save-to-RAM	RAM context preserved; CPU clocks stopped
S3		RAM context preserved; All clocks stopped
S4		RAM and CPU context not preserved
S4BIOS	Save-to-Disk	RAM and CPU context not preserved
S5		Soft OFF

15.11.6 MSG_EVENT

MSG_EVENT is the most common message. When a registered event occurs, this message is sent to the VSM with the highest priority. If a VSM handles the event, the VSM does not have to do anything explicitly to notify the System Manager. However, if a VSM chooses not to handle the event, it must invoke the SYS_PASS_EVENT system call (in the Geode GX1 processor only) to give other VSMs that have registered for the same event an opportunity to handle it. If no VSM handles the event (all registered VSMs invoked the SYS_PASS_EVENT system call), an error is signaled. See Section 15.4 “Events” on page 213.

- Parameter0: Event code
- Parameter1: Dependent on event
- Parameter2: Dependent on event
- Parameter3: Dependent on event
- Parameter4: Dependent on event

15.11.7 MSG_QUEUE_OVERFLOW

The System Manager always reserves one message queue entry for this message. If an event occurs that would overflow the message queue, a MSG_QUEUE_OVERFLOW message is sent instead of the original message. The original message code is passed in Parameter0. If any more events occur before the MSG_QUEUE_OVERFLOW message is retrieved, those events are discarded and an error is signaled.

This message is primarily designed to notify a VSM of an event overrun. In many cases, nothing can be done about this error condition. However, some VSMs are able to change their behavior to alleviate the condition. For example, an audio VSM can reduce the audio sampling rate.

- Parameter0: Event code

15.11.8 MSG_WARM_BOOT

This message is sent to each VSM immediately before the system is warm booted. VSMs should respond to this message by preparing the related hardware. This typically means ensuring that no more SMIs are generated by the hardware. For example, the audio VSM should disable the audio hardware and wait for the output FIFO to empty. The video VSM should turn off vertical retrace SMI.

- No Parameters

15.11.9 MSG_SET_POWER_MODE (Geode GX processor only)

This message is broadcast to all VSMs when the power management mode changes. If a VSM power manages one or more devices, it should respond appropriately to this message. Typically, the ACPI VSM manages ACPI mode exclusively and the APM manages APM mode exclusively. Legacy mode is managed at the discretion of each VSM. If PM is disabled, the VSM should return any of the devices it manages to Full Power and cease to perform PM.

Power management mode changes may occur in several ways:

- APM connect/disconnect
- ACPI enable/disable
- BIOS setting the PM default mode via virtual register VRC_PM::POWER_MODE

Parameter0: New mode

— 0000 = Disabled
— 0001 = Legacy PM
— 0002 = APM
— 0003 = ACPI

15.12 Events

The main routine of all VSMs is a message handling loop. When an event occurs, the VSM(s) registered for that event are sent a MSG_EVENT message with the event code in Parameter0. Other parameters may also be passed, depending on the event. A VSM is only sent a MSG_EVENT message for the events that it registered as a handler.

Table 15-7. Events

Event	Meaning
EVENT_GRAPHICS	VGA I/O access, text buffer access, or vertical retrace
EVENT_VBLANK[1]	Vertical retrace SMI
EVENT_AUDIO[1]	Audio event
EVENT_USB	USB event
EVENT_ACPI	The ACPI timer expired
EVENT_ACPI_TIMER[1]	The ACPI timer expired
EVENT_IO_TRAP	I/O trap
EVENT_IO_TIMEOUT	I/O timeout
EVENT_MEMORY_TRAP[1]	Memory trap
EVENT_MEMORY_TIMEOUT[1]	Memory trap timeout
EVENT_VIDEO_INACTIVITY	Video inactivity timer expired
EVENT_GPIO	GPIO transition
EVENT_SOFTWARE_SMI	Software SMI
EVENT_PCI_TRAP	PCI trap
EVENT_TIMER	A millisecond timer expired
EVENT_VIRTUAL_REGISTER	Virtual register access
EVENT_A20	A change in the A20 mask has occurred
EVENT_NMI[1]	An NMI has occurred.
EVENT_GT1[1]	General Purpose Timer 1 has expired

1. Geode GX1 processor only. Not applicable to Geode GX processor and later processors.

15.12.1 EVENT_GRAPHICS

This event is sent when there is an SMI from the graphics unit. The parameters are only valid for trapped I/O, not asynchronous graphics events.

- Parameter1
  — Flags field (from SMM header)
- Parameter2
  — Bits [31:16] = Data Size field from SMM header
  — Bits [15:0] = I/O address from SMM header
- Parameter3
  — Data (if I/O write)
- Parameter4
  — Memory address if string I/O

15.12.2 EVENT_VBLANK

A vertical blank interrupt has occurred.

- No Parameters

15.12.3 EVENT_AUDIO

An audio event has occurred. The audio VSM reads the audio SMI source registers to determine the exact type of audio event. The parameters are only valid for trapped I/O, not asynchronous audio events such as audio FIFO empty.

- Parameter1
  — Flags field (from SMM header)
- Parameter2
  — Bits [31:16] = Data size field from SMM header
  — Bits [15:0] = I/O address from SMM header
- Parameter3
  — Data (if I/O write)
- Parameter4
  — Memory address if string I/O

15.12.4 EVENT_USB

A USB event has occurred.

- No Parameters

15.12.5 EVENT_ACPI

An access to an ACPI register has occurred.

- Parameter1
  — ACPI register index
- Parameter2
  — 01h = BYTE access
  — 03h = WORD access
  — 0Fh = DWORD access
  — Bit 7 set if access is an I/O write
- Parameter3
  — Data (valid only if access is a write)

EVENT_ACPI_TIMER

This event is sent each time the MSB of the ACPI timer register toggles. The 24-bit ACPI counter increments at 14.31818/4 MHz. Therefore, when enabled, the ACPI timer generates an SMI every 2.3435 seconds.

- No Parameters

15.12.6 EVENT_IO_TRAP

An access to a registered I/O location has occurred.

- Parameter1
  — I/O address
- Parameter2
  — 01h = BYTE access
  — 03h = WORD access
  — 0Fh = DWORD access
  — Bit 7 set if access is an I/O write
- Parameter3
  — Data (valid only if access is a write)

15.12.7 EVENT_IO_TIMEOUT

An access to a trapped I/O location has not occurred for the interval specified when this event was registered.

- Parameter1
  — I/O address

15.12.8 EVENT_MEMORY_TRAP

An access to a registered memory location has occurred.

- Parameter1
  — Memory address (physical)
- Parameter2
  — 01h = BYTE access
  — 03h = WORD access
  — 0Fh = DWORD access
  — Bit 7 is set if access is a memory write
- Parameter3
  — Data (valid only if access is a write)

15.12.9 EVENT_MEMORY_TIMEOUT

An access to a trapped memory location has not occurred for the interval specified when this event was registered.

- Parameter1
  — Memory address

15.12.10 EVENT_VIDEO_INACTIVITY

This event is sent if the video has been inactive for the interval specified when this event was registered.

- No Parameters

15.12.11 EVENT_GPIO

A transition has occurred on a GPIO pin. Event GPIO symbols are defined in VSA2.H.

- Parameter1
  — GPIO number
- Parameter2
  — 00h = Falling edge
  — 01h = Rising edge

15.12.12 EVENT_SOFTWARE_SMI

The receipt of this event signals that a software SMI has occurred. A VSM is only sent this message for software SMIs of the value for which it registered. The SMI code is the value in AX at the time the SMI occurred. This event is provided primarily for compatibility with BIOSs that are not VSA2 technology aware. Newer BIOSs should use virtual registers for communication with VSA technology.

- Parameter1
  — SMI code

15.12.13 EVENT_PCI_TRAP

An access to a PCI configuration space has occurred. The VSM is only sent this message for PCI functions that were registered.

- Parameter1
  — PCI config address
- Parameter2
  — 01h = BYTE access
  — 03h = WORD access
  — 0Fh = DWORD access
  — Bit 7 set if access is an I/O write
- Parameter3
  — Data (valid only if access is a write)

15.12.14 EVENT_TIMER

A VSM may request to be notified every n milliseconds. This event is generated when the requested time interval has expired. The timer request remains active until the VSM cancels the request via SYS_UNREGISTER_EVENT. Since a VSM can request more than one timer to run concurrently, a handle may be specified when each timer is registered. When a timer elapses, the corresponding handle is passed as a parameter to distinguish among multiple timers.

- Parameter1
  - Bit 31 = Reserved
  - Bits [30:0] = Interval bits
- Parameter2
  - Handle

15.12.15 EVENT_VIRTUAL_REGISTER

Access to a virtual register has occurred. A VSM is only sent this message for virtual register accesses for class(es) for which it registered.

- Parameter1
  - Virtual register
    - Bits [15:8] = VR class
    - Bits [7:0] = Class index
- Parameter2
  - 00h = WORD read
  - 01h = WORD write
- Parameter3
  - Data (valid only if access is a write)

15.12.16 EVENT_A20

A change in the A20 mask has occurred. This may be either by bit 1 of I/O Port 92h or by issuing a keyboard controller command.

- No Parameters

15.12.17 EVENT_NMI

An NMI has occurred.

- No Parameters

15.12.18 EVENT_GT1

The General Purpose Timer 1 has expired.

- Parameter1
  - Timeout in seconds
- Parameter2
  - Mask of devices that can reset GT1
    - Bits [7:5] = Reserved
    - Bit 4 = Secondary hard disk
    - Bit 3 = Keyboard/Mouse
    - Bit 2 = Parallel/Serial
    - Bit 1 = Floppy disk
    - Bit 0 = Primary hard disk

15.13 Macros

In addition to the system call macros discussed in Section 15.6 on page 214, there are other macros available to the VSM programmer. These are designed to achieve certain required functionality without the burden of understanding the implementation details. For example, if a VSM requires information from the SMM header, the method of reading the SMM header location is CPU dependent.

