

Analysis of Hard Disk Drives: Initialization and Partitioning

In this article, the effects of Initialization and Partitioning operations on computer hard disk drives will be analyzed. A 518MB virtual hard drive (Figure 1.1) has been created and filled with values of '0x0F0F' for illustration purpose (Figure 1.2).




Figure 1.1: "Not Initialized" Disk.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00000000	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000010	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000020	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000030	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000040	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000050	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000060	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000070	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000080	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000090	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000000A0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000000B0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000000C0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000000D0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000000E0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000000F0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000100	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000110	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000120	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000130	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000140	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000150	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000160	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000170	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000180	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000190	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000001A0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000001B0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000001C0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000001D0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000001E0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
000001F0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000200	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00000210	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F

Sector 0 of 1076355 Offset: 10 = 15 Block:

Figure 1.2: All Signature Values with "0F".

1. Initializing the Disk

Right click on  and then click on "initialize disk" to perform an initialization. A MBR (Master Boot Record) will be written to sector 0. Within this sector (Figure 1.3):

- Offset 0 to offset 0x1B7: Boot Code, this occupies 440 bytes. The code may not exist on hard drives not being used as operating system boot devices.
- Offset 0x1B8 to offset 0x1BD: Hard drive unique identification code assigned by the computer.
- Offset 0x1BE to 0x1FD: 64 bytes DPT (Disk Partition Table).
- Offset 0x1FE: '0xAA55' is an MBR signature.

Only sector 0 is overwritten during this initialization process. All the other sectors remain as '0x0F0F'.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
00000000	33	C0	8E	D0	BC	00	7C	FB	50	07	50	1F	FC	BE	1B	7C	3Ã1D4 úP P ü%
00000010	BF	1B	06	50	57	B9	E5	01	F3	A4	CB	BD	BE	07	B1	04	¿ PW'á ó*É%±
00000020	38	6E	00	7C	09	75	13	83	C5	10	E2	F4	CD	18	8B	F5	8n u IÃ áóÍ Ið
00000030	83	C6	10	49	74	19	38	2C	74	F6	A0	B5	07	B4	07	8B	IÆ It 8,tó µ ' I
00000040	F0	AC	3C	00	74	FC	BB	07	00	B4	0E	CD	10	EB	F2	88	ä-< tü» ' Í èòI
00000050	4E	10	E8	46	00	73	2A	FE	46	10	80	7E	04	0B	74	0B	N èF s*pF I~ t
00000060	80	7E	04	0C	74	05	A0	B6	07	75	D2	80	46	02	06	83	I~ t ¶ u0IF I
00000070	46	08	06	83	56	0A	00	E8	21	00	73	05	A0	B6	07	EB	F IV è! s ¶ è
00000080	BC	81	3E	FE	7D	55	AA	74	0B	80	7E	10	00	74	C8	A0	%I>þ}Ust I~ tÈ
00000090	B7	07	EB	A9	8B	FC	1E	57	8B	F5	CB	BF	05	00	8A	56	· è0Iü WISÈ¿ IV
000000A0	00	B4	08	CD	13	72	23	8A	C1	24	3F	98	8A	DE	8A	FC	' Í r#IÃ\$?IIBIü
000000B0	43	F7	E3	8B	D1	86	D6	B1	06	D2	EE	42	F7	E2	39	56	C=ãIÑIÖ± ÒiB+ã9V
000000C0	0A	77	23	72	05	39	46	08	73	1C	B8	01	02	BB	00	7C	w#r 9F s , »
000000D0	8B	4E	02	8B	56	00	CD	13	73	51	4F	74	4E	32	E4	8A	IN IV Í sQOtN2ãI
000000E0	56	00	CD	13	EB	E4	8A	56	00	60	BB	AA	55	B4	41	CD	V Í eãIV `»ãU'Aí
000000F0	13	72	36	81	FB	55	AA	75	30	F6	C1	01	74	2B	61	60	r6IúUãu0óÁ t+a`
00000100	6A	00	6A	00	FF	76	0A	FF	76	08	6A	00	68	00	7C	6A	j j ýv ýv j h lj
00000110	01	6A	10	B4	42	8B	F4	CD	13	61	61	73	0E	4F	74	0B	j 'BIóÍ aas Ot
00000120	32	E4	8A	56	00	CD	13	EB	D6	61	F9	C3	49	6E	76	61	2ãIV í è0auÃInva
00000130	6C	69	64	20	70	61	72	74	69	74	69	6F	6E	20	74	61	lid partition ta
00000140	62	6C	65	00	45	72	72	6F	72	20	6C	6F	61	64	69	6E	ble Error loadin
00000150	67	20	6F	70	65	72	61	74	69	6E	67	20	73	79	73	74	g operating syst
00000160	65	6D	00	4D	69	73	73	69	6E	67	20	6F	70	65	72	61	em Missing opera
00000170	74	69	6E	67	20	73	79	73	74	65	6D	00	00	00	00	00	ting system
00000180	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00000190	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001B0	00	00	00	00	00	2C	44	63	C1	40	3D	0B	0F	0F	00	00	,DcÁ@=
000001C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	55	AA	Uã
00000200	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00000210	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	

Figure 1.3: Sector 0 after Initialization

2. Partitioning

There are three types of MBR partitions, namely: Primary DOS Partition, Extended DOS Partition and Non-DOS Partition. Each hard drive can have a maximum of 4 Primary DOS Partitions. Data stored in a Non-DOS partition is only accessible by Non-DOS based operating systems. Once the hard disk drive has been initialized, it can be partitioned into a number of usable areas. For illustration, a primary partition which has a capacity of 16MB is created without formatting (Figure 1.4). At the same time, the first partition table entry in DPT at sector 0 is written with the following data (Figure 1.5).

