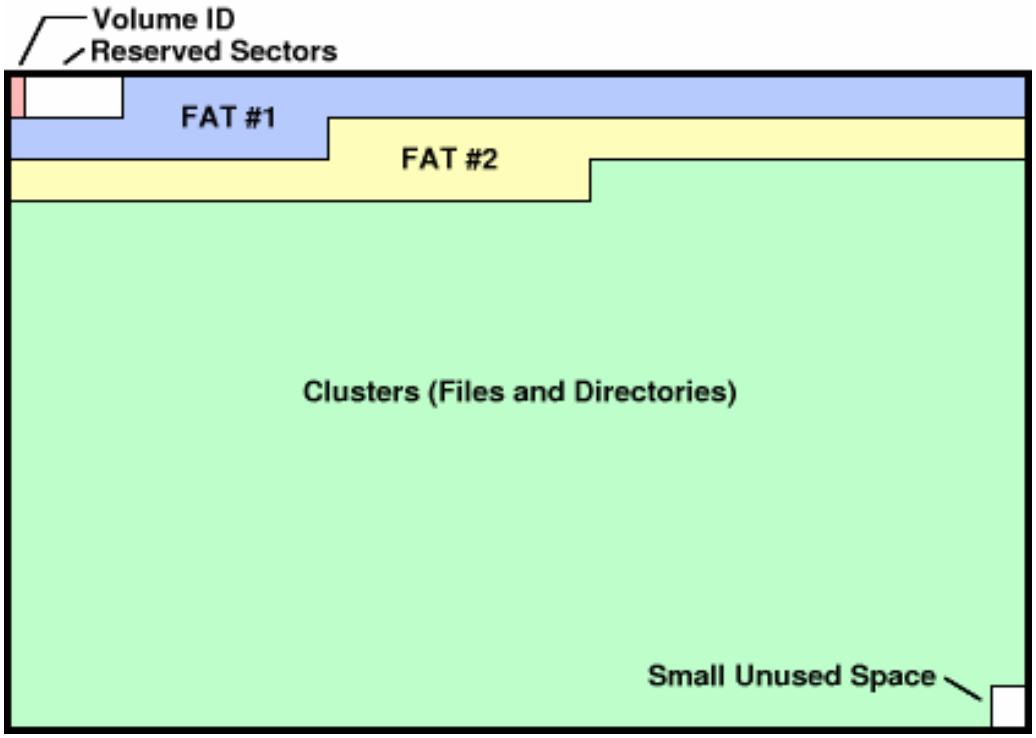
FAT32 Project

FAT32 Layout



FAT32 Layout

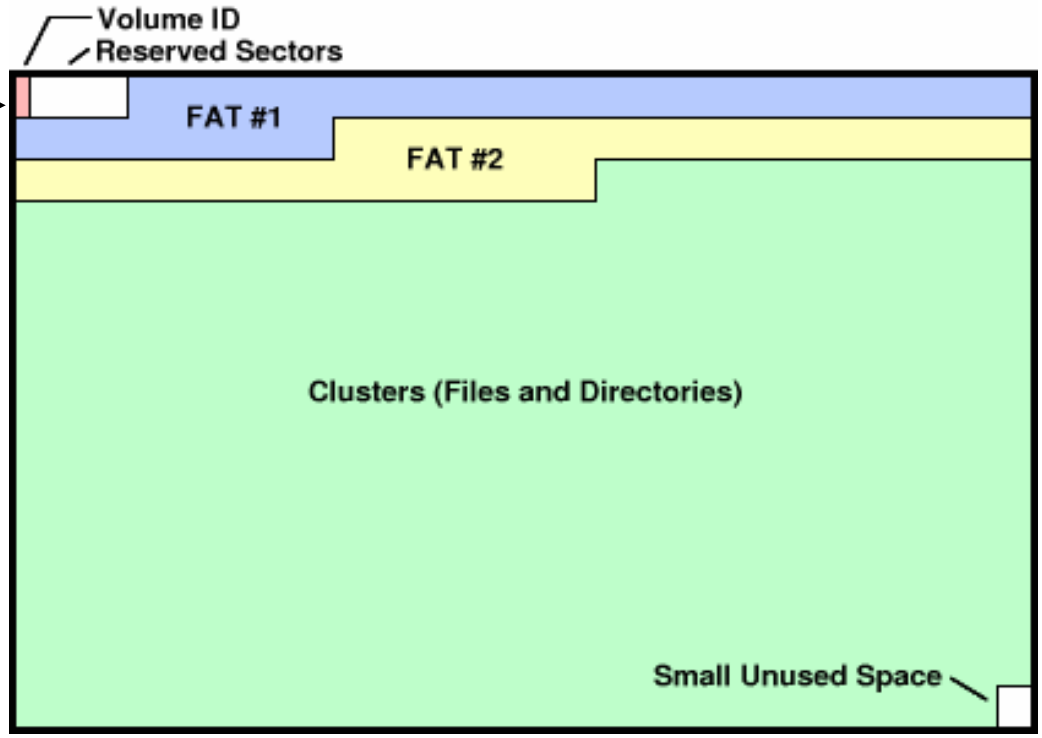
```
char      BS_OEMName[8];
int16_t   BPB_BytsPerSec;
int8_t    BPB_SecPerClus;
int16_t   BPB_RsvdSecCnt;
int8_t    BPB_NumFATs;
int16_t   BPB_RootEntCnt;
char      BS_VolLab[11];
int32_t   BPB_FATSz32;
int32_t   BPB_RootClus;

int32_t   RootDirSectors = 0;
int32_t   FirstDataSector = 0;
int32_t   FirstSectorofCluster = 0;
```