Table 15-8. Macros

Macro	Usage
ENTER_CRITICAL_SECTION	Disable nested SMIs
EXIT_CRITICAL_SECTION	Enable nested SMIs
SET_VIRTUAL_REGISTER	Write a virtual register
GET_VIRTUAL_REGISTER	Read a virtual register
SET_REGISTER	Store a value to an interrupted general purpose register
GET_REGISTER	Get a trapped general purpose register
SET_HEADER_DATA	Set a field in the SMM header
GET_HEADER_DATA	Get a field from the SMM header
READ_PCI_BYTE	Read a BYTE from PCI configuration space
READ_PCI_WORD	Read a WORD from PCI configuration space
READ_PCI_DWORD	Read a DWORD from PCI configuration space
READ_PCI_DWORD_NO_TRAP	Disable trapping on the PCI address, perform a PCI configuration space read, then re-enable PCI trapping on the address.
READ_PCI_WORD_NO_TRAP	
READ_PCI_BYTE_NO_TRAP	
WRITE_PCI_BYTE	Write a BYTE to PCI configuration space
WRITE_PCI_WORD	Write a WORD to PCI configuration space
WRITE_PCI_DWORD	Write a DWORD to PCI configuration space
WRITE_PCI_DWORD_NO_TRAP	Disable trapping on the PCI address, perform a PCI configuration space write, then re-enable PCI trapping on the address.
WRITE_PCI_WORD_NO_TRAP	
WRITE_PCI_BYTE_NO_TRAP	

15.13.1 ENTER_CRITICAL_SECTION, EXIT_CRITICAL_SECTION

The critical section macros are used to mark the beginning and end of VSM code that should not be interrupted. Typically, this is brief sections of code that are very timing sensitive. For example, if a VSM creates a software-generated pulse of a precise duration, the VSM must not be interrupted. Otherwise, the pulse would be longer than desired. Surrounding such code with critical section macros prevents any interruption.

Implementing critical sections ensures that structures are updated automatically.

Example of usage:

```
ENTER_CRITICAL_SECTION();         // timing sensitive code goes here
EXIT_CRITICAL_SECTION();
```

15.13.2 SET_VIRTUAL_REGISTER

The SET_VIRTUAL_REGISTER macro is used to write to a virtual register from within a VSM. While I/O operations can be performed to accomplish the same effect, using this macro allows the System Manager to perform the operation more efficiently.

Example of usage:

```
SET_VIRTUAL_REGISTER(Virtual_Class, Virtual_Index, data);
```

15.13.3 GET_VIRTUAL_REGISTER

The GET_VIRTUAL_REGISTER macro is used to read to a virtual register from within a VSM. While I/O operations can be performed to accomplish the same effect, using this macro allows the System Manager to perform the operation more efficiently.

Example of usage:

```
Data = GET_VIRTUAL_REGISTER(Virtual_Class, Virtual_Index);
```

15.13.4 General Purpose Register Access

15.13.4.1 SET_REGISTER

The SET_REGISTER macro is used to modify the interrupted (non-SMM) task's registers.

- Parameter0
  — Register name
- Parameter1
  — Data value

Note: This system call is only valid when servicing a synchronous event (EVENT_SOFTWARE_SMI, EVENT_IO_TRAP, EVENT_MEMORY_TRAP). Attempting to use it when servicing an asynchronous event is a programming error.

Valid register names are:
R_EAX, R_AX, R_AH, R_AL
R_EBX, R_BX, R_BH, R_BL
R_ECX, R_CX, R_CH, R_CL
R_EDX, R_DX, R_DH, R_DL
R_ESI, R_SI
R_EDI, R_DI
R_EBP, R_BP
R_ESP, R_SP
R_DS

R_SS
R_ES
R_FS

R_GS

Example of usage:

```
SET_REGISTER (R_EAX, 0x123456578);      // Set caller's EAX to 0x12345678
```

15.13.4.2 GET_REGISTER

The GET_REGISTER macro is used to retrieve a general-purpose register from the interrupted (non-SMM) task.

- Parameter0
  — Register name

Note: This system call is only valid when servicing a synchronous event (EVENT_SOFTWARE_SMI, EVENT_IO_TRAP, EVENT_MEMORY_TRAP). Attempting to use it when servicing an asynchronous event is a programming error.

Example of usage:

```
Register_EDX = GET_REGISTER (R_EDX);    // Get caller's EDX
```

15.13.4.3 SET_HEADER_DATA

The SET_HEADER_DATA macro is used to write data to the SMI header from the interrupted (non-SMM) task. The size of the field written is determined by the field.

- Parameter0
  — Name of SMM header field
- Parameter1
  — Data

Note: This system call is only valid when servicing a synchronous event (EVENT_SOFTWARE_SMI, EVENT_IO_TRAP, EVENT_MEMORY_TRAP). Attempting to use it when servicing an asynchronous event signals an error.

Example of usage:

```
SET_HEADER_DATA(CURRENT_EIP, GET_HEADER_DATA (NEXT_EIP));
```

15.13.4.4 GET_HEADER_DATA

The GET_HEADER_DATA macro is used to read data from the SMI header from the interrupted (non-SMM) task. The size of the field retrieved is determined by the field.

- Parameter0
  — Name of SMM header field

Note: This system call is only valid when servicing a synchronous event (EVENT_SOFTWARE_SMI, EVENT_IO_TRAP, EVENT_MEMORY_TRAP). Attempting to use it when servicing an asynchronous event signals an error.

Valid SMM header field names are:
NEXT_EIP
CURRENT_EIP
CS_LIMIT
CS_BASE
CS_SELECTOR
CS_ATTRIBUTE
R_CR0
R_DR7
EFLAGS
DATA_SIZE
IO_ADDRESS
WRITE_DATA

Example of usage:

```
Address = GET_HEADER_DATA (NEXT_EIP);   // Get address of trapped instruction
```

15.13.5 Shorthand Macros

Since the AL, AX and EAX registers are the most commonly accessed registers, specific macros are defined to facilitate readability of the code. These macros and their equivalent definitions are shown in Table 15-9.

Table 15-9. Shorthand Macros

Shorthand Macro	Equivalent Macro
GET_AL( )	GET_REGISTER(R_AL)
GET_AH( )	GET_REGISTER (R_AH)
GET_AX( )	GET_REGISTER(R_AX)
GET_EAX( )	GET_REGISTER(R_EAX)
SET_AL(data)	SET_REGISTER(R_AL, (unsigned char) data)
SET_AH (data)	SET_REGISTER (R_AH, (unsigned char) data)
SET_AX(data)	SET_REGISTER(R_AX, (unsigned short) data)
SET_EAX(data)	SET_REGISTER(R_EAX, (unsigned long) data)
SET EFLAGS (data)	SET_HEADER_DATA (EFLAGS, (unsigned long) data)

15.13.6 PCI Register Access

All PCI accesses must be naturally aligned. Otherwise, unpredictable results will occur.

15.13.6.1 READ_PCI_BYTE

- Parameter0
  — PCI configuration address

Example of usage:

```
HeaderType = READ_PCI_BYTE(0x8000930E);
```

15.13.6.2 READ_PCI_WORD

- Parameter0
  — PCI configuration address

Example of usage:

```
DeviceID = READ_PCI_WORD(0x80009302);
```

15.13.6.3 READ_PCI_DWORD

- Parameter0
  — PCI configuration address

Example of usage:

```
BAR0 = READ_PCI_DWORD(0x80009310);
```

15.13.6.4 READ_PCI_DWORD_NO_TRAP, READ_PCI_WORD_NO_TRAP, READ_PCI_BYTE_NO_TRAP

These macros disable trapping on the PCI address, perform a PCI configuration space read, then re-enable PCI trapping on the address. This is useful for accessing hardware directly and avoiding any trapping that may be in place.

- Parameter0
  — PCI Configuration Address

Example of usage:

```
BAR1 = READ_PCI_DWORD_NO_TRAP (0x800093144);
```

15.13.6.5 WRITE_PCI_BYTE

- Parameter0
  — PCI configuration address
- Parameter1
  — Data to write

Example of usage:

```
WRITE_PCI_BYTE(0x8000933D, InterruptPin);
```

15.13.6.6 WRITE_PCI_WORD

- Parameter0
  — PCI configuration address
- Parameter1
  — Data to write

Example of usage:

```
WRITE_PCI_WORD(0x80009304, Command);
```

WRITE_PCI_DWORD

- Parameter0
  — PCI configuration address
- Parameter1
  — Data to write

Example of usage:

```
WRITE_PCI_DWORD(0x80009314, BAR1);
```

15.13.6.7 WRITE_PCI_DWORD_NO_TRAP, WRITE_PCI_WORD_NO_TRAP, WRITE_PCI_BYTE_NO_TRAP

This macro disables trapping on the PCI address, performs a PCI DWORD write, then re-enables PCI trapping on the address. This is useful for forwarding trapped PCI writes to the hardware.

- Parameter0
  — PCI configuration address
- Parameter1
  — Data to write

Example of usage:

```
WRITE_PCI_DWORD_NO_TRAP (0x80009314, BAR1);
```

16 Virtual Hardware

AMD Geode™ solutions and the GeodeROM SMM software make it possible to emulate hardware functionality. The firmware responds to SMIs generated by specialized hardware and provides virtual devices such as the XpressAUDIO™ subsystem, the XpressGRAPHICS™ subsystem, RTC/CMOS devices, and UARTs.

16.1 Virtual Video

Note: Section 16.1 applies to SoftVGA and the Geode GX1 processor only. For other SMI handlers, see their graphics software specification.

Using Virtual System Architecture™ technology, GeodeROM optionally includes support for SoftVGA. SoftVGA takes advantage of embedded hardware capability to provide a VGA graphics subsystem compatible with the IBM VGA with additional functionality to support the VESA BIOS extensions.

The SoftVGA virtualizes the video interface by supporting the standard VGA interface with the VESA BIOS extensions and a single indexed register. This register operates as an indexed pair such that the register index is written to 0AC1Ch, and the data is then read from or written to 0AC1Eh. This register is used to define three initialization parameters: the size of the video memory in 128 KB segments, determine whether SoftVGA is to be enabled, and if enabled, determine whether it is to be initially active. This register is to be written only at initialization. Writing this register after initialization creates unpredictable results. After initialization, the preferred video interface is the standard VGA interface.

The initialization parameters fit within one byte and have the format of that shown in Table 16-1.