- Offset 0x01BE (1 byte): Boot indicator. '0x00' indicates that this partition is not bootable. If it were '0x80', the partition would be bootable. Right clicking on this partition and selecting "Make Partition as Active" will change the value at this address from '0x00' to '0x80'.
- Offset 0x01C2 (1byte): Partition type indicator.
- Offset 0x01C6 (4 bytes): Starting sector of current partition is sector 63 ('0x3F'; little-endian format used in FAT file system)
- Offset 0x1CA (4 bytes): 32067 ('0x7D43') usable sectors.

It also indicates that this partition starts from sector 63 to sector 32129 (= 63 + 32067).

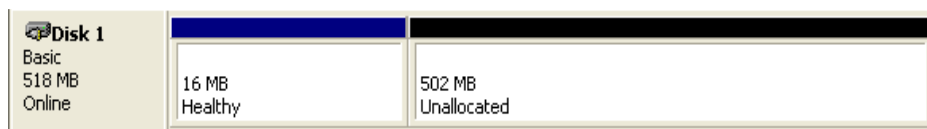


Figure 1.4: Creating a Primary Partition without Formatting.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
00000000	33	C0	8E	D0	BC	00	7C	FB	50	07	50	1F	FC	BE	1B	7C	3ÄIÐ¼ úP P ü%
00000010	BF	1B	06	50	57	B9	E5	01	F3	A4	CB	BD	BE	07	B1	04	¿ PW!á ó*É%±
00000020	38	6E	00	7C	09	75	13	83	C5	10	E2	F4	CD	18	8B	F5	8n u Á áóÍ ð
00000030	83	C6	10	49	74	19	38	2C	74	F6	A0	B5	07	B4	07	8B	!Æ It 8,tö µ '
00000040	F0	AC	3C	00	74	FC	BB	07	00	B4	0E	CD	10	EB	F2	88	á-< tü» ' Í èö
00000050	4E	10	E8	46	00	73	2A	FE	46	10	80	7E	04	0B	74	0B	N èF s*þF ~ t
00000060	80	7E	04	0C	74	05	A0	B6	07	75	D2	80	46	02	06	83	~ t ¶ uóIF
00000070	46	08	06	83	56	0A	00	E8	21	00	73	05	A0	B6	07	EB	F V è! s ¶ è
00000080	BC	81	3E	FE	7D	55	AA	74	0B	80	7E	10	00	74	C8	A0	¼ >þ}Uæt ~ tÈ
00000090	B7	07	EB	A9	8B	FC	1E	57	8B	F5	CB	BF	05	00	8A	56	· è@ü w ðÈ¿ V
000000A0	00	B4	08	CD	13	72	23	8A	C1	24	3F	98	8A	DE	8A	FC	' Í r# Á\$? !þ ü
000000B0	43	F7	E3	8B	D1	86	D6	B1	06	D2	EE	42	F7	E2	39	56	C-ã Ñ Ö± ÖiB+á9V
000000C0	0A	77	23	72	05	39	46	08	73	1C	B8	01	02	BB	00	7C	w#r 9F s , »
000000D0	8B	4E	02	8B	56	00	CD	13	73	51	4F	74	4E	32	E4	8A	N V Í sQOtN2á
000000E0	56	00	CD	13	EB	E4	8A	56	00	60	BB	AA	55	B4	41	CD	V Í èä V `»aU'Áí
000000F0	13	72	36	81	FB	55	AA	75	30	F6	C1	01	74	2B	61	60	r6 úU²u0öÁ t+a`
00000100	6A	00	6A	00	FF	76	0A	FF	76	08	6A	00	68	00	7C	6A	j j ýv ýv j h j
00000110	01	6A	10	B4	42	8B	F4	CD	13	61	61	73	0E	4F	74	0B	j 'B óÍ aas Ot
00000120	32	E4	8A	56	00	CD	13	EB	D6	61	F9	C3	49	6E	76	61	2ä V í èÖauÃInva
00000130	6C	69	64	20	70	61	72	74	69	74	69	6F	6E	20	74	61	lid partition ta
00000140	62	6C	65	00	45	72	72	6F	72	20	6C	6F	61	64	69	6E	ble Error loadin
00000150	67	20	6F	70	65	72	61	74	69	6E	67	20	73	79	73	74	g operating syst
00000160	65	6D	00	4D	69	73	73	69	6E	67	20	6F	70	65	72	61	em Missing opera
00000170	74	69	6E	67	20	73	79	73	74	65	6D	00	00	00	00	00	ting system
00000180	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00000190	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001B0	00	00	00	00	00	2C	44	63	C1	40	3D	0B	0F	0F	00	01	‚DcÁ@=
000001C0	01	00	06	FE	3F	01	3F	00	00	00	43	7D	00	00	00	00	þ? ? C}
000001D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	55	AA	Uª
00000200	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00000210	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	

Figure 1.5: Sector 0 after Creating a Primary Partition.