FAT32 Layout

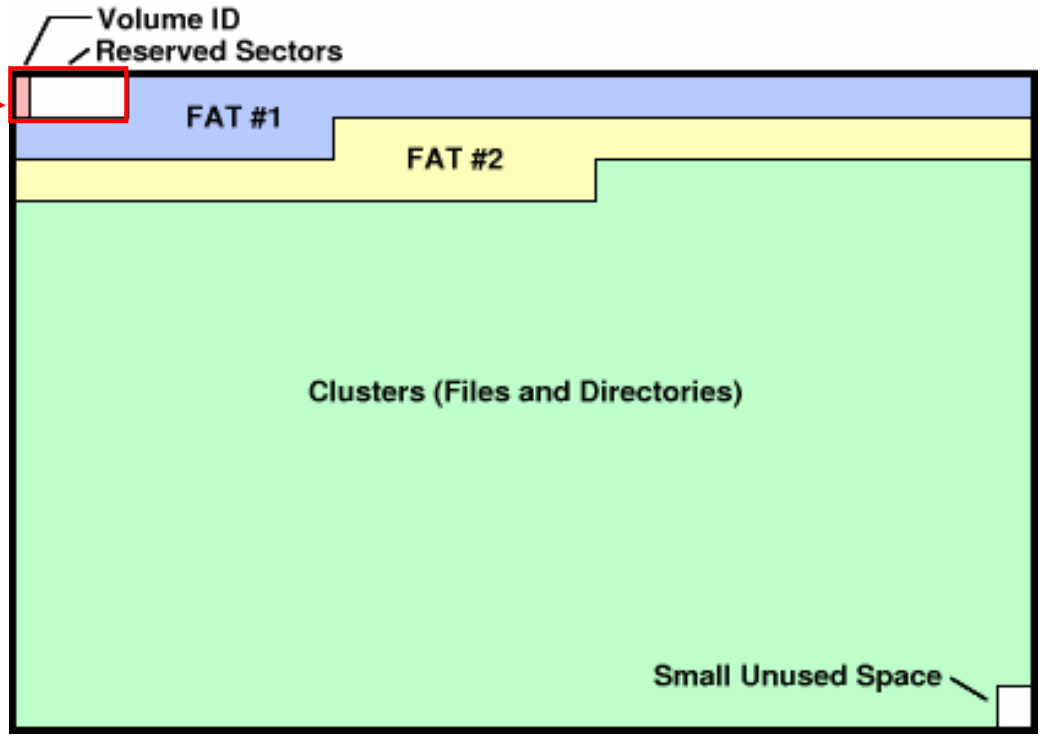
Boot sector and BPB sector

Page 9,10,12 of spec



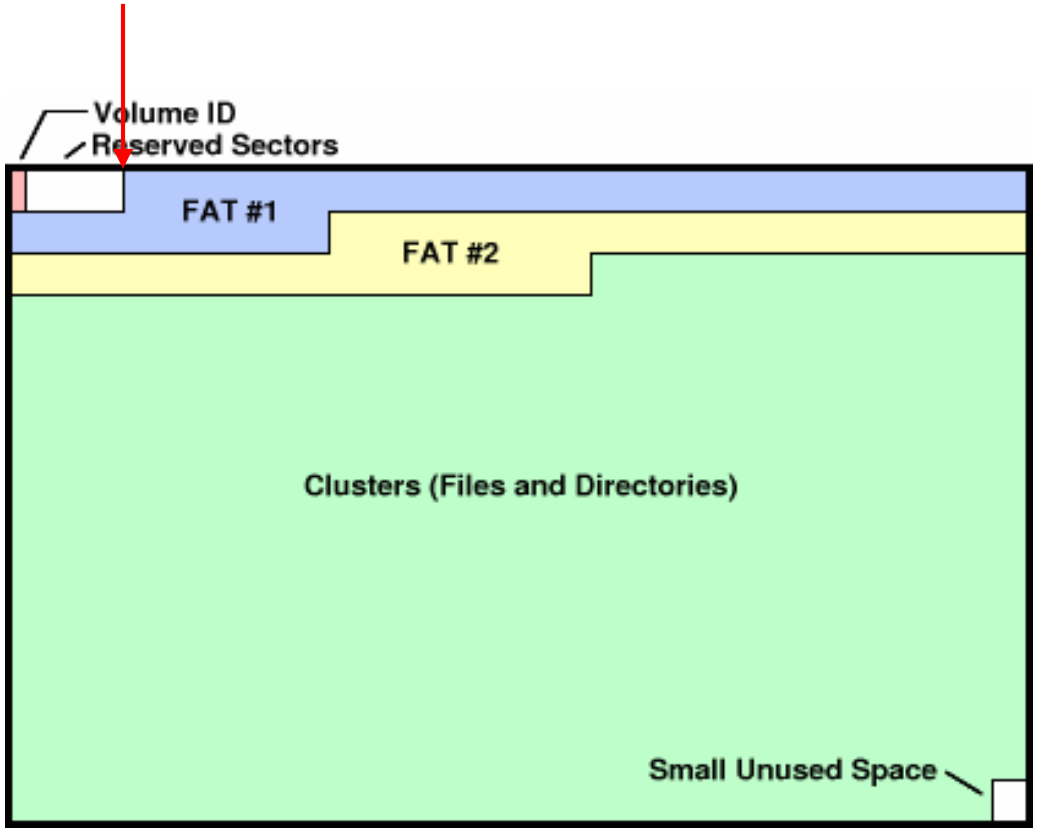
FAT32 Layout