Table 16-1. Virtual Video Register

Register Index	Register Name or Use	Access	Description
0200h	Video initialization	Write Only	Set the video initialization parameters. Default is SoftVGA installed and on, using the memory size specified during the GeodeROM configuration. The bit formats are: Bit 7: 0 = SoftVGA is initially active 1 = SoftVGA is initially inactive (used for dual-monitor support). Bits [6:1]: Amount of video memory in 128 KB blocks. Bit 0: 0 = SoftVGA is not to be installed 1 = Install SoftVGA.

Example 1:

```
; Set the SoftVGA initialization parameters
      mov    dx, 0AC1Ch    ; The index register address
      mov    ax, 0200h     ; The index of the initialization register
      out    dx, ax        ; Set the index
      mov    dx, 0AC1Eh    ; The data register address
      mov    ax, 0029h     ; SoftVGA installed and initially active, 2.5 MB video memory
```

16.2 Virtual RTC/CMOS

The GeodeROM SMM software can simulate an RTC/CMOS device by registering for the following two types of events at initialization: a timer to be notified every second (1000 ms) and I/O access to 70h and 71h.

During the operation, two other timers are used for the following events: periodic interrupt and update in progress.

During POST, the date and time in the V-RTC is initialized to midnight, January 1, 1980. Other initial values are:

- Status_A = 26h
- Status_B = 02h
- Status_C = 00h
- Status_D = 80h
- All other V-CMOS locations = 00h

Note that POST initializes various “legacy” locations.

17 Power Management

There are multiple industry-standard power management (PM) methods to be supported, each sharing common PM concepts such as device timeouts, power states, and power state transition diagrams. Power management methods typically differ primarily in the API and in some of the details, such as the number of power states and the types of power state transitions supported.

The GeodeROM power management is modularized relative to SMM in a carefully defined manner. For example, the API for Advanced Power Management (APM) is implemented in an APM-specific VSM. The setting of a particular power state (e.g. Standby), however, is common among several PM methods. Rather than duplicate power state logic in each VSM, such common functionality is implemented in a generic PM VSM. Other PM VSMs leverage this common code by communicating its requirements to the generic PM VSM via virtual registers. This distributed architecture results in smaller overall code size when multiple PM schemes are supported. In addition, when a change (e.g., a bug fix or feature enhancement) is made to the generic PM VSM, all of the PM VSMs benefit from such changes, usually without recompilation of the API-specific VSMs.

The generic PM VSM handles the low-level details of power management. It controls the CPU power state directly. It also coordinates power management among other VSMs. Specifically, when the power state changes, it broadcasts a MSG_POWER_STATE message to all other VSMs. The new power state is passed as a parameter. This gives other VSMs a chance to put their associated hardware, if any, into the new power state. VSMs that do not control actual hardware would typically ignore these messages. However, VSMs such as the XpressGRAPHICS™ subsystem, XpressAUDIO™ subsystem, a SuperI/O or battery VSM would take appropriate action. As stated earlier, this distributed design provides the ability for custom VSMs to be written to handle platform-specific power management issues without the need to modify the basic power management software.

17.1 Power States

Different power management methods define the various power states differently. However, they typically have enough in common that they can be mapped onto one of the following:

- FULL ON - The processor is running at full speed with all peripherals at a ready state.
- DOZE - Peripherals are at a ready state. The processor is in a clock-throttled mode. Any user input (keyboard or mouse activity) returns the system to FULL ON in a negligible amount of time. SMIs and IRQs also return the system to FULL ON for a short duration, then the system is clock-throttled again. This ensures quick interrupt and video servicing. Transitions in and out of this state usually cannot be noticed by the user.
- STANDBY - Peripherals may be put in a lower power state (minimal recovery time). The processor is in its lowest power state. The state of DRAM is preserved, the video is blanked and the hard drive is spun down. Any SMI or IRQ defined as a wake-up event returns the system to FULL ON.
- SUSPEND - This state preserves the entire state of the system, either in a Suspend-to-RAM or Suspend-to-Disk mode. The processor is off, but the power to the DRAM controller remains on in the case of Suspend-to-RAM.
- OFF - Power to the system is turned off. The system is typically set to this state after a Suspend-to-Disk or after the operating system has made the system ready for shutdown.

17.2 PM Initialization

Initialization requirements of power management consist primarily of writing various virtual registers within the PM virtual register class (see Table 17-1 on page 240). The sample code that follows demonstrates how to write a single virtual register:

```
MOV    DX, 0AC1Ch           ; virtual register index
MOV    AH, 04h              ; PM class
MOV    AL, 02h              ; Doze timeout register
OUT    DX, AX
ADD    DX, 2                ; virtual register data
MOV    AX, <doze_timeout>   ; units = seconds
OUT    DX, AX
```

Table 17-1. PM Virtual Registers

Register	Defined As	Description
0401h	PM_MODE	Defines the PM API (e.g. APM, Legacy, etc.) currently in use. This register is written by a PM VSM. It is not initialized by the boot ROM.
01h	POWER_STATE	Defines the desired power state. This register is written by a PM VSM. It is not initialized by the boot ROM.
02h	DOZE_TIMEOUT[1]	Defines the duration of system idleness (in seconds), defined as lack of user input, after which the system is transitioned to the DOZE power state.
03h	STANDBY_TIMEOUT[1]	Defines the duration of system idleness (in seconds), as lack of user input, after which the system is transitioned to the STANDBY power state.
04h	SUSPEND_TIMEOUT[1]	Defines the duration of system idleness (in seconds), as lack of user input, after which the system is transitioned to the SUSPEND power state.
05h	KEYBOARD_TIMEOUT	Defines duration inactivity of the keyboard before the system is considered idle.
06h	MOUSE_TIMEOUT	Defines duration inactivity of the mouse before the system is considered idle.
07h	VIDEO_TIMEOUT	Defines duration inactivity of the video before the system is considered idle.
08h	DISK_TIMEOUT[1]	Defines duration of the hard drive idleness (in seconds), as lack of I/O to the IDE interface, after which the disk drive(s) are spun down.
09h	FLOPPY_TIMEOUT[1]	Defines duration of the floppy drive idleness (in seconds), as lack of floppy I/O, after which the floppy subsystem is put in a low power state. This type of power control is typically located in the superI/O chipset.
0Ah	SERIAL_TIMEOUT[1]	Defines the duration of serial port idleness (in seconds), as lack of COM I/O, after which the serial port subsystem is put in a low power state. This type of power control is typically located in the superI/O chipset.
0Bh	PARALLEL_TIMEOUT[1]	Defines the duration of parallel port idleness (in seconds), as lack of LPT I/O, after which the parallel port subsystem is put in a low power state. This type of power control is typically located in the superI/O chipset.
0Ch	IRQ_WAKEUP_MASK	A mask of IRQs (LSB = IRQ0; MSB = IRQ15) that are to be used as wake-up events from STANDBY mode. These typically include IRQ1 (keyboard), IRQ12 (PS/2 mouse), as well as others such as IRQ3/4 (modem) or network IRQs.
0Dh	SUSPEND_MODULATION	Defines the effective clock frequency to be used during DOZE mode. The upper byte defines the OFF time while the lower byte defines the ON time. For example, 0x0901 would yield a 10% effective clock speed.
0Eh	VIDEO_SPEEDUP	Defines the number of milliseconds that video activity disables clock throttling (DOZE power state). After the time lapse, clock throttling resumes.
0Fh	IRQ_SPEEDUP	Defines the number of milliseconds that IRQ activity disables clock throttling (DOZE power state). After the time lapse, clock throttling resumes.
10h	WAKEUP_SMI_MASK	Not implemented: Reserved.

Table 17-1. PM Virtual Registers (Continued)

Register	Defined As	Description
11h	INACTIVITY_CONTROL	Used internally by APM VSM.
12h	MOUSE_CONTROL	Not implemented: Reserved.
13h	RESUME_ON_RING	Used internally by APM VSM.
14h	SCI_CONTROL	Used internally by V-ACPI VSM.
15h	SCI_ROUTING	Used internally by V-ACPI VSM.
16h	VECTOR_SEGMENT	Used internally by V-ACPI VSM.
17h	VECTOR_OFFSET	Used internally by V-ACPI VSM.

1. These timeout values are only applicable to legacy power management. Other power management interfaces change power states under program control rather than with inactivity timers.

18 Configuring/Customizing

18.1 Quick Start

1) Make sure you have ml.exe (masm), link.exe, and nmake in your path.
2) Change directory (cd) to examples\newproj (this is a user dir).
3) Type “nmake all”.
4) Answer the questions.

18.2 Build Process

The build process starts in the user directory by running nmake. The first time nmake runs, the configurator asks a series of questions about the platform. nmake, then attempts to complete the build according to the answers. When the build successfully completes, the following is displayed:

```
##############################################################################
#__________________________GeodeROM build complete__________________________#
##############################################################################
```

18.3 Environment Variable(s)

- Path - Should include the bin and binr directories from masm 6.11 and msvc 1.52, as well as the normal files for DOS / Windows
- Include - Should include the directories for masm 6.11 and msvc.
- Lib - Should include the lib directories from masm6.11 and msvc.

18.4 The Configurator

The configurator is a perl script used to configure the GeodeROM build. The build process includes a series of questions to which the system designer provides information about board wiring, installation options, and general configuration for GeodeROM. The configurator utility runs automatically the first time the build process takes place, and on subsequent builds, uses information from a saved option file:

- Debug/Test - Debug questions are accessed by running nmake debug (otherwise, they are not asked). These include cache defaulting to OFF instead of ON, halting on unknown interrupts, conservative memory timings, etc.
- VSA2 - XpressAUDIO™ and XpressGRAPHICS™ subsystems.
- Hardware - Chipset, SIO, and LCD.
- Boot screen - Splash screen support and summary screen support.
- General configuration - Hard drive support, floppy support, video memory used, user option ROMs, etc.

The configurator outputs the file’s xromcfg.opt, rules.mak, and options.inc into the user directory. It also decodes and recreates an xromcfg.opt file from an xpress.rom file. This is useful both for recreating old ROM files and for debugging problems with the ROMs.

