May 28, 1991

To: X3T9.2 Attendees

Subject: Proposed additions/changes to ATA Document
          Rev 2.3 to support removable media drives.

From: Patrick Manley   SyQuest Technology

    Attached you will find a copy of proposed changes and
additions to the ATA (AT Attachment) Rev 2.3

The changes are to the following sections.

    7.2.9 Error Register

    8.4 Error Posting

    9.0 Command Descriptions

    Table 9-1: Command Codes and Parameters

    9.4 Identify Drive

    TABLE 9-3: Identify Drive Information

    9.4.1

    Addition of sections
    9.28 to 9.32

The portion labeled IDE Interface Supplement is not
part of the changes . It is for your information in
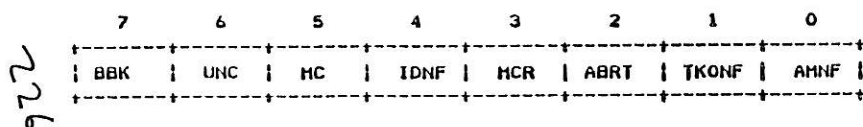support of the changes.

The errors that are valid for each command are defined in Table 8-1. It is
not a requirement that all valid conditions be implemented. See 7.2.9 and
7.2.13 for the definition of the Error Register and Status Register bits.

Changes to the ATA document

Section 7.2.9

7.2.9 Error Register

This register contains status from the last command executed by the
drive or a Diagnostic Code.

At the completion of any command except Execute Drive Diagnostic, the
contents of this register are valid when ERR=1 in the Status Register.

Following a power on, a reset, or completion of an Execute Drive
Diagnostic command, this register contains a Diagnostic Code (see
Table 9-2).

```
   7      6      5      4      3      2      1      0
+------+------+------+------+------+------+------+------+
| BBK  | UNC  |  MC  | IDNF | MCR  | ABRT | TKONF| AMNF |
+------+------+------+------+------+------+------+------+
```

- BBK (Bad Block Detected) indicates a bad block mark was detected in
  the requested sector's ID field.
- UNC (Uncorrectable Data Error) indicates an uncorrectable data
  error has been encountered.

-MC(Media Changed)indicates that the media has been changed.
  A transition from Media not ready to ready.

- IDNF (ID Not Found) indicates the requested sector's ID field could
  not be found.

-MCR(Media Change Requested) The Door button on a Removable Media
  Drive has been pressed. Indicating the operator's wish to
  remove the Media.
  This may require some program to issue a Media eject command
  or a door unlock command.

- ABRT (Aborted Command) indicates the requested command has been
  aborted due to a drive status error (Not Ready, Write Fault, etc.)
  or because the command code is invalid.
- TKONF (Track 0 Not Found) indicates track 0 has not been found
  during a Recalibrate command.
- AMNF (Address Mark Not Found) indicates the data address mark has
  not been found after finding the correct ID field.

TABLE 8-2: REGISTER CONTENTS

	BBK	UNC	MC	IDNF	MCR	ABRT	TKO NF	AM NF	DRDY	DWF	DSC	CORR	ERR
Check Power Mode						v			v	v	v		v
Execute Drive Diags			See 9.2										v
Format Track			v	v		v			v	v	v		v
Identify Drive						v			v	v	v		v
Idle						v			v	v	v		v
Idle Immediate						v			v	v	v		v
Initialize Drive Params			v			v			v	v	v		v
Recalibrate			v			v	v		v	v	v		v
Read Buffer			v			v			v	v	v		v
Read DMA	v	v	v	v		v		v	v	v	v	v	v
Read Long	v	v	v	v		v		v	v	v	v		v
Read Multiple	v	v	v	v		v		v	v	v	v		v
Read Sector(s)	v	v	v	v		v		v	v	v	v	v	v
Read Verify Sector(s)	v	v	v	v		v		v	v	v	v	v	v
Seek			v	v		v			v	v	v		v
Set Features						v			v	v	v		v
Set Multiple Mode			v			v			v	v	v		v
Sleep						v			v	v	v		v
Standby			v			v			v	v	v		v
Standby Immediate			v			v			v	v	v		v
Write Buffer			v			v			v	v	v		v
Write DMA	v		v	v		v			v	v	v		v
Write Long	v		v	v		v			v	v	v		v
Write Multiple	v		v	v		v			v	v	v		v
Write Same	v		v	v		v			v	v	v		v
Write Sector(s)	v		v	v		v			v	v	v		v
Write Verify	v	v	v	v		v		v	v	v	v	v	v
Acknowledge Media Chng						v							
Pre boot command						v							
Door unlock						v							
Door lock					v	v			v				
Post boot						v							
Invalid Command Code						v	v		v	v	v		v

v = valid on this command

9. Command Descriptions

Commands are issued to the drive by loading the pertinent registers in the command block with the needed parameters, and then writing the command code to the Command Register.