BPB_RsvdSecCnt * BPB_BytsPerSec
in size



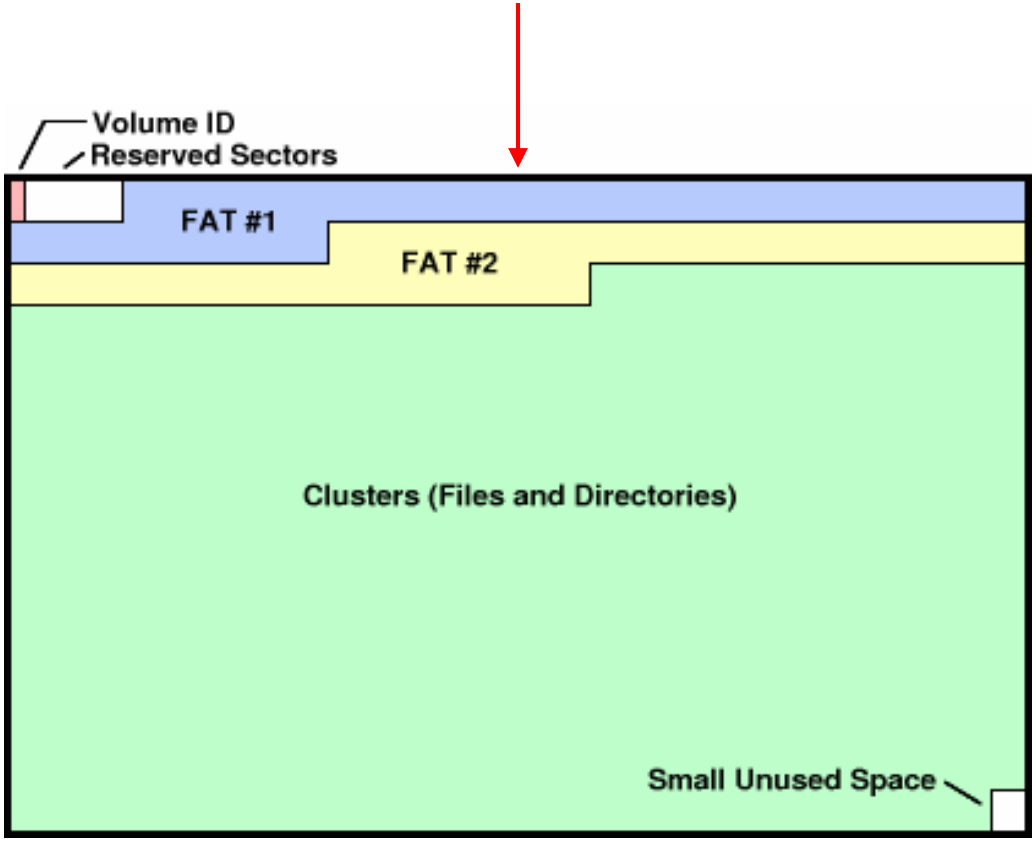
FAT32 Layout

FAT #1 starts at address BPB_RsvdSecCnt * BPB_BytsPerSec