As well as the new partition record being written to the partition table at MBR at sector 0, sector 63 (starting sector of this partition) will also be cleared to '0x00' this pattern is reserved for a DBR (DOS Boot Record). The other sectors will remain as '0x0F' (as shown in Figure 1.6).

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00007E00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E40	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007E90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007EA0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007EB0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007EC0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007ED0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007EE0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007EF0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F40	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007F90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007FA0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007FB0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007FC0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007FD0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007FE0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00007FF0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008000	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
00008010	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F

Sector 63 of 1076355 Offset: 7E00 = 0 | Block:

Figure 1.6: Sector 63 after partitioning

An Extended DOS Partition is created in the rest of the drive as shown in Figure 1.7. As the first partition starts from sector 63 to sector 32129, the extended partition will start from sector 32130 to the end of the drive (sector 1076355 in this example).



Figure 1.7: Creating an Extended Partition.

The second table entry of the DPT at sector 0 is filled with the information about the extended partition. It has a partition type indicator of '0x05' which represents this is a DOS Extended Partition. Figure 1.8 shows that it starts from sector 32130 (0x00007D82) to sector 1060289.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
00000000	33	C0	8E	D0	BC	00	7C	FB	50	07	50	1F	FC	BE	1B	7C	3Ã D% úP P ü%
00000010	BF	1B	06	50	57	B9	E5	01	F3	A4	CB	BD	BE	07	B1	04	ì PW+á óPÉ% ±
00000020	38	6E	00	7C	09	75	13	83	C5	10	E2	F4	CD	18	8B	F5	8n u Á áóÍ Ö
00000030	83	C6	10	49	74	19	38	2C	74	F6	A0	B5	07	B4	07	8B	Æ It 8,tö µ ´
00000040	F0	AC	3C	00	74	FC	BB	07	00	B4	0E	CD	10	EB	F2	88	ä-< tü» ´ Í èò
00000050	4E	10	E8	46	00	73	2A	FE	46	10	80	7E	04	0B	74	0B	N èF s*bF ~ t
00000060	80	7E	04	0C	74	05	A0	B6	07	75	D2	80	46	02	06	83	~ t % uò F
00000070	46	08	06	83	56	0A	00	E8	21	00	73	05	A0	B6	07	EB	F V è! s % è
00000080	BC	81	3E	FE	7D	55	AA	74	0B	80	7E	10	00	74	C8	A0	% >þ}U±t ~ tÈ
00000090	B7	07	EB	A9	8B	FC	1E	57	8B	F5	CB	BF	05	00	8A	56	· è@ ü W öÈè V
000000A0	00	B4	08	CD	13	72	23	8A	C1	24	3F	98	8A	DE	8A	FC	´ í r# Á\$? !Þ ü
000000B0	43	F7	E3	8B	D1	86	D6	B1	06	D2	EE	42	F7	E2	39	56	C+ã N Ö± ÖiB+á9V
000000C0	0A	77	23	72	05	39	46	08	73	1C	B8	01	02	BB	00	7C	w#r 9F s , »
000000D0	8B	4E	02	8B	56	00	CD	13	73	51	4F	74	4E	32	E4	8A	N V Í sQOtN2ã
000000E0	56	00	CD	13	EB	E4	8A	56	00	60	BB	AA	55	B4	41	CD	V í èã V `»±U'AI
000000F0	13	72	36	81	FB	55	AA	75	30	F6	C1	01	74	2B	61	60	r6 úU±u0öÁ t+a`
00000100	6A	00	6A	00	FF	76	0A	FF	76	08	6A	00	68	00	7C	6A	j j ýv ýv j h j
00000110	01	6A	10	B4	42	8B	F4	CD	13	61	61	73	0E	4F	74	0B	j 'B óÍ aas Ot
00000120	32	E4	8A	56	00	CD	13	EB	D6	61	F9	C3	49	6E	76	61	2ã V Í èÖaùÃInva
00000130	6C	69	64	20	70	61	72	74	69	74	69	6F	6E	20	74	61	lid partition ta
00000140	62	6C	65	00	45	72	72	6F	72	20	6C	6F	61	64	69	6E	ble Error loadin
00000150	67	20	6F	70	65	72	61	74	69	6E	67	20	73	79	73	74	g operating syst
00000160	65	6D	00	4D	69	73	73	69	6E	67	20	6F	70	65	72	61	em Missing opera
00000170	74	69	6E	67	20	73	79	73	74	65	6D	00	00	00	00	00	ting system
00000180	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00000190	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001B0	00	00	00	00	00	2C	44	63	23	D9	E8	06	0F	0F	00	01	,Dc#Üè
000001C0	01	00	01	FE	3F	01	3F	00	00	00	43	7D	00	00	00	00	b? ? C}
000001D0	01	02	05	FE	3F	41	82	7D	00	00	40	B0	0F	00	00	00	b?A } @°
000001E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
000001F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	55	AA U±
00000200	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00000210	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	

Figure 1.8: Sector 0 after Creating an Extended Partition.