The manner in which a command is accepted varies. There are three classes (see Table 9-1) of command acceptance, all predicated on the fact that to receive a command, BSY=0:

- Upon receipt of a Class 1 command, the drive sets BSY within 400 nsec.
- Upon receipt of a Class 2 command, the drive sets BSY within 400 nsec, sets up the sector buffer for a write operation, sets DRQ within 700 usec, and clears BSY within 400 nsec of setting DRQ.
- Upon receipt of a Class 3 command, the drive sets BSY within 400 nsec, sets up the sector buffer for a write operation, sets DRQ within 20 msec, and clears BSY within 400 nsec of setting DRQ.

NOTE: DRQ may be set so quickly on Class 2 and Class 3 that the BSY transition is too short for BSY=1 to be recognized.

The drive shall implement all mandatory commands as identified by an M, and may implement the optional commands identified by an O, in Table 9-1. V indicates a Vendor Specific command code.

If a new command is issued to a drive which has an uncompleted command (subsequently referred to as Old_Command) in progress, the drive shall immediately respond to the new command (Subsequently referred to as New_Command), even if execution of the Old_Command could have been completed.

There shall be no indication given to the system as to the status of the Old_Command which was being executed at the time the New_Command was issued.

TABLE 9-1: COMMAND CODES AND PARAMETERS

Class		Command Code	FR	SC	SN	CY	DH
1	Check Power Mode	98h E5h		y			D
1	Execute Drive Diagnostic	90h					Dv
2	Format Track	50h	v	y		y	y
1	Identify Drive	ECh					D
1	Idle	97h E3h		y			D
1	Idle Immediate	95h E1h					D
1	Initialize Drive Parameters	91h		y			y
1	Recalibrate	1xh					D
1	Read Buffer	E4h					D
1	Read DMA (w/retry)	C8h		y	y	y	y
1	Read DMA (w/o retry)	C9h		y	y	y	y
1	Read Multiple	C4h		y	y	y	y
1	Read Sector(s) (w/retry)	20		y	y	y	y
1	Read Sector(s) (w/o retry)	21		y	y	y	y
1	Read Long (w/retry) See 9.13	22		y	y	y	y
1	Read Long (w/o retry) See 9.13	23		y	y	y	y
1	Read Verify Sector(s) (w/retry)	40		y	y	y	y
1	Read Verify Sector(s) (w/o retry)	41		y	y	y	y
1	Seek	7xh			y	y	y
1	Set Features	EFh	y				D
1	Set Multiple Mode	C6h		y			D
1	Set Sleep Mode	99h E6h					D
1	Standby	96h E2h		y			D
1	Standby Immediate	94h E0h					D
2	Write Buffer	E8h					D
3	Write DMA (w/retry)	CAh		y	y	y	y
3	Write DMA (w/o retry)	CBh		y	y	y	y
3	Write Multiple	C5h	v	y	y	y	y
3	Write Same	E9h	y	y	y	y	y
2	Write Sector(s) (w/retry)	30	v	y	y	y	y
2	Write Sector(s) (w/o retry)	31	v	y	y	y	y
2	Write Long (w/retry)	32	v	y	y	y	y
2	Write Long (w/o retry)	33	v	y	y	y	y
3	Write Verify	3Ch	v	y	y	y	y
	Vendor Unique	9Ah					
	Vendor Unique	C0-C3h					
	Acknowledge Media Change	0Bh					D
	Pre boot command	0Ch					D
	Door unlock	0Dh					D
	Door lock	0Eh					D
	Post boot	0Fh					D
	Vendor Unique	0xh					
	Vendor Unique	F0h-FFh					
	Reserved: All remaining codes						

```
+----------------------------------------------------+
| CY = Cylinder Registers      SC = Sector Count Register |
| DH = Drive/Head Register     SN = Sector Number Register |
| FR = Features Register (see command descriptions for use) |
| y - the register contains a valid parameter for this command. |
|     For the Drive/Head Register, y means both the drive and |
|     head parameters are used.                      |
| D - only the drive parameter is valid and not the head parameter. |
| Dm - Addressed to Drive 0 but both drives execute it. |
| m - Maintained for compatibility (see 7.2.9)       |
+----------------------------------------------------+
```

9.4 Identify Drive

The Identify Drive command enables the host to receive parameter information from the drive. When the command is issued, the drive sets BSY, stores the required parameter information in the sector buffer, sets DRQ, and generates an interrupt. The host then reads the information out of the sector buffer. The parameter words in the buffer have the arrangement and meanings defined in Table 9-3. All reserved bits or words shall be zero.