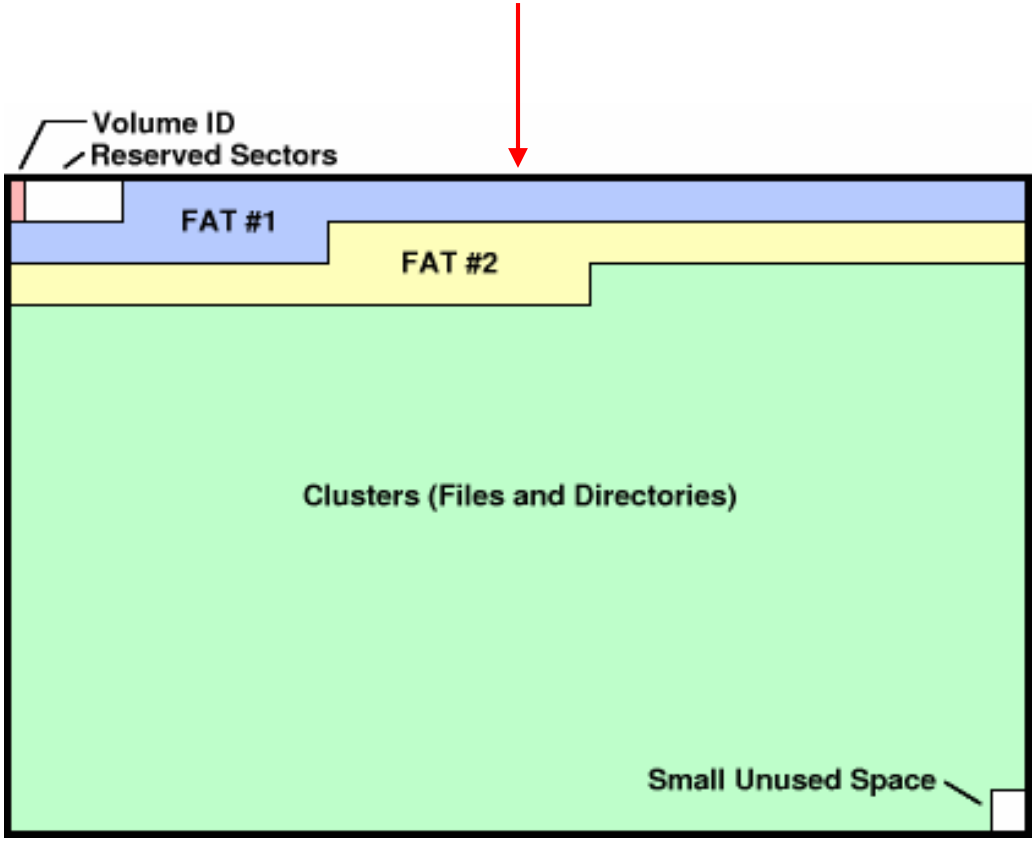
FAT32 Layout

Each FAT has 1 32-bit word for every cluster. Each entry is the logical block of the next block in the file.