18.5 Build Files

Non-source files used by the build process:

- xpress\makefile - The master makefile for the GeodeROM tree - build options (targets) are discussed in Section 18.6 “Build Options”.
- xpress\xromcfg.pl (The Configurator) - Sets up the build options for GeodeROM.
- user\makefile - The makefile in the user directory sets up the user path and calls the xpress\makefile to do the build. The common targets in this makefile are the same as for the xpress\makefile.
- user\xromcfg.opt - The configuration file used by xromcfg.pl to set up the build options. This file is also generated by xromcfg.pl.
- user\rules.mak - Generated by xromcfg.pl, this file gets included by the xpress\makefile when building. DO NOT EDIT THIS FILE. Any changes made to this file are lost when xromcfg.pl is run again.
- user\options.inc - Generated by xromcfg.pl, this file gets included by the asm files to control various options. DO NOT EDIT THIS FILE. Any changes made to this file are lost when xromcfg.pl is run again.
- user\userrule.mak - This is a makefile that targets may be added to. This file gets included by the user\rules.mak file if it exists.

18.6 Build Options

- nmake all - builds xpress.rom. Will do a nmake configuration if needed. This is the default if no target is specified for the build.
- nmake help - Displays makefile options.
- nmake clean - Removes object files, ROM files, etc.
- nmake cleanall - Removes all output files of build, including xromcfg.opt.
- nmake config - Runs the configurator to set up build options.
- nmake refresh - Uses the configurator's output file (xromcfg.opt) to rebuild the rules.mak and options.inc files.
- nmake debug - Runs the configurator to set up build options and debugging options.
- nmake checktools - Generates toollist.txt, an option provided to help debug build problems.
- nmake checkbuild - Generates toollist.txt the same as checktools, and starts GeodeROM build operation.
- nmake decode - Recreates an xromcfg.opt file used to build a ROM, and generates a list of filenames that were overrides when the ROM was built.

18.7 Splash Screen

The splash screen is used to provide a vendor or platform-specific graphic display at the end of POST, and includes a selectable display time, before the system loads the operating system.

Considerations when using splash screen:

- The GeodeROM splash screen feature supports 320x200 resolution for external video cards. The Geode device(s) supports resolutions up to the maximum resolution of the built-in graphics controller. Higher resolutions yield a larger splash screen image size that may not fit the allotted BIOS memory size.
- Option ROM or setup entry prompts are displayed during display of the splash screen. Both Option ROM and setup entry prompts use palette 0 for the text background and palette 7 for the text foreground. These can be customized to highlight the text entries or to allow them to blend into the splash graphics display.
- RLE compression is used for all GeodeROM compression, limiting the size and complexity of the splash screen chosen.

18.8 Summary Screen

The summary screen reports the basic configuration of GeodeROM with regard to a target platform.

18.9 CMOS Setup

18.9.1 Setup Menus

To enter setup, press the F1 key while booting the system.

18.9.1.1 General Menu Navigation

Table 18-1 describes the keys used to navigate within menus.

Table 18-1. Setup Navigation Keys

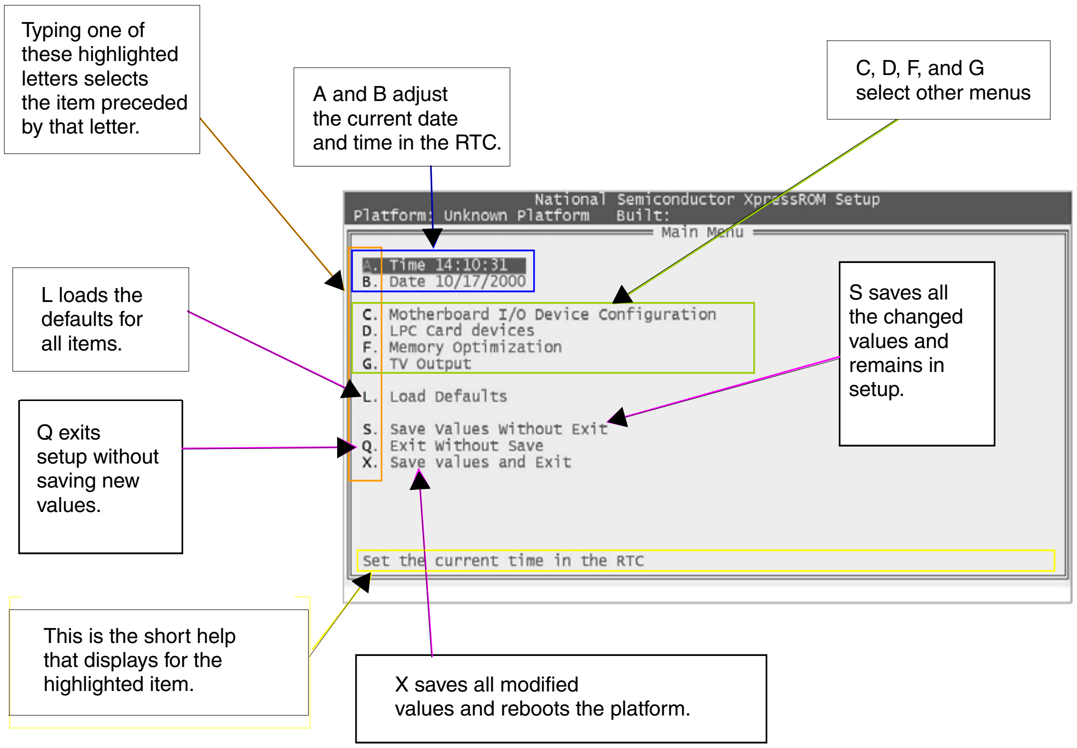
Key	Function
Up Arrow	Highlights the item above the currently highlighted item. If on the top item, highlights the last item.
Down Arrow or Space	Highlights the item below the currently highlighted item. If on the bottom item, highlights the top item.
Left arrow	Highlights the item to the left of the currently highlighted item. If there is no item directly to the left, the rightmost item on the previous line is highlighted.
Right Arrow	Highlights the item to the right of the currently highlighted item. If there is no item directly to the right, the leftmost item on the next line is highlighted.
Press Enter or a the character that matches the first highlighted character of an item	Selects the currently highlighted item. This cycles through the Choices for an item or brings up an entry box for direct entry of a value depending on how the item is configured.
F1	Displays a Long Help for the currently highlighted item. If there is no Long Help for the item, the Short Help is displayed.
Escape	Closes the current menu and returns to the previous menu. If there is no previous menu, this key does nothing.

18.9.1.2 Setup Main Menu

When entering setup, Figure 18-1 on page 246 is the first menu displayed.

18.9.1.3 Motherboard I/O Device Configuration Menu

Figure 18-2 is the motherboard I/O devices menu. Note that some entries may not display depending on the platform and processor chip configured. For instance, serial port C is displayed only for Geode single chip processors. The values can be changed by highlighting the entry and pressing Enter to cycle through the choices. When done, press the escape key to exit this menu.



```
                  National Semiconductor XpressROM Setup
Platform: Unknown Platform   Built:
                              Main Menu
 A. Time 14:10:31
 B. Date 10/17/2000

 C. Motherboard I/O Device Configuration
 D. LPC Card devices
 F. Memory Optimization
 G. TV Output

 L. Load Defaults

 S. Save Values Without Exit
 Q. Exit Without Save
 X. Save values and Exit


 Set the current time in the RTC
```

Typing one of these highlighted letters selects the item preceded by that letter.

A and B adjust the current date and time in the RTC.

C, D, F, and G select other menus

L loads the defaults for all items.

S saves all the changed values and remains in setup.

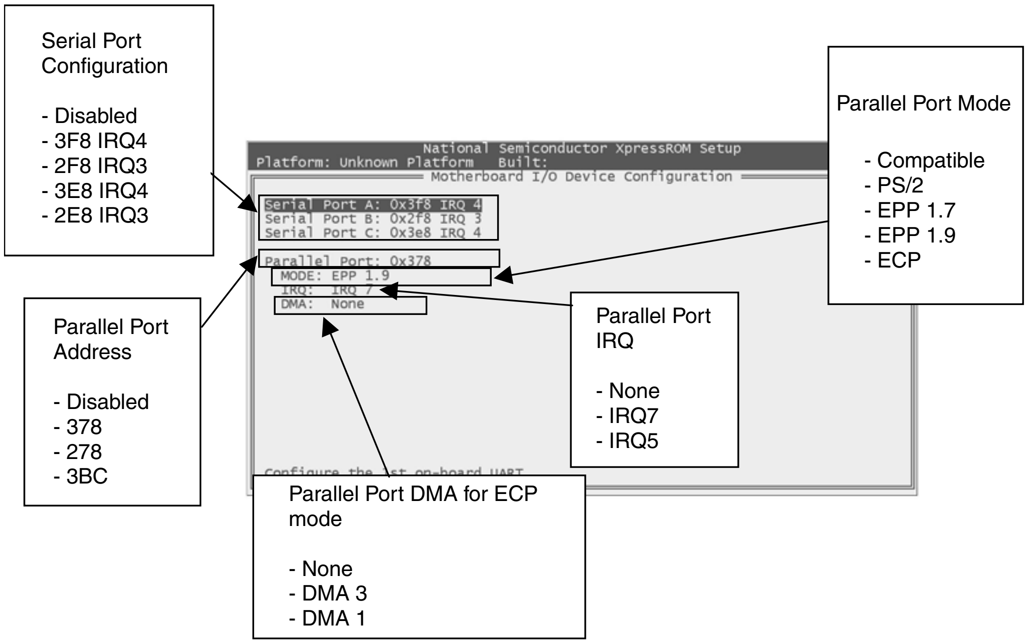
Q exits setup without saving new values.

This is the short help that displays for the highlighted item.

X saves all modified values and reboots the platform.