An EBR (Extended Boot Record) is created at sector 32130 (Figure 1.9). Four empty partition table entries and signature '0xAA55' have been written at the end of this sector. Unlike the MBR partition table at sector 0, only two partition table entries for an EBR will be used later. The first entry points to the current logical partition of this extended partition, whereas the second entry is used simply to define the location of the next EBR. This is because Extended DOS Partition can be further divided into a number of logical extended partitions. Note however, that the partition starting sector number in any one of the EBR table entries would be represented as a relative offset address rather than an absolute offset.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
00FB0400	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0410	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0420	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0430	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0440	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0450	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0460	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0470	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0480	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0490	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB04A0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB04B0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB04C0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB04D0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB04E0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB04F0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0500	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0510	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0520	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0530	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0540	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0550	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0560	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0570	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0580	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0590	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB05A0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB05B0	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	00	00
00FB05C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00FB05D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00FB05E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00FB05F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	55	AA	Ua
00FB0600	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	
00FB0610	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	OF	

Sector 32130 of 1076355 Offset: FB0400 = 15 Block:

Figure 1.9: The EBR Sector of an Extended Partition.

Two logical partitions are created within the extended partition area, as shown in Figure 1.10. The first entry of the extended partition table (Sector 32130) has been written with the record of the first logical partition (126MB logical partition). The second entry points to the next EBR where the second logical partition will be specified (377MB Partition) (Figure 1.11).

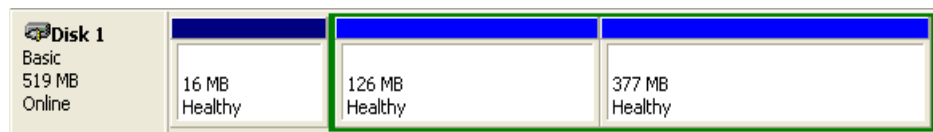


Figure 1.10: Creating Two Logical Partitions on the Extended Partition.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
00FB0400	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0410	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0420	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0430	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0440	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0450	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0460	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0470	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0480	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0490	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB04A0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB04B0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB04C0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB04D0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB04E0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB04F0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0500	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0510	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0520	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0530	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0540	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0550	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0560	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0570	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0580	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0590	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB05A0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB05B0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	00	01	
00FB05C0	01	02	0B	FE	3F	11	3F	00	00	00	D1	EB	03	00	00	00	b? ? Nè
00FB05D0	01	12	05	FE	3F	41	10	EC	03	00	30	C4	0B	00	00	00	b?A i OÅ
00FB05E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FB05F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	55	AA	Uà
00FB0600	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	
00FB0610	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	

Figure 1.11: The EBR sector of the First Extended Partition.

The second EBR is located at sector 289170 (32130 + 257040). The first table entry points to the second logical partition (377MB logical partition). The second table entry is empty because there are no further logical partitions being created, see Figure 1.12.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
08D32400	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32410	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32420	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32430	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32440	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32450	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32460	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32470	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32480	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32490	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D324A0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D324B0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D324C0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D324D0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D324E0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D324F0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32500	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32510	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32520	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32530	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32540	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32550	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32560	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32570	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32580	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32590	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D325A0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D325B0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	00	01
08D325C0	01	12	07	FE	3F	41	3F	00	00	00	F1	C3	0B	00	00	00
08D325D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
08D325E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
08D325F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	55	AA
08D32600	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
08D32610	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F

Sector 289170 of 1076355 Offset: 8D32400

Figure 1.12: The EBR sector of the Second Extended Partition.

3. Formatting

Three partitions are to be formatted as in Figure 1.13. The first partition is formatted to FAT16, and labeled as 'F16', the second is formatted to FAT32, and labeled as 'F32' and the last partition is formatted to NTFS, and labeled as 'NTFS'.

Disk 1 Basic 519 MB Online	F16	F32	NTFS
	16 MB FAT Healthy	126 MB FAT32 Healthy	377 MB NTFS Healthy

Figure 1.13: Three formatted partitions

3.1 Formatting in FAT16

The BPB (BIOS Parameter Block) template of a FAT16 partition is given in Figure 1.14. It shows that there are 8 reserved sectors, 2 FATs (File Allocation Tables) each of which occupies 12 sectors and a FDT (File Directory Table) that can hold at most 512 directory entries. This figure is based on 512 bytes per sector, multiplied by 32 sectors per root directory, and then divided by 32 bytes per directory. The user data area starts from the first sector after the end of the FDT. The entire user data area is divided equally into a number of clusters. A cluster is the minimum data storage unit on computer hard drives. Note that the first user data cluster is Cluster 2 (Cluster 0 and Cluster 1 are reserved). Table 1.1 is an overview of the structure of the F16 partition.