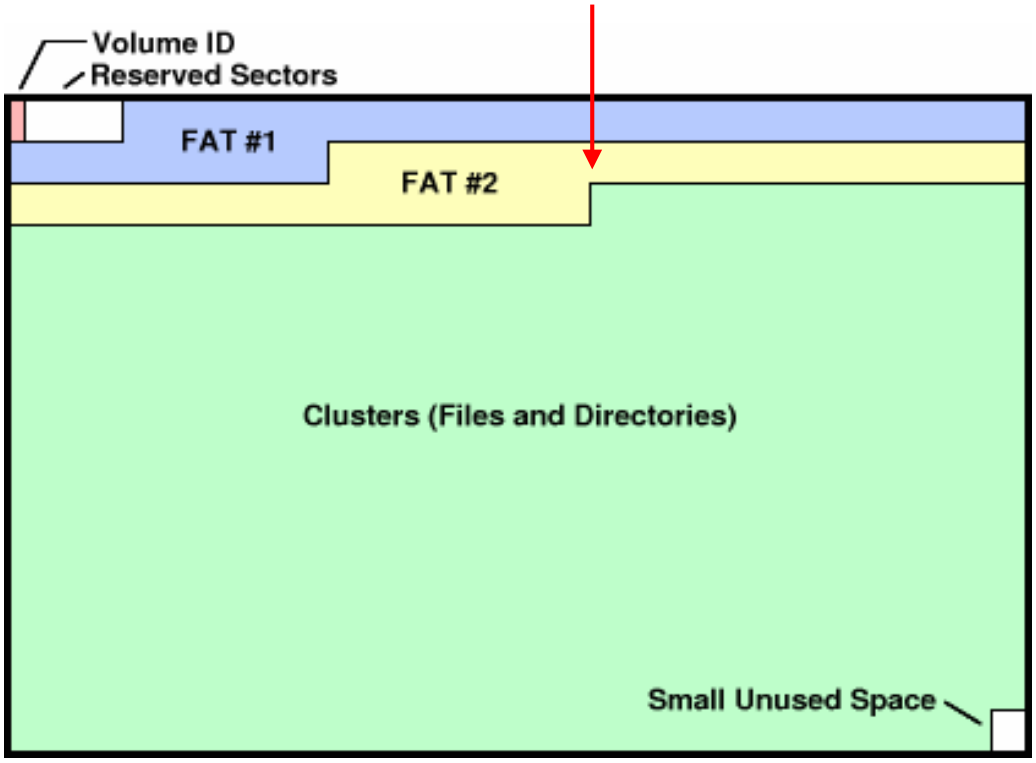
FAT32 Layout

Total FAT size is BPB_NumFATs * BPB_FATSz32 * BPB_BytsPerSec



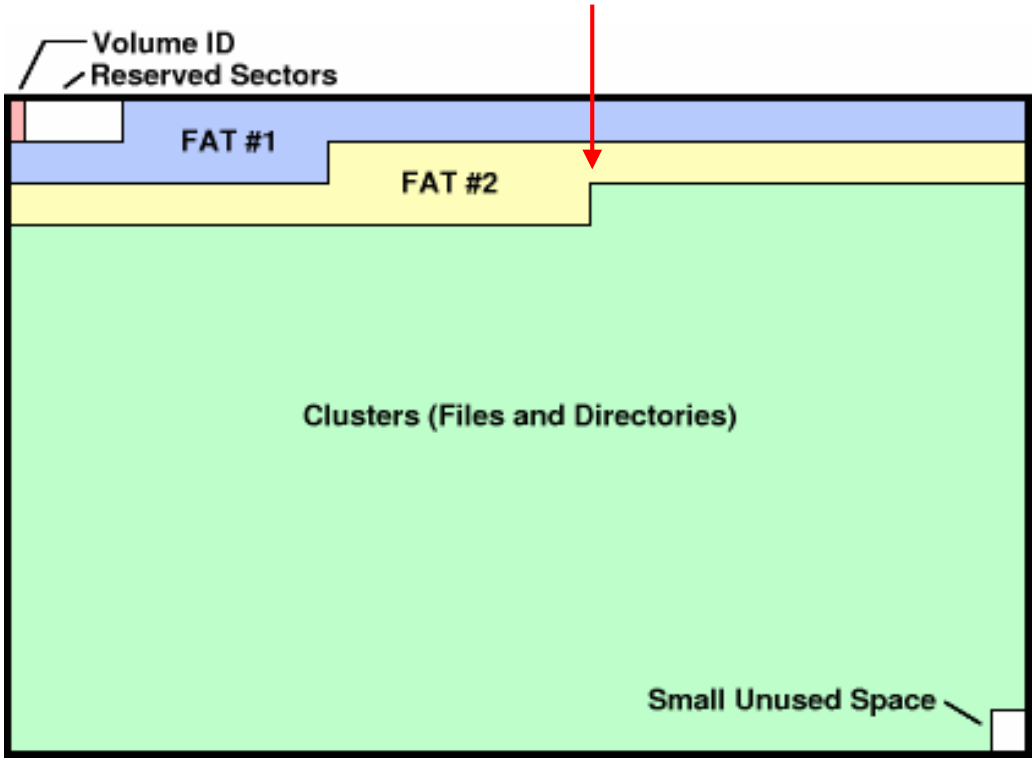
FAT32 Layout

Clusters start at address (BPB_NumFATs * BPB_FATSz32 * BPB_BytsPerSec) + (BPB_RsvdSecCnt * BPB_BytsPerSec)