Figure 18-1. Setup Main Menu Display

.



```
               National Semiconductor XpressROM Setup
Platform: Unknown Platform   Built:
              Motherboard I/O Device Configuration
 Serial Port A: 0x3f8 IRQ 4
 Serial Port B: 0x2f8 IRQ 3
 Serial Port C: 0x3e8 IRQ 4

 Parallel Port: 0x378
   MODE: EPP 1.9
   IRQ:  IRQ 7
   DMA:  None


 Configure the 1st on-board UART
```

Serial Port Configuration

- Disabled
- 3F8 IRQ4
- 2F8 IRQ3
- 3E8 IRQ4
- 2E8 IRQ3

Parallel Port Mode

- Compatible
- PS/2
- EPP 1.7
- EPP 1.9
- ECP

Parallel Port Address

- Disabled
- 378
- 278
- 3BC

Parallel Port IRQ

- None
- IRQ7
- IRQ5

Parallel Port DMA for ECP mode

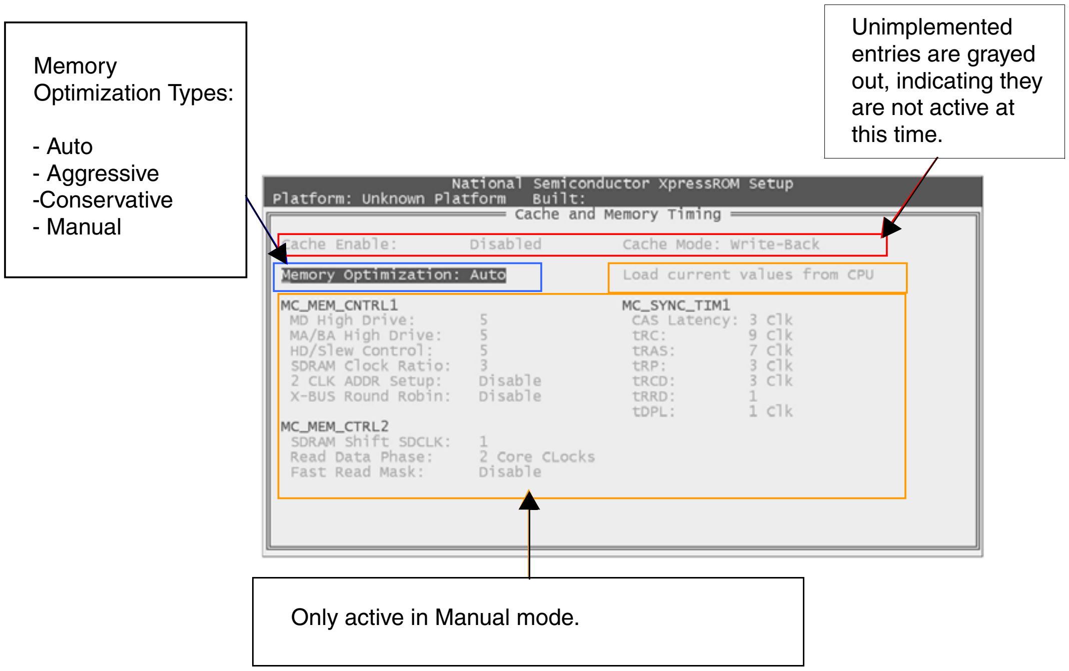
- None
- DMA 3
- DMA 1

Figure 18-2. I/O Device Configuration Menu

18.9.1.4 Memory Optimization Menu

Standard Menu

Figure 18-3 shows the standard Memory Optimization menu.


Memory Optimization Types:
- Auto
- Aggressive
-Conservative
- Manual
Unimplemented entries are grayed out, indicating they are not active at this time.
Only active in Manual mode.

```
                 National Semiconductor XpressROM Setup
Platform: Unknown Platform   Built:
                        Cache and Memory Timing
 Cache Enable:          Disabled          Cache Mode: Write-Back
 Memory Optimization: Auto                Load current values from CPU

 MC_MEM_CNTRL1                            MC_SYNC_TIM1
  MD High Drive:        5                  CAS Latency: 3 Clk
  MA/BA High Drive:     5                  tRC:         9 Clk
  HD/Slew Control:      5                  tRAS:        7 Clk
  SDRAM Clock Ratio:    3                  tRP:         3 Clk
  2 CLK ADDR Setup:     Disable            tRCD:        3 Clk
  X-BUS Round Robin:    Disable            tRRD:        1
                                           tDPL:        1 Clk
 MC_MEM_CTRL2
  SDRAM Shift SDCLK:    1
  Read Data Phase:      2 Core CLocks
  Fast Read Mask:       Disable
```

Figure 18-3. Standard Memory Optimization Menu

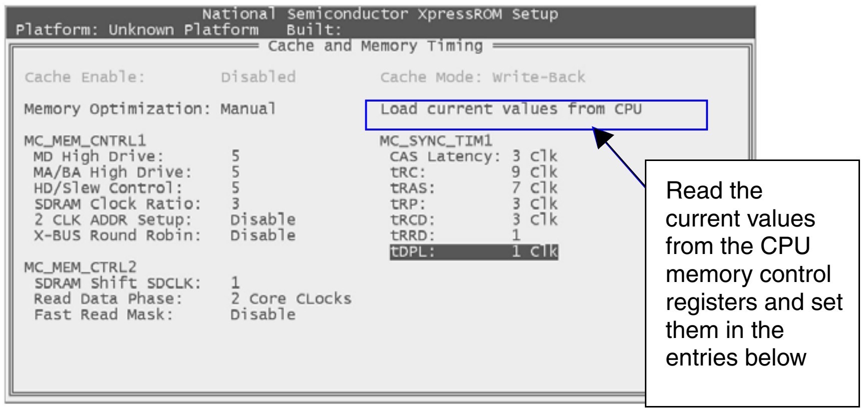
Manual Settings Menu

When Manual is selected for Memory Optimization, the remaining menu entries become active, indicating the entries are alterable and are no longer greyed out. If saved, the values in these entries become active when setup is exited and the system reboots.

It is highly recommended that the user selects Load Current Values From CPU when first switching to Manual Optimization in order to obtain the correct base values the system is using.

WARNING: Altering memory optimization values can result in a non-operational system. Only alter these values upon understanding the proper values and use of each field from the appropriate CPU's manual.

If the system becomes non-operational, resetting or restarting the platform three times restores the default values.


Read the current values from the CPU memory control registers and set them in the entries below

```
                 National Semiconductor XpressROM Setup
Platform: Unknown Platform   Built:
                        Cache and Memory Timing

 Cache Enable:          Disabled          Cache Mode: Write-Back

 Memory Optimization: Manual              Load current values from CPU

 MC_MEM_CNTRL1                            MC_SYNC_TIM1
  MD High Drive:        5                  CAS Latency: 3 Clk
  MA/BA High Drive:     5                  tRC:         9 Clk
  HD/Slew Control:      5                  tRAS:        7 Clk
  SDRAM Clock Ratio:    3                  tRP:         3 Clk
  2 CLK ADDR Setup:     Disable            tRCD:        3 Clk
  X-BUS Round Robin:    Disable            tRRD:        1
                                           tDPL:        1 Clk
 MC_MEM_CTRL2
  SDRAM Shift SDCLK:    1
  Read Data Phase:      2 Core CLocks
  Fast Read Mask:       Disable
```

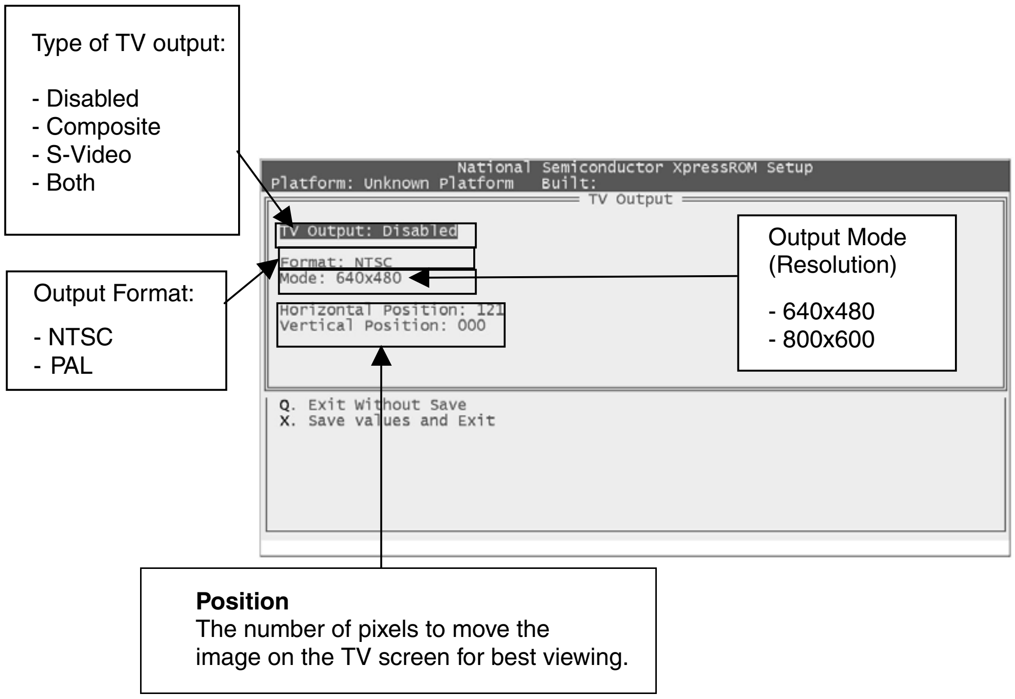
Figure 18-4. Manual Memory Configuration Menu Display

18.9.1.5 TV Output Menu

Figure 18-5 "TV Output and Configuration Menu" is present only with setup compiled for Geode single chip processors with TV Out support.