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TABLE 9-3: IDENTIFY DRIVE INFORMATION

Word	
0	General configuration bit-significant information:
	15 0 reserved for non-magnetic drives
	14 1=format speed tolerance gap required
	13 1=track offset option available
	12 1=data strobe offset option available
	11 1=rotational speed tolerance is > 0.5%
	10 1=disk transfer rate > 10 Mbs
	9 1=disk transfer rate > 5Mbs but <= 10Mbs
	8 1=disk transfer rate <= 5Mbs
	7 1=removable cartridge drive
	6 1=fixed drive
	5 1=spindle motor control option implemented
	4 1=head switch time > 15 usec
	3 1=not MFM encoded
	2 1=soft sectored
	1 1=hard sectored
	0 0=reserved
1	Number of cylinders
2	reserved
3	Number of heads
4	Number of unformatted bytes per track
5	Number of unformatted bytes per sector
6	Number of sectors per track
7-9	Vendor Unique
10-19	Serial number (20 ASCII characters, 0000h=not specified)
20	Buffer type
21	Buffer size in 512 byte increments (0000h=not specified)
22	# of ECC bytes passed on Read/Write Long cmds (0000h=not spec'd)
23-26	Firmware revision (8 ASCII characters, 0000h=not specified)
27-46	Model number (40 ASCII characters, 0000h=not specified)
47	15-8 Vendor Unique
	7-0 00h = Read/Write Multiple commands not implemented
	xxh = Maximum number of sectors that can be transferred
	per interrupt on Read and Write Multiple commands
48	0000h = cannot perform doubleword I/O
	0001h = can perform doubleword I/O
49	Capabilities
	15-9 0=reserved
	8 1=DMA Supported
	7-0 Vendor Unique
50	reserved
51	15-8 PIO data transfer cycle timing mode
	7-0 Vendor Unique
52	15-8 DMA data transfer cycle timing mode
	7-0 Vendor Unique
53-127	reserved
128-159	Vendor Unique
160-255	reserved

9.4.1 Number of cylinders

The number of translated cylinders in the default translation mode.

9.28   Acknowledge Media Change command (NEW)(Command code DBh)
If the drive is operating in SAFE mode, this command clears the media change error so normal operation can resume. If the drive is not in SAFE mode, this command returns with abort error.

9.29   Pre boot command (NEW) (Command code DCh)
This command is issued by the device driver or operating system prior to reboot of the system.This command will switch any removable drive (master or slave) from the normal operating mode to the boot response mode.
If the boot mode switch jumper is not installed this command will return an error of ABRT.

9.30   Door unlock command (NEW) (Command code DDh)
Command returns drive not ready if drive is not ready.
It unlocks door if drive is ready and locked.

9.31   Door lock command (NEW) (Command code DEh)
Command returns drive not ready if drive is not ready. It locks door if drive is ready and not locked. If drive is ready and locked, the BIOS shall check the door button and return a MRR(media removal requested) error if the button is pressed. This command provides a method of polling door button activity while the door is locked.

9.32   Post boot command (NEW) (Command code DFh)
Basically the drives may need to send false information to the BIOS if they are in a pre bootmode to pass the diagnostics. See attached for further explanation.

SyQuest has defined a few new IDE DISK COMMANDS, ERROR CODES and DRIVE MODE SWITCHES to support removable IDE drive(s).

1.   New error code MEDIA CHANGE DETECTED (NEW)
Bit 5 of the error register will be used to indicate this condition. This bit should be returned with the result of any drive command. If the drive is operating in SAFE mode (to be explained later),this error will not be cleared until a special command is send to the drive. It is posted only once if the drive is not in SAFE mode.

2.   New error code MEDIA CHANGE REQUESTED (NEW)
Bit 3 of the error register will be used to indicate this condition. This bit is set when the Door button is pressed and certain other conditions are met.
1. In response to a door lock command on a drive with the door already locked.
2. If by a Vendor Unique command the drive is told to interrupt when the door button is pressed. (this mode requires an interrupt handler)
See below for when this bit is set.