FAT32 Layout

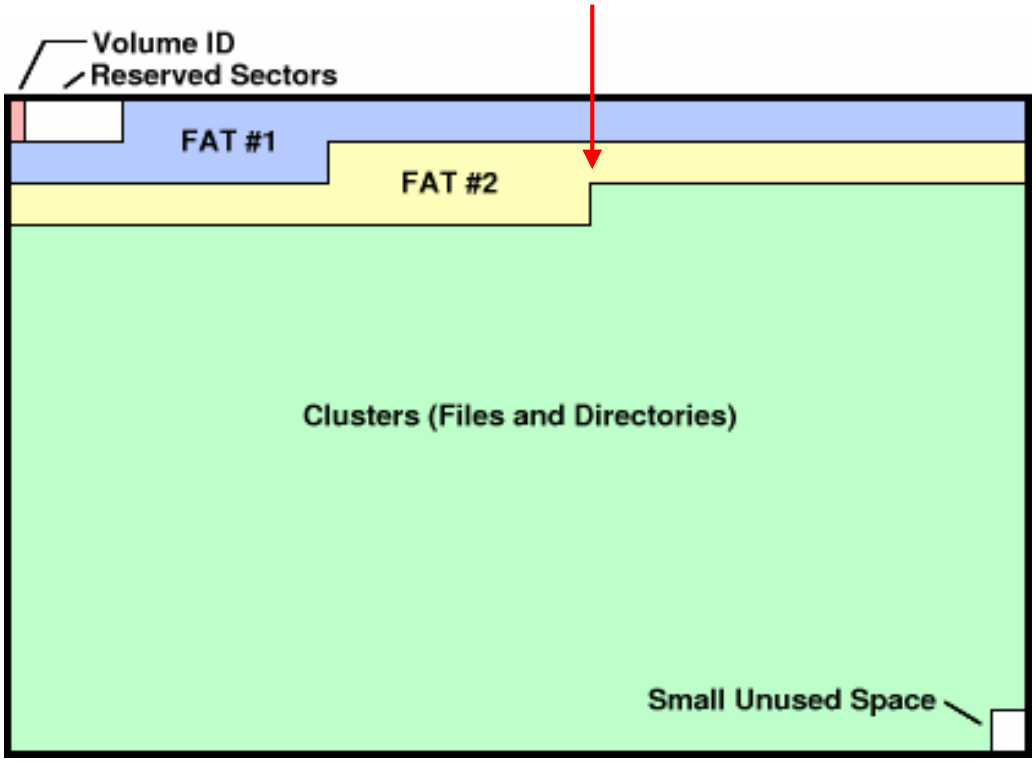
Clusters are each (BPB_SecPerClus * BPB_BytsPerSec) in bytes



FAT32 Layout

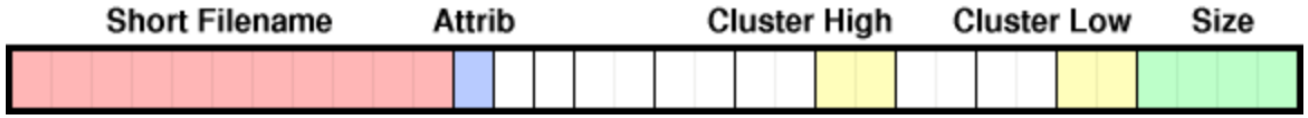
Root Directory is at the first cluster.