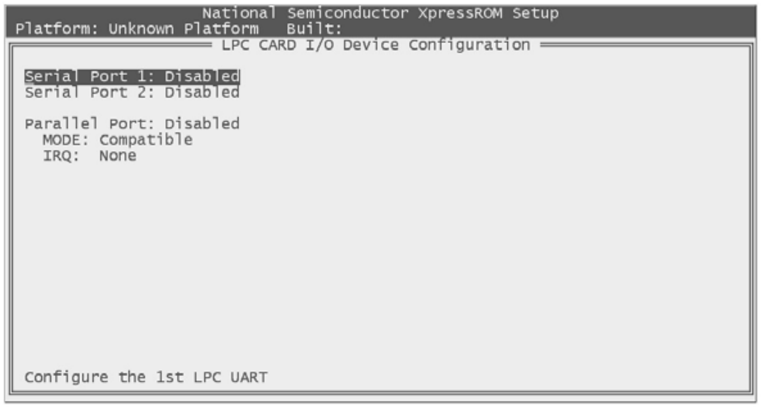
18.9.1.6 LPC Card Devices Menu

Figure 18-6 "Low Pin Count (LPC) Bus Setup Menu" is present only with setup compiled for Geode single chip processors. Designs using these processors may not include a SIO. The LPC bus may be available as a platform dependent feature as an expansion connector where an LPC card can be inserted that provides SIO functionality that is not provided through the processor. This menu is used to configure such a card for operation in concert with other Geode single chip devices, such as serial ports, etc.



```
National Semiconductor XpressROM Setup
Platform: Unknown Platform   Built:
TV Output
TV Output: Disabled
Format: NTSC
Mode: 640x480
Horizontal Position: 121
Vertical Position: 000
Q. Exit Without Save
X. Save values and Exit
```

Figure 18-5. TV Output and Configuration Menu



```
National Semiconductor XpressROM Setup
Platform: Unknown Platform   Built:
LPC CARD I/O Device Configuration

Serial Port 1: Disabled
Serial Port 2: Disabled

Parallel Port: Disabled
  MODE: Compatible
  IRQ:  None

Configure the 1st LPC UART
```

Figure 18-6. Low Pin Count (LPC) Bus Setup Menu

18.9.2 Programming Reference

18.9.2.1 Sample SMENU.ASM file:

```
INIT_MENU

  MENU m_menu,"Main Menu",3,1,24,80,TOP_MENU
    ITEM "A. Time "
      SPECIAL_RTC_TIME "Time"
      ITEM_HELP "Set the current time in the RTC"
    ITEM "B. Date "
      SPECIAL_RTC_DATE "Date"
      ITEM_HELP"Set the current date in the RTC"
    SKIP_LINE
    ITEM "C. Motherboard I/O Device Configuration"
      GOTO_MENU io_menu
      ITEM_HELP "Set addresses for motherboard devices"
    SKIP_LINE
    ITEM "L. Load Defaults"
      DO_FUNCTION load_defaults
      ITEM_HELP "Load Default Values"
    SKIP_LINE
    ITEM "S. Save Values Without Exit"
      LABEL_ITEM no_exit_save
      DO_FUNCTION save_changed_values
    ITEM_HELP "Saved the changed values (if any) to CMOS"
    ITEM "Q. Exit Without Save"
      DO_FUNCTION exit_no_save
      ITEM_HELP "Exit without saving changes."
      LONG_HELP "Exit without saving any changes except for Date And Time. "
    ITEM "X. Save values and Exit"
      DO_FUNCTION exit_with_save
      ITEM_HELP "Save all changes and Exit"
      LONG_HELP "Save all changed values and then re-boot the system "
      LONG_HELP "in order that the changed values will take effect."
  MENU io_menu,"Motherboard I/O Device Configuration",3,1,25,80,NO_DIRECT
    ITEM "Serial Port A: "
      ITEM_HELP "Configure the 1st on-board UART"
      LABEL_ITEM uart1_port
      FIELD_DEF TOKEN,TOKEN_UART1_CONFIG,UART_CONFIG_WIDTH,1 or ZERO_OK
        CHOICE"Disabled",TVALUE_UART_CONFIG_DIS
        CHOICE"0x3f8 IRQ 4",TVALUE_UART_CONFIG_3F8
        CHOICE"0x2f8 IRQ 3",TVALUE_UART_CONFIG_2F8
        CHOICE"0x3e8 IRQ 4",TVALUE_UART_CONFIG_3E8
        CHOICE"0x2e8 IRQ 3",TVALUE_UART_CONFIG_2E8
    ITEM "Serial Port B: "
      ITEM_HELP "Configure the 2nd on-board UART"
      LABEL_ITEMuart2_port
      FIELD_DEF TOKEN,TOKEN_UART2_CONFIG,UART_CONFIG_WIDTH,1 or ZERO_OK
        SAME_CHOICES
    SKIP_LINE
    ITEM "TV Horizontal Position: "
      LABEL_ITEM tv_hpos
      FIELD_DEF TOKEN,TOKEN_TV_HPOS,TV_HPOS_WIDTH
        RANGE"TV Horizontal Position (0-255) ",DECIMAL,0,255
END_MENU
```

18.9.2.2 Macro Reference

INIT_MENU

INIT_MENU must be the first entry. It initializes the internal variables needed for the menu system.

MENU name,title,ul,uc,lr,lc,flags

This entry defines a menu screen.

Parameters	Description
name	The name of the menu.
title	The title of the menu displayed on the top border line of the menu.
ul	The location of this menu's top row on the screen~~.~~
uc	The location of this menu's leftmost column on the screen.
lr	The location of this menu's bottom row on the screen.
lc	The location of this menu's rightmost column on the screen.
flags (optional)	Any special flags required for this menu. Valid Flags are: • NO_DIRECT - If present, this flag suppresses the direct selection of a menu item by typing the first character of the item name. • TOP_MENU - If present, this flag declares this menu to be the "Top Menu". The TOP_MENU flag modifies the exit functionality of the menu where the escape key is no longer functional as a direct exit. Instead, a dialog displays a selection of "SAVE" or "QUIT". The next step is to exit setup and the selection instructs setup to save or ignore the selections made during the current session.

When this entry is processed, the menu is assigned an ordinal number. The first menu is ordinal 0 and each subsequent menu is assigned the next number in sequence. This ordinal is made PUBLIC as ORDINAL_name. This may be used by user functions to determine the menu being processed.

The address of the menu definition entry is also made PUBLIC in the form LABEL_name. This label may be used by user functions to alter various parts of the menu definition. Use with extreme care as there is no error checking of altered entries.

SKIP_LINE

SKIP_LINE places a blank line on the screen and forces the next item to appear one line down from where it would normally be placed. This item only has an effect if the row entry in the item entry is omitted.

ITEM name,row,col,flags

This entry defines an item.

Parameters	Description
name	The text placed on the menu window at the given row and column.
row (optional)	The row of the menu window where the item is placed. If omitted, the item is placed on the line after the last defined item, or if this is the first item, line two is used.
col (optional)	The column of the menu screen where the item is placed. If "col" is omitted, the name or text item is placed in the same column as the previous entry. If this menu item is the first entry in a menu, the default starting column for this entry is column 2. If col is provided, it becomes the default starting column for all following entries in the current menu.
flags	Contains flags that modify the default behavior of this item: • NO_SELECT - Do not allow this item to be selected. • NO_DISPLAY - Do not display this item. The item appears as a blank line on the Menu. • GRAY_OUT - Display this item in low intensity. Normally combined with NO_SELECT. • BOLD - Display this item in high intensity.

LABEL_ITEM user_label

Labels the current item with the user label and makes the following information PUBLIC:

- LABEL_ITEM_user_label - The label of the item entry definition for the current item.
- ITEM_MENU_ORDINAL_user_label - The ordinal of the menu containing the item.
- ITEM_ORDINAL_user_label - The ordinal of the item within the menu.

ITEM_HELP help_text

Defines the help text that appears on the bottom line of the menu screen when this item is highlighted. Help text must consist of only one line and be no wider than the menu screen. The help text starts in column two of the menu screen. There may be only one ITEM_HELP line for each item.

LONG_HELP long_help_text

Defines one line of a long help displayed when the F1 key is pressed while an item is highlighted. There may be more than one LONG_HELP line for the item. Each displays as a separate line in the long help screen. If there are more lines than fit on the long help screen, the user can scroll up and down using the PgUp and PgDown keys.

GOTO_MENU menu_name

Tells the system to display the menu specified by menu_name. Menu_name must be the same as a Name parameter of a MENU entry. In addition menu_name may be one of the following special entries:

- QUIT_TO_TOP - Exit to the menu with the TOP_MENU flag. If no menu has a TOP_MENU flag set, then exit the menu system.
- PREV_MENU - Go to the menu that called this menu.
- SAME_MENU - Stay on this menu.

DO_FUNCTION function_name

Tells the system that the function specified by function_name will be executed. The function is a ‘c’ function external to the smenu.asm file. This function cannot be used for an item containing the CHOICE or RANGE entries described on page 252. The prototype of the function is:

```
int function_name(int menu, int item);
```

Menu is the ordinal number of the menu that contains the item.

Item is the ordinal number of the item within the menu.

The function must return one of the following:

- Zero - The function had an error. An error beep will sound. No GOTO_MENU (if any was defined) will be executed.
- One - The function was successful. Any GOTO_MENU defined will be executed.
- Negative number - Exit up n levels of menu. A -1 will go up one menu.

FIELD_DEF field_type,field_name,length,conflict

Defines a field that is executed when the item is selected. There may be only one FIELD_DEF for an item.

Parameters	Description
field_type	Always the literal “TOKEN”
field_name	The NVRAM TOKEN this field acts upon.
length	The length of this field in bits.
conflict	Used for conflict checking. All fields with the same conflict number are compared for identical values. If identical values are found “?Conflict nn” is displayed next to all items with the same conflict number. (nn is the conflict number.) In addition, the flag “ZERO_OK” may be OR’ed in with the conflict number to indicate that multiple items with the value zero are not a conflict.

The following entries (CHOICE, SAME_CHOICES and RANGE) are mutually exclusive:

CHOICE prompt,value

Defines one of several choices for this field. Each time the item is selected, the system cycles to the next choice. There may be multiple CHOICE entries for a FIELD_DEFINITION.

Parameters	Description
prompt	Displayed next to the item when the value matches the current selected value.
value	The value for this choice.

SAME_CHOICES

Indicates this item has the same choices as the previous item.

RANGE prompt,type,lowvalue,highvalue

Indicates a data entry box will be displayed asking for the value to assign to this field. The value entered is checked to see if it is greater than or equal to the lowvalue, and less than or equal to the highvalue. If the value is valid, it is stored in the field. If the value is outside the range, it is not stored and an error beep will sound.