Offset	Title	Value
32256	JMP instruction	EB 3C 90
32259	OEM	MSDOS5.0
BIOS Parameter Block		
32267	Bytes per sector	512
32269	Sectors per cluster	8
32270	Reserved sectors	8
32272	Number of FATs	2
32273	Root entries	512
32275	Sectors (under 32 MB)	32067
32277	Media descriptor (hex)	F8
32278	Sectors per FAT	12
32280	Sectors per track	63
32282	Heads	255
32284	Hidden sectors	63
32288	Sectors (over 32 MB)	0

Figure 1.14: BPB Template of the F16 Partition

Contents	Reserved Sectors	FAT1	FAT2	FDT	Data Region
Size in Sectors	8	12	12	32	32003
Absolute Sector Number	From 63 to 70	From 71 to 82	From 83 to 94	From 95 to 126	From 127 to 32129

Table 1.1: The Structure of F16

Every 2 bytes represent a cluster number, where Cluster 0 and Cluster 1 are reserved. The first sector of the FAT is given in Figure 1.15. At the beginning, the signature of “0xFFF8” indicates that this is a FAT from a FAT16 file system, and this is where the Cluster 0 is to be found. Cluster 1 is written as ‘0xFF00’ which indicates it is the ROOT directory. User data will start from Cluster 2, at the offset of 0x8E04. The FAT1 and

FAT2 tables are created during formatting. The size and content of both are identical. Figure 1.16 shows the first sector of FAT2.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00008E00	8	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E40	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008E90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008EA0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008EB0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008EC0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008ED0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008EE0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008EF0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F40	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008F90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008FA0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008FB0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008FC0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008FD0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008FE0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00008FF0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00009000	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00009010	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

Sector 71 of 1076355 Offset: 8E00

Figure 1.15: The First Sector of FAT1.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
0000A600	F8	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A610	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A620	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A630	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A640	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A650	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A660	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A670	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A680	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A690	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A6A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A6B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A6C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A6D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A6E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A6F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A700	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A710	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A720	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A730	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A740	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A750	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A760	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A770	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A780	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A790	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A7A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A7B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A7C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A7D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A7E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A7F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A800	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000A810	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

Sector 83 of 1076355 Offset: A600

Figure 1.16: The First Sector of FAT2.

The FDT starts from sector 95. The first directory entry is used to record the volume name, 'F16' in this example as shown in Figure 1.17. All the remaining values in FDT table are cleared to zero. Figure 1.18 shows that no operation is performed after sector 126 (=95+ 32 -1) on this partition because the FDT only occupies 32 sectors.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0000BE00	06	31	36	20	20	20	20	20	20	20	20	08	00	00	00	00	F16
0000BE10	00	00	00	00	00	00	E9	B2	CD	3C	00	00	00	00	00	00	é²í<
0000BE20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BE30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BE40	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BE50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BE60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BE70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BE80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BE90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BEA0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BEB0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BEC0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BED0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BEE0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BEF0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF40	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF50	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF70	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BF90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BFA0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BFB0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BFC0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BFD0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BFE0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000BFF0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000C000	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
0000C010	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	

Figure 1.17: The First Sector of the Root Directory in F16.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000FD80	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000FD90	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000FDA0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000FDB0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000FDC0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000FDD0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000FDE0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000DF0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
0000FE00	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE10	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE20	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE30	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE40	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE50	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE60	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE70	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE80	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FE90	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FEA0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FEB0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FEC0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FED0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FEE0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FEF0	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF00	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF10	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF20	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF30	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF40	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF50	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF60	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF70	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF80	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F
0000FF90	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F	0F

Sector 127 of 1076355 Offset: FEEE = 15 Block:

Figure 1.18: The Last Sector of the Root Directory in F16.

In conclusion, the effects of formatting in FAT16 are as follows:

- The first sector of the partition is written with a boot record; the values of other reserved sectors are cleared to zero.
- The starting sectors of FAT1 and FAT2 are written with the relevant signatures at the beginning; the values of other regions are cleared to zero.
- The values of the root directory table are cleared to zero. If a volume label is given, it will be recorded at the beginning of the FDT.
- No changes are made to the data region.

3.2 Formatting in FAT32

The BPB template of the second partition is given in Figure 1.19. There are 32 reserved sectors and each cluster has 2 sectors. Also, there are two identical FAT tables same as for FAT16. Each table occupies of 996 sectors. The FDT starts from cluster 2, which is sector 34217 (63 + 32130 + 32 + 996 + 996). Table 1.2 shows the structure of F32 partition. In the reserved regions, the first sector is the boot sector; the second sector is the FSINFO sector; the third sector is written with "0xAA55" at the end; the fourth to sixth sectors are cleared to zero and the seventh to ninth sectors are the backup of first three sectors. The values of the remaining reserved sectors are all cleared to zero except the thirteenth sector, which may be written with data and a signature of "0xAA55" at the end.

Offset	Title	Value
16482816	JMP instruction	EB 58 90
16482819	DEM	MSDOS5.0
BIOS Parameter Block		
16482827	Bytes per sector	512
16482829	Sectors per cluster	2
16482830	Reserved sectors	32
16482832	Number of FATs	2
16482833	Root entries (unused)	0
16482835	Sectors (on small volumes)	0
16482837	Media descriptor (hex)	F8
16482838	Sectors per FAT (small vol.)	0
16482840	Sectors per track	63
16482842	Heads	255
16482844	Hidden sectors	63
16482848	Sectors (on large volumes)	256977
FAT32 Section		
16482852	Sectors per FAT	996
16482856	Extended flags	0
16482856	FAT mirroring disabled?	0
16482858	Version (usually 0)	0
16482860	Root dir 1st cluster	2
16482864	FSInfo sector	1
16482866	Backup boot sector	6
16482868	(Reserved)	00 00 00 00 00 00 00 00 00 00 00 00

Figure 1.19: BPB Template of the F32 Partition.