3.   Door lock command (NEW) (Command code DEh)
Command returns drive not ready if drive is not ready. It locks door if drive is ready and not locked. If drive is ready and locked, the BIOS shall check the door button and return a MRR(media removal requested) error if the button is pressed. This command provides a method of polling door button activity while the door is locked.

4.   Door unlock command (NEW) (Command code DDh)
Command returns drive not ready if drive is not ready.
It unlocks door if drive is ready and locked.

5.   Identify Drive Command
SyQuest would like Word 2 renamed from Number of Fix cylinders to Number of cylinders and use bit 7 of Word 1 = 1 to indicate this is a removable drive.
For BIOS vendor who would like to modify their code to accommodate a removable media IDE drive,they should incorporate the above .commands in the INT13 interface. In addition, they should change the FIX DISK diagnostic to allow for not installing the cartridge at boot time.
For customers who use BIOS that do not support removable drives they can either use a device driver to handle the removable drives, or they can use a removable drive the same way as a fix drive. That is, they have to reboot after changing media.
In addition to the above, and because of the way existing BIOSs diagnose the drives, if a user does not install his media at boot time, he will normally get a 178x error, and he may need to press the F1 key in order to continue booting. This can be avoided if two more commands are implemented by the drives and used by a device driver. The two commands are:

6.   Pre boot command (NEW) (Command code DCh)
See Definitions below

7.   Post boot command (NEW) (Command code DFh)
    Basically the drives may need to send false information to the
BIOS if they are in a pre bootmode to pass the diagnostics.
See Definitions below

8.   Acknowledge Media Change command (NEW)(Command code DBh)
        If the drive is operating in SAFE mode, this command clears
the media change error so normal operation can resume.   If the
drive is not in SAFE mode, this command returns with abort error.

Definitions

    1.   Boot Mode Switch
        A removable jumper or other means must be provided on 'the
drive to indicate to the local microprocessor whether the drive
will be booted with the preboot and postboot modes enabled. This
feature is for systems with mother board BIOS's which do not
support removable drives.This modifies the sequences of drive
letters installed under DOS.
    2.   Safe Mode Switch
        A removable jumper or other means will be provided on the
drive to make it operating in SAFE mode. When the drive is in
safe mode, media change must be acknowledged by the operating
system.in other words, after a media change took place, the drive
will not allowed any reads or writes until a acknowledge command
is received by the drive.
    3.   Post Boot Mode
        A new drive command needs to be defined to allow a device
driver or operating system to notify the drive that the boot
sequence has been completed. The drive initially resets in the *
Boot Response Mode* if the DOS jumper (described in 1 above) is
present. This allows the installed drive to provide the necessary
responses to be properly installed by DOS. After the drive has
been installed by DOS and control passed to the device driver or
operating system this enables the drive to respond normally to
subsequent commands.
        If the boot mode switch jumper is not installed this command
will return an error of ABRT.
    4.   Pre Boot (PB) Mode
        This command is issued by the device driver or operating
system prior to reboot of the system.This command will switch any
removable drive (master or slave) from the normal operating
mode to the boot response mode.
        If the boot mode switch jumper is not installed this command
will return an error of ABRT.

5.   DOS Boot Response
        It is possible for a removable media drive(s) to either have
media installed or not have media installed in both the master or
slave drives at boot time. If the media is not installed at boot
time this will cause the drive not to be recognized by DOS or
result in DOS assigning an incorrect drive letter.   These
difficulties are avoided if the removable drive provides the
proper "BootResponse".

The following table provides the correct drive response to a
read for variables such as master/slave, disk installed and
Postboot (PB) command received.

Master/ Slave	PB Received	Media Installed	Appropriate Response
Master	no	no	Send false sector data
Master	no	yes	Send actual sector data
Master	yes	no	Send drive not ready
Master	yes	yes	Send actual sector data
Slave	no	no	Send false sector data
Slave	no	yes	send false sector data
Slave	yes	no	Send drive not ready
Slave	yes	yes	Send actual sector data

    Note: False Sector Data refers to any data pattern of
the correct length that does not end with 55AA hex (i.e. all
zeros). This is interpreted as a valid read by the host. Other
commands such as Read Verify must also return a correct response,
even with no media installed,until the "PB" command is received.