Parameters	Description
prompt	The prompt displayed for this item in the entry box.
type	The entry/display format desired. Values are: • DECIMAL – Entry is an unsigned decimal number • HEX – Entry is an unsigned number in hexadecimal format • Lowvalue –The lowest value allowed for this entry • Highvalue – The highest value allowed for this entry

SPECIAL_RTC_TIME prompt

A special entry indicating that the current item is the current time from the RTC. This item is continuously updated when it is on the current menu and that menu is the current displayed window. When this item is selected, an entry box opens requesting the new time to be entered (24-hour format).

This entry may be used only once in the smenu.asm file.

Parameters	Description
prompt	The prompt displayed for this item in the entry box.

SPECIAL_RTC_DATE prompt

This is a special entry indicating that the current item is the current date from the RTC. This item is continuously updated when it is on the current menu and that menu is the current displayed window. When this item is selected, an entry box opens requesting the new date to be entered (mm/dd/yyyy format).

This entry may be used only once in the smenu.asm file.

Parameters	Description
prompt	The prompt displayed for this item in the entry box.

COMMENT_ITEM iname,row,col

Defines a non-selectable item on the menu. This may be used for headings within a menu. It is the same as defining an item with the “NO_SELECT” flag.

Parameters	Description
name	The text placed on the menu window at the given row and column.
row (optional)	The row in the menu window where the item is placed. If omitted, the item is placed on the line after the last defined item. If the item is first, line two of the menu screen is used.
col (optional)	The column of the menu screen where the item or text is placed. If omitted, the item is placed in the same column as the previous entry. If this is the first entry in a menu, the default starting column is column 2. If col is provided, it becomes the default starting column for all following entries in the current menu.

SKIP_IF_NOT xx and END_SKIP xx

Special macros are used to remove code from the menu system for features not needed for a particular platform. These macros are used due to the fact that predefined code in SETMAIN.C may use an external function made PUBLIC by SMENU.ASM. These functions set a flag to preserve the PUBLICs in SMENU.ASM without generating code. Any LABEL_ is made PUBLIC as a NULL. Any ORDINAL_ is made PUBLIC as -1. The code in SETMAIN.C recognizes that no operations are to be performed on these entries.

xx is compared to 0 and, if = 0, turns on the skip flag. If xx is not zero, the skip flag is unchanged.

SKIP_IF_NOT and END_SKIP may be nested, but must not overlap. For example:

GOOD:

```
SKIP_IF_NOT A
                :
                :
                SKIP_IF NOT B
                :
                :
                END_SKIP B
                :
                END_SKIP A
```

WRONG!:

```
                SKIP_IF_NOT A
                :
                :
                SKIP_IF NOT B
                :
                END_SKIP A
                :
                :
                END_SKIP B
```

END_MENU

Closes out the menu definitions and performs final clean-up as needed. END_MENU is required as the final menu definition.

User Functions

The DO_FUNCTION functions are contained in the SETMAIN.C file, and may be modified by the user. The function is a ‘c’ function with a ‘c’ calling sequence. The prototype of the function is:

int function_name(int menu, int item);

- Where:
  - — Menu is the ordinal number of the menu that contains the item.
  - — Item is the ordinal number of the item within the menu.

The function must return one of the following:

- Zero – The function had an error. An error beep will sound. No GOTO_MENU (if any was defined) will be done.
- One – The function was successful. Any GOTO_MENU define will be done.
- Negative number – Exit up n levels of menu. A -1 will go up one menu.

Predefined Special User Functions

The following functions are pre-written, contained in the SETMAIN.C file, and may be called with the DO_FUNCTION macro.

load_current

Loads all fields with the current values from NVRAM for each token defined in a FIELD_DEF macro. Any value stored in a field is replaced. Unsaved values are lost.

This function always returns a 1.

- Function prototype: int load_current(int menu,int item);

load_defaults

Loads all fields with the default values of NVRAM for each token defined in a FIELD_DEF macro. Any value stored in a field is replaced.

This function always returns a 1.

- Function prototype: int load_defaults(int menu,int item);

save_changed_values

Loads all fields with the default values of NVRAM for each token. In addition, NVRAM is checksummed and the failed boot flag in NVRAM is cleared.

This function always returns a 1.

- Function prototype: int save_changed_values(int menu,int item);

exit_no_save

Brings up a question box asking if the user wants to exit without saving. If the user answers “no”, the function exits with a return code 1, keeping the same menu and item. If the user answers “yes”, the function exits with a -99, forcing setup to terminate. The system will then reboot.

- Function prototype: int exit_no_save(int menu,int item);

exit_with_save

Closes out the menu definitions and performs final clean-up as needed.

- Function prototype: int exit_with_save(int menu,int item);

get_mem_stuff

Reads the MC_MEM_CTRL1, MC_MEM_CTRL2, and the MC_SYNC_TIM1 registers, splits out the subfields, and sets the appropriate fields for MANUAL memory optimization.

This function always returns a 1.

- Function prototype: int get_mem_stuff(void);

19 Debugging

19.1 MTEST PINS:

MTEST is a Geode processor feature that generates special debug information used by hardware engineers to trace program execution. MTEST disables cache and DIMM1.

DO NOT enable this feature if you do not plan on using it.

19.2 GPCS#

The GPCS (General Purpose Chip Select) can be set to activate on I/O reads and writes to a 16-bit I/O location with a width of 1 to 32 bytes. This can be used to monitor Port 80h writes on a system that has no other way to provide access to I/O writes to Port 80h.

20 Build Utilities

This chapter discusses the usage of custom and off-the-shelf build utilities, each of which is required for building and debugging GeodeROM.

20.1 Custom Build Utilities by AMD

- X2ROM.EXE - Converts a .EXE file to a zero-based binary image.
- FLASHROM.COM - Updates the contents of a memory-mapped Flash ROM device.
- RLE.EXE - Compresses a file using a Run Length Encoding algorithm.
- BMPFLIP.EXE - Flips the order of the bytes that appear in the OEM splash screen bitmap file.
- CPRPAD.EXE - Pads out the concatenated rle files to 192 KB.
  - which.pl - a perl implementation used to locate from where files are being executed (downloaded from: http://language.perl.com/ppt/what.html).
  - buildtool.pl - a perl script used by the build to generate the date and time of the build to be used in the display screen. It maintains the file userdir.txt that ensures all files are rebuilt correctly when building from different user directories.
- ROMPAD.EXE - Adjusts a ROM image to be 64 KB in size, padding the file with FFhs at the beginning.
- BINCOPY.EXE - Concatenates files together from a list of files.

20.1.1 X2ROM.EXE – .EXE to .ROM Conversion Utility Version 1.0

Converts a .EXE file to its zero-based, .ROM equivalent. As part of this conversion process, X2ROM performs the following sequence of operations on the .EXE file:

1) Calculates the binary image size based on information within the .EXE header.
2) Strips off .EXE relocation header.
3) Pads the file with trailing FFh bytes according to the user-specified size argument.
4) Prepends the file with leading FFh bytes if the user has so specified.
5) Checksums the file image and places the checksum in the last location.
6) Writes the resulting binary file image to the user-specified filename.

Additionally, X2ROM.EXE provides a mode compatible with DOS.

Example of usage:

```
X2ROM filename      /F:xxxx      /O:xxxx      /S:xxxx      /V     /X     /Y
```

Filename = .EXE file to convert (No Extension):

/F:xxxx	= Hex fixup segment	– Default F000h
/O:xxxx	= Hex code origin in .ROM	– Default 0
/S:xxxx	= Hex size .ROM to make	– Hex size .ROM to make
/V	= Verbose	– Default OFF
/X	= EXE2BIN mode	– Default OFF
/Y	= EXE2BIN mode w/padding	– Default OFF

The usage for each command line parameter is as follows:

```
X2ROM.EXE – .EXE to .ROM file conversion utility version 1.0
Magic number:                 5A4Dh
Bytes on last page:           01E4h
Pages in file:                0008h
Relocations:                  0000h
Paragraphs in header:         0020h
Extra paragraphs needed:      0000h
Extra paragraphs wanted:      FFFFh
Initial stack location:       0000:0000h
Word checksum:                0000h
Entry point:                  0000:0000h
Relocation table address:     001Eh
Memory Needed:                4 KB
```

X2ROM.EXE – The “/F:xxxx” (Fixup Segment) Command Line Argument

The “/F” argument is used to “fix” far (segment:offset) links within the .EXE file with the hexidecimal value xxxxh supplied by the developer. Segment fix-ups are typically supplied by DOS’ .EXE loader, however, this loader is unavailable to ROM modules and therefore must be supplied by the developer during the build process. Also, a ROM module in need of a fix-up is normally (but not always) indicative of a problem with the code’s structure.

X2ROM.EXE – The “/O:xxxx” (Code Origin) Command Line Argument

The “/O” argument is used to move the code origin in the resulting .ROM output file from offset 0 to the caller-specified offset xxxxh. This option is used to “pad” the beginning of the .ROM output file with FFh bytes if so desired. It saves the developer from having to create an additional utility to prepend “empty” space to the end of the .ROM output file.

X2ROM.EXE – The “/S:xxxx” (Code Size) Command Line Argument

The “/S” argument is used to specify the size, in bytes, of the resulting .ROM output file. Unless executing in EXE2BIN mode (described below), X2ROM.EXE calculates the 2’s complement of the binary ROM image and places the checksum value at offset xxxxh – 1 within the resulting .ROM output file. It is the responsibility of the developer to ensure the placement of this checksum byte does not overwrite, or in any way affect the operating of the code within the ROM image.

X2ROM.EXE – The “/V” (Verbose Output) Command Line Argument

The “/V” argument is used to display information contained in the .EXE header. The format of this information is similar to that output by the Microsoft® EXEHDR.EXE utility. The following section displays the output information for a ROM-based keyboard handler. For an explanation of each field, consult a PC technical reference book, such as Raymond Duncan’s, “Advanced MS-DOS Programming”, available from Microsoft Press.