Contents	Reserved Sectors	FAT1	FAT2	Data Region	
				Root Directory (Initially)	User Data Region (Initially)
Size in Sectors	32	996	996	2	254949
Absolute Sector Number	From 32193 to 32224	From 32225 to 33220	From 33221 to 34216	From 34217 to 34218	From 34219 to 289169

Table: 1.2: The Structure of an F32 Partition.

Figure 1.20 shows the first sector of FAT1. Every 4 bytes represents a cluster number. The first 4 bytes of FAT are written as a signature of '0xOFFF8', which indicates that this is a FAT table of a FAT32 partition. The third entry of '0xFFFF0F' represents the ROOT directory. All the unused values are cleared to zero. FAT2 is otherwise identical to FAT1.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
00FBC200	8	FF	FF	0F	FF	FF	FF	FF	FF	FF	FF	0F	00	00	00	00	yy yyyyyy
00FBC210	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC220	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC230	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC240	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC250	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC260	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC270	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC280	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC290	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC2A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC2B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC2C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC2D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC2E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC2F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC300	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC310	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC320	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC330	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC340	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC350	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC360	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC370	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC380	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC390	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC3A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC3B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC3C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC3D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC3E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC3F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC400	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00FBC410	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	

Sector 32225 of 1076355 Offset: FBC200 = 248 Block:

Figure 1.20: The First Sector of File Allocation Table 1

The first cluster after FAT2 is allocated to the first part of the FDT where the ROOT directory is stored. In FAT32, the FDT is considered as data, unlike the FAT16 where the whole FDT is stored in the front of user data area. When a hard disk is formatted in FAT32 file system, the content of Cluster 2 (Figure 1.21) is reserved for storing ROOT directory and sub ROOT directories if there are any. Each directory entry occupies 32 bytes. The maximum number of directory entries for one cluster is 32 (if 2 sectors per cluster as in this example). Extra clusters will be allocated to the FDT if the data directory grows bigger than one cluster could store. Consequently, the root directory may be stored in non-consecutive regions.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
010B5200	46	33	32	20	20	20	20	20	20	20	20	08	00	00	00	00	32
010B5210	00	00	00	00	00	00	E0	B2	CD	3C	00	00	00	00	00	00	à²í<
010B5220	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5230	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5240	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5250	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5260	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5270	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5280	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5290	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B52A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B52B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B52C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B52D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B52E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B52F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5300	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5310	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5320	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5330	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5340	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5350	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5360	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5370	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5380	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5390	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B53A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B53B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B53C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B53D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B53E0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B53F0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5400	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
010B5410	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	

Sector 34217 of 1076355 Offset: 10B5200 = 70 Block:

Figure 1.21: The First Sector of the File Directory Table.

In conclusion, the effects of formatting to F32 are as follows:

- A boot record is written in the first sector of the partition. FSINFO is written in the second sector. "0xAA55" is written at the end of the third sector.
- The values of the fourth to sixth sectors are cleared; the values of the first sectors are copied to the seventh to ninth sectors.
- The values of the other reserved sectors are cleared (Note: the thirteenth sector might be used).

- The values of FAT1 and FAT2 are cleared. Signatures are written at the beginning of them.
- The values of the clusters storing the root directory are cleared to be zero. The label (F32 in this example) is written in the ASC code area at the beginning of this cluster.

3.3 Formatting in NTFS

All NTFS content is created as either files or directories, including the file system management data. When formatting a disk to the NTFS file system, certain metadata is written into the partition. Except for \$Boot, which must start from the first sector of the partition, the other metadata can be located anywhere within the partition. Figure 1.22 gives an example of the DBR sector of \$Boot. The first sector of the NTFS partition is at sector 289233 in this example, i.e. 32130 (starting sector of the extended partition + 257040 (the relative starting sector of the NTFS logical partition) + 63. Table 1.3 gives a general NTFS structure.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
08D3A200	B	52	90	4E	54	46	53	20	20	20	00	02	01	00	00	00	NTFS
08D3A210	00	00	00	00	00	F8	00	00	3F	00	FF	00	3F	00	00	00	? y ?
08D3A220	00	00	00	00	80	00	80	00	F0	C3	0B	00	00	00	00	00	3
08D3A230	FB	EB	03	00	00	00	00	00	F8	E1	05	00	00	00	00	00	ué 3
08D3A240	02	00	00	00	08	00	00	00	34	08	57	08	13	57	08	C0	4 W W A
08D3A250	00	00	00	00	FA	33	C0	8E	D0	BC	00	7C	FB	B8	C0	07	ú3A D% ú,Á
08D3A260	8E	D8	E8	16	00	B8	00	0D	8E	C0	33	DB	C6	06	0E	00	0è , À30Æ
08D3A270	10	E8	53	00	68	00	0D	68	6A	02	CB	8A	16	24	00	B4	èS h hj È \$ ´
08D3A280	08	CD	13	73	05	B9	FF	FF	8A	F1	66	0F	B6	C6	40	66	Í s 'yy ñf Æ@f
08D3A290	0F	B6	D1	80	E2	3F	F7	E2	86	CD	C0	ED	06	41	66	0F	N á?+á Ái Af
08D3A2A0	B7	C9	66	F7	E1	66	A3	20	00	C3	B4	41	BB	AA	55	8A	·Éf+áf Á`A»U
08D3A2B0	16	24	00	CD	13	72	0F	81	FB	55	AA	75	09	F6	C1	01	\$ í r úUau 3Á
08D3A2C0	74	04	FE	06	14	00	C3	66	60	1E	06	66	A1	10	00	66	t b Áf' fi f
08D3A2D0	03	06	1C	00	66	3B	06	20	00	0F	82	3A	00	1E	66	6A	f; : fj
08D3A2E0	00	66	50	06	53	66	68	10	00	01	00	80	3E	14	00	00	fP Sfh >
08D3A2F0	0F	85	0C	00	E8	B3	FF	80	3E	14	00	00	0F	84	61	00	è'y > a
08D3A300	B4	42	8A	16	24	00	16	1F	8B	F4	CD	13	66	58	5B	07	'B \$ óí fX[
08D3A310	66	58	66	58	1F	EB	2D	66	33	D2	66	0F	B7	0E	18	00	fXfX è-f30f ·
08D3A320	66	F7	F1	FE	C2	8A	CA	66	8B	D0	66	C1	EA	10	F7	36	f-ñpÁ Éf ÐfÁé ÷6
08D3A330	1A	00	86	D6	8A	16	24	00	8A	E8	C0	E4	06	0A	CC	B8	Ö \$ èÁá Í,
08D3A340	01	02	CD	13	0F	82	19	00	8C	C0	05	20	00	8E	C0	66	Í Á Áf
08D3A350	FF	06	10	00	FF	0E	0E	00	0F	85	6F	FF	07	1F	66	61	y y oy fa
08D3A360	C3	A0	F8	01	E8	09	00	A0	FB	01	E8	03	00	FB	EB	FE	Á ø è ú è úèp
08D3A370	B4	01	8B	F0	AC	3C	00	74	09	B4	0E	BB	07	00	CD	10	' ð-< t ' » Í
08D3A380	EB	F2	C3	0D	0A	41	20	64	69	73	6B	20	72	65	61	64	èöÁ A disk read
08D3A390	20	65	72	72	6F	72	20	6F	63	63	75	72	72	65	64	00	error occurred
08D3A3A0	0D	0A	4E	54	4C	44	52	20	69	73	20	6D	69	73	73	69	NTLDR is missi
08D3A3B0	6E	67	00	0D	0A	4E	54	4C	44	52	20	69	73	20	63	6F	ng NTLDR is co
08D3A3C0	6D	70	72	65	73	73	65	64	00	0D	0A	50	72	65	73	73	mpressed Press
08D3A3D0	20	43	74	72	6C	2B	41	6C	74	2B	44	65	6C	20	74	6F	Ctrl+Alt+Del to
08D3A3E0	20	72	65	73	74	61	72	74	0D	0A	00	00	00	00	00	00	restart
08D3A3F0	00	00	00	00	00	00	00	00	83	A0	B3	C9	00	00	55	AA	»É Ua
08D3A400	05	00	4E	00	54	00	4C	00	44	00	52	00	04	00	24	00	N T L D R \$
08D3A410	49	00	33	00	30	00	00	E0	00	00	00	30	00	00	00	00	I 3 0 à 0

Figure 1.22: The DBR sector of an NTFS File System.

\$Boot	Metadata	\$MFT	Metadata	\$MFTMirr	
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Table 1.3: The Structure of NTFS Partitions.

The BPB template of this NTFS file system is shown in Figure 1.23, which shows that the relative offset between the DBR sector and the \$MFT (Master File Table) is 257019. Therefore the address of \$MFT can be derived by:

The DBR sector number plus the relative offset, which is $289233 + 257019 = 546252$.

The first sector of \$MFT is shown in Figure 1.24.

Offset	Title	Value
8D3A200	JMP instruction	EB 52 90
8D3A203	File system ID	NTFS
8D3A208	Bytes per sector	512
8D3A20D	Sectors per cluster	1
8D3A20E	Reserved sectors	0
8D3A210	(always zero)	00 00 00
8D3A213	(unused)	00 00
8D3A215	Media descriptor	F8
8D3A216	(unused)	00 00
8D3A218	Sectors per track	63
8D3A21A	Heads	255
8D3A21C	Hidden sectors	63
8D3A220	(unused)	00 00 00 00
8D3A224	(always 80 00 80 00)	80 00 80 00
8D3A228	Total sectors	771056
8D3A230	Start C# \$MFT	257019
8D3A238	Start C# \$MFTMirr	385528
8D3A240	FILE record size indicato	2
8D3A241	(unused)	0
8D3A244	INDX buffer size indicato	8
8D3A245	(unused)	0
8D3A248	32-bit serial number (hex)	34 08 57 08
8D3A248	32-bit SN (hex, reversed)	8570834
8D3A248	64-bit serial number (hex)	34 08 57 08 13 57 08 C0
8D3A250	Checksum	0
8D3A3FE	Signature (55 AA)	55 AA

Figure 1.23: The BPB Template of an NTFS File System.