X2ROM.EXE – The “/X” (EXE2BIN Compatible) Command Line Argument

The “/X” option is used primarily to validate the X2ROM.EXE utility. When this argument is specified, X2ROM outputs a file with no checksum, nor any leading or trailing “pad” bytes. This is the same format as that output by the MS-DOS EXE2BIN utility. Therefore, X2ROM.EXE functionality can be checked by running X2ROM.EXE (with the “/X” option specified) and EXE2BIN.EXE on the same .EXE file and comparing the resulting output files. Note that the “/X” option cannot be used in conjunction with the “/O” or “/S” command line switches, nor can it be used in conjunction with the “/Y” option, which is described in the next section.

X2ROM.EXE – The “/Y” (EXE2BIN Mode w/Padding) Command Line Argument

The “/Y” option is identical in nature to the “/X” option described in the previous section, except it causes X2ROM to “round up” the file size to the next paragraph boundary, and pads the trailing paragraph of the output file with FFh bytes.

20.1.2 FLASHROM.COM – Flash ROM Device Update Utility

FLASHROM.COM is used to update the contents of a Flash ROM device with a new version of GeodeROM or equivalent boot loader.

Example of usage:
"FlashROM file_name" [Flash & clear CMOS]

The following displays the command line options supported by versions 8.00 and newer of FLASHROM.COM:

```
FlashROM: Version 8.11
Platform = unknown/unknown

FlashROM:   Version 8.11
FlashROM flash updates Geode-based systems that have one of the following ROMs installed:
```

AMD	28F020	29F200	29F020N	29F002(N)(T)
Atmel	29C020	29C040A	49F020	29LV020
MXIC	28F2000P	28F2000TP		
SST	29F002T	29F002B		
SST	29EE020	29LE020		
Intel	28F020			
Fujitsu	29F200T			
Winbond	29C020			

Options:

```
FlashROM    file_name    /D"    Flash & don't clear CMOS
FlashROM    file_name    /N"    No messages
FlashROM    file_name    /R"    Read ROM and write to file
FlashROM    /C"                 Clear CMOS only]
FlashROM    /I"                 ID ROM]
FlashROM    /?"                 [This message
```

FLASHROM.COM – The "/D" Command Line Argument

The "/D" command line argument prevents FLASHROM.COM from clearing the contents of the RTC CMOS RAM following the completion of the Flash ROM update. This argument is required if the caller wants to preserve the current CMOS settings when updating the system Flash ROM device.

FLASHROM.COM – The "/N" Command Line Argument

The "/N" option prevents FLASHROM.COM from displaying sign-on/status messages during the Flash update procedure.

FLASHROM.COM – The "/R" Command Line Argument

The "/R" option instructs FLASHROM.COM to read the contents of the Flash device into the file "file_name" as specified by the user. FLASHROM determines the size of the output file by first "ID"-ing the installed Flash part and retrieving its size from an internal table.

FLASHROM.COM – The "/C" Command Line Argument

The "/C" option instructs FLASHROM to clear the contents of the RTC CMOS RAM. This feature is useful for enabling options that have been newly introduced to the system firmware and would otherwise not get enabled automatically. The "/C" option can be used in conjunction with any command line option other than "/D" (Don't clear CMOS RAM).

FLASHROM.COM – The "/I" Command Line Argument

The "/I" option instructs FLASHROM.COM to display the manufacturer and type of installed Flash ROM device.

20.1.3 RLE.EXE – Run Length Encoded Compression Utility

RLE.EXE is used to compress code/data modules intended for inclusion in an GeodeROM firmware component image.

RLE: Version 1.30
Run Length Encoding utility

Example of usage:

RLE filename		[Run length encodes filename, finds best fit]
RLE filename	/A:xxxx	[xxxx = phys dest address (DWORD)]
RLE filename	/C:x	[x = forced compression mode (0,1,2)
RLE filename	/D:x	[x = forced decompression mode(0,1,2)]
RLE filename	/B	[Make header a $BMP not $IMG]

The files RLE generates are:

- RLE.CMP [Compressed version of filename]
- RLE.EXP [Decompressed version of RLE.CMP (i.e., same as filename)]
- RLE.HDR [Header information plus the RLE.CMP file]

Normally, the operation of RLE.EXE is embedded in “makefiles and is transparent to the developer. The following section details each command line argument that RLE.EXE supports:

RLE.EXE – The “/A” Command Line Argument

The “/A:xxxxxxxx” argument instructs RLE.EXE to insert the physical address xxxxxxxxh in the header that it prepends to the compressed image. This address specifies the location where the companion decompression code, within the boot loader, inserts the decompressed code or data module.

RLE.EXE – The “/C” Command Line Argument

The “/C:x” argument instructs RLE.EXE to use the caller-specified compression mode. By default, RLE.EXE tries each compression method and uses the most optimal. The “/C:x” argument allows the caller to override the optimal method and use method n (where n=[0, 1, 2 …] instead. This command line switch is used primarily to test RLE.EXE.

RLE.EXE – The “/D” Command Line Argument

The “/D:x” argument instructs RLE.EXE to use the caller-specified decompression mode. By default, RLE.EXE decompresses a file based on the compression mode indicator that RLE.EXE placed in the compressed file information header when the file was originally compressed. The “/D:x” argument allows the caller to override the method contained in the compression information header and use method n (where n=[0, 1, 2 …] instead. This command line switch is used primarily to test RLE.EXE.

RLE.EXE – The “/B” Command Line Argument

The “/B” command line argument instructs RLE.EXE to embed the string “$BMP” (rather than “$IMG”) in the file’s compression information header. This argument is used when the source file is a bit-map rather than a code or data image. The primary use of this argument is to simplify the GeodeROM device’s search for the system’s splash screen image during the power-on sequence. Table 20-1 details the format of the information header that RLE.EXE prepends to each compressed code or data image.

Table 20-1. Information Header Format

Offset	Description
00h	‘$IMG’ or ‘$BMP’ image type identification string
04h	Compression mode (0 = byte count, 1 = word count, 2 = dword count)
05h	Physical address at which to decompress the image
09h	Length of code/data image file prior to compression
0Dh	Length of code/data image file following compression
11h	Checksum of compressed file
15h	Start of compressed data

20.1.4 BMPFLIP.EXE – Windows .BMP File Conditioning Utility

BMPFLIP.EXE is used during the code build process to flip the order of bytes that appear in the OEM splash screen bitmap file. The resulting bitmap file contains the original image in a format more easily displayed by the GeodeROM component power-on code.

Example of usage:
bmpflip [in.bmp] [outfile] [width] [height]

Normally, BMPFLIP is executed automatically from the makefile and is never invoked directly by the developer.

20.1.5 CPRPAD.EXE – Compressed ROM Pad Utility

CPRPAD.EXE is used during the code build process to "pad" the CPR "Compressed ROM" image to 192 KB by adding FFh bytes to the beginning of this image. The GeodeROM component is structured such that any components other than the boot loader reside in compressed form in the 192 KB region between FFFC0000h and FFFEFFFFh. The boot loader occupies the remaining 64 KB of Flash ROM address space starting at FFFF0000h.

Example of usage:
CPRPAD [filename.cpr]

Filename.cpr is the name of both the input and output files. Normally, CPRPAD is executed automatically by the makefile and requires no intervention by the developer.

20.1.6 ROMPAD.EXE – Boot Loader Image Pad Utility

ROMPAD.EXE is used during the GeodeROM component build process to condition the 64 KB boot loader image that resides in the traditional system BIOS space at F000:0h. ROMPAD prepends FFh bytes to the GeodeROM component boot loader to ensure the file is exactly 64 KB in length.

Example of usage:
ROMPAD [filename.rom]

Filename.rom is the name of both the input and output files.

Normally, ROMPAD is executed automatically by the makefile and requires no intervention by the developer.

20.1.7 BINCOPY.EXE

Concatenates a group of files into one.

Example of usage:
bincopy [file.lst]

File.lst contains the destination file on a single line followed by full/relative files to add to destination file, each on a separate line.

Example file.lst

- OUTPUT.BIN
- PART1.ROM
- C:\WINDOWS\PART2.ROM
- D:\TEMP\PART3.DOC

Normally, BINCOPY is executed automatically by the makefile and requires no intervention by the developer.

20.2 Off-The-Shelf Build Utilities

This section lists those widely available build utilities required for building the GeodeROM component. A brief description accompanies each utility program's name.

- PERL.EXE – "PERL" language interpreter for creating the platform-specific RULES.MAK script.
- MASM 6.11c or greater. This is a commercial product that must be purchased separately.
  - Upgrade to 6.14: ftp://ftp.microsoft.com/softlib/mslfiles/ML614.EXE
  - ML.EXE 6.11c or greater
  - ML.EXE is the assembler
  - H2INC.EXE – version 6.12a comes with MASM 6.11
  - H2INC translates the msvc style .h files to the masm style .inc files
- MSVC 1.52. This is a commercial product that must be purchased separately. Newer versions do not work correctly as they are 32-bit, not 16-bit compilers.
  - CL.EXE – version 8.00c
  - CL is the C compiler
  - LINK.EXE - Version 5.60.339 comes with MSVC152(link 5.31.009 comes with MASM6.11). Link combines all the object code from libraries and object files, resolves the named resources, and builds an executable file. Update to 5.60.339: ftp://ftp.microsoft.com/softlib/MSLFILES/LNK563.EXE
- NMAKE.EXE - 1.40 or greater (1.20 is included with MASM 6.11 – the upgrade is needed to build)
  - Nmake is used to build & rebuild the project
  - Update to 1.50: ftp://ftp.microsoft.com/softlib/mslfiles/NMAKE15.EXE
- LIB.EXE – Version 3.20.010 or greater (comes with both msvc 1.52 and masm 6.11)
  - LIB creates standard libraries, import libraries, and export files that can be used with link.exe

A Revision History

This document is a report of the revision/creation process of the *AMD Geode™ GeodeROM Functional Specification.* Any revisions (i.e., additions, deletions, parameter corrections, etc.) are recorded in the table(s) below.

Table A-1. Revision History

Revision # (PDF Date)	Revisions / Comments
1.0 (7/27/01)	Release 1.0
1.1 (1/02/02)	Minor changes.
A (August 2004)	Many engineering changes.
B (June 2005)	Changed all references of XpressROM to GeodeROM and added LX processor as being supported.
C (March 2006)	Removed “Confidential” from document.

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