Offset	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
10AB9800	46	49	4C	45	30	00	03	00	3D	0F	10	00	00	00	00	00	FILE0 =
10AB9810	01	00	01	00	38	00	01	00	98	01	00	00	00	04	00	00	8
10AB9820	00	00	00	00	00	00	00	00	06	00	00	00	00	00	00	00	
10AB9830	02	00	00	00	00	00	00	00	10	00	00	00	60	00	00	00	,
10AB9840	00	00	18	00	00	00	00	00	48	00	00	00	18	00	00	00	H
10AB9850	F0	12	D6	56	F7	06	CB	01	F0	12	D6	56	F7	06	CB	01	š ÖV÷ È š ÖV÷ È
10AB9860	F0	12	D6	56	F7	06	CB	01	F0	12	D6	56	F7	06	CB	01	š ÖV÷ È š ÖV÷ È
10AB9870	06	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
10AB9880	00	00	00	00	00	01	00	00	00	00	00	00	00	00	00	00	
10AB9890	00	00	00	00	00	00	00	00	30	00	00	00	68	00	00	00	0 h
10AB98A0	00	00	18	00	00	03	00	00	4A	00	00	00	18	00	01	00	J
10AB98B0	05	00	00	00	00	05	00	00	F0	12	D6	56	F7	06	CB	01	š ÖV÷ È
10AB98C0	F0	12	D6	56	F7	06	CB	01	F0	12	D6	56	F7	06	CB	01	š ÖV÷ È š ÖV÷ È
10AB98D0	F0	12	D6	56	F7	06	CB	01	00	40	00	00	00	00	00	00	š ÖV÷ È @
10AB98E0	00	40	00	00	00	00	00	00	06	00	00	00	00	00	00	00	@
10AB98F0	04	03	24	00	4D	00	46	00	54	00	00	00	00	00	00	00	\$ M F T
10AB9900	80	00	00	00	48	00	00	00	01	00	40	00	00	00	01	00	H @
10AB9910	00	00	00	00	00	00	00	00	3F	00	00	00	00	00	00	00	?
10AB9920	40	00	00	00	00	00	00	00	00	80	00	00	00	00	00	00	@
10AB9930	00	80	00	00	00	00	00	00	00	80	00	00	00	00	00	00	
10AB9940	31	40	FB	EB	03	00	01	00	B0	00	00	00	48	00	00	00	1@úë ° H
10AB9950	01	00	40	00	00	05	00	00	00	00	00	00	00	00	00	00	@
10AB9960	00	00	00	00	00	00	00	00	40	00	00	00	00	00	00	00	@
10AB9970	00	02	00	00	00	00	00	00	08	00	00	00	00	00	00	00	
10AB9980	08	00	00	00	00	00	00	00	31	01	FA	EB	03	00	00	00	1 úë
10AB9990	FF	FF	FF	FF	00	00	00	00	00	80	00	00	00	00	00	00	yyyy
10AB99A0	00	80	00	00	00	00	00	00	31	40	FB	EB	03	00	01	00	1@úë
10AB99B0	E0	00	00	00	48	00	00	00	01	00	40	00	00	05	00	00	° H @
10AB99C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
10AB99D0	40	00	00	00	00	00	00	00	00	02	00	00	00	00	00	00	@
10AB99E0	08	00	00	00	00	00	00	00	08	00	00	00	00	00	00	00	
10AB99F0	31	01	FA	EB	03	00	00	00	FF	FF	FF	FF	00	00	02	00	1 úë yyyy
10AB9A00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
10AB9A10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	

Figure 1.24: The First Sector of \$MFT.

While formatting in NTFS, the following needs to be noted:

- Normally the \$Boot file is allocated 16 sectors at the beginning of the partition, in which only the first 7 sectors are used, the values of the others are cleared to zero. During experiments, it has been found that sometimes sectors 16 to 32 might be used as well, i.e. either they are used to store files or cleared to zero.
- The \$MFT file is initially 32KB, occupying 64 sectors. The values of sectors 16 to 23 of MFT are all cleared to zero. If the disk is formatted to a higher version of NTFS, for example if formatting to NTFS under Windows XP, the position of \$MFT may be after millions of sectors. Otherwise (e.g. formatting in NTFS under Windows 2000), the \$MFT file may be allocated not far from the beginning of the partition.
- \$MFTMirr mirrors the first four records of the \$MFT, and occupies 8 sectors. Normally, it is in the middle of the partition.
- Additional metadata is stored either in front of, or behind, the \$MFT. Some elements will have a fixed size, whereas the sizes of others are related to that of the partition. The size of \$objId, \$Quota, \$Reparse, \$Secure and \$Volume are normally zero. Initially, \$AttrDef is 2.5KB, \$Secure:\$SDS is 256KB and \$UpCase is 128KB. The size of both the \$Bitmap and the \$LogFile are related to the size of the partition. Although space is allocated for all of them, few elements actually have content written in these spaces. For instance, given a NTFS volume of 20GB, the log file is initially 64MB. However, only the first 88 sectors are written with content, while others are not.