Address: (BPB_NumFATs * BPB_FATSz32 * BPB_BytsPerSec) +(BPB_RsvdSecCnt * BPB_BytsPerSec)



FAT32 Layout

Root Directory contains 16 32-byte records



Field	Microsoft's Name	Offset	Size
Short Filename	DIR_Name	0x00	11 Bytes
Attrib Byte	DIR_Attr	0x0B	8 Bits
First Cluster High	DIR_FstClusHI	0x14	16 Bits
First Cluster Low	DIR_FstClusLO	0x1A	16 Bits
File Size	DIR_FileSize	0x1C	32 Bits

FAT32 Layout

First character of the filename:

0x00 - Filename never used.
0xe5 - The filename has been used, but the file has been deleted.
0x05 - The first character of the filename is actually 0xe5.
0x2e - The entry is for a directory, not a normal file. If the second byte is also 0x2e, the cluster field contains the cluster number of this directory's parent directory. If the parent directory is the root directory (which is statically allocated and doesn't have a cluster number), cluster number 0x0000 is specified here.

FAT32 Layout

File Attributes:

0x01 - Indicates that the file is read only.
0x02 - Indicates a hidden file. Such files can be displayed if it is really required.
0x04 - Indicates a system file. These are hidden as well.
0x08 - Indicates a special entry containing the disk's volume label, instead of describing a file. This kind of entry appears only in the root directory.
0x10 - The entry describes a subdirectory.
0x20 - This is the archive flag. This can be set and cleared by the programmer or user, but is always set when the file is modified. It is used by backup programs.
0x40 - Not used; must be set to 0.
0x80 - Not used; must be set to 0.

Only show if attribute is 0x01, 0x10, or 0x20

FAT32 Layout

Each record can be represented by:

```
#include <stdint.h>

struct __attribute__((__packed__)) DirectoryEntry {
  char      DIR_Name[11];
  uint8_t   DIR_Attr;
  uint8_t   Unused1[8];
  uint16_t  DIR_FirstClusterHigh;
  uint8_t   Unused2[4];
  uint16_t  DIR_FirstClusterLow;
  uint32_t  DIR_FileSize;
};

struct DirectoryEntry dir[16];
```

FAT32 Layout

First directory entry

```
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
42 41 52 20 20 20 20 20 54 58 54 20 18 64 9B 8D 6F 3E 79 4A 00 00 9B 8D 6F 3E 11 00 08 00 00 00  BAR     TXT .d..o>yJ....o>......
4E 55 4D 20 20 20 20 20 54 58 54 20 18 34 8D 63 7A 4A 7A 4A 00 00 8D 63 7A 4A 30 1C 00 0A 00 00  NUM     TXT .4.czJzJ...czJ0.....
44 45 41 44 42 45 45 46 54 58 54 20 18 75 55 5A 7A 4A 7A 4A 00 00 55 5A 7A 4A 29 1D 31 10 00 00  DEADBEEFTXT .uUZzJzJ..UZzJ).1...
41 2E 00 5F 00 2E 00 54 00 72 00 0F 00 7F 61 00 73 00 68 00 65 00 73 00 00 00 00 00 FF FF FF FF  A.._...T.r....a.s.h.e.s.........
7E 31 20 20 20 20 20 20 54 52 41 22 00 1B 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 5A 19 00 10 00 00  ~1      TRA"...czJzJ...czJZ.....
E5 52 41 53 48 45 7E 31 4C 5A 4B 12 00 1B 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 59 19 00 00 00 00  .RASHE~1LZK....czJzJ...czJY.....
46 4F 4F 20 20 20 20 20 54 58 54 20 18 64 99 8D 6F 3E 79 4A 00 00 99 8D 6F 3E 10 00 08 00 00 00  FOO     TXT .d..o>yJ....o>......
41 46 00 6F 00 6C 00 64 00 65 00 0F 00 03 72 00 41 00 00 00 FF FF FF FF FF FF 00 00 FF FF FF FF  AF.o.l.d.e....r.A...............
46 4F 4C 44 45 52 41 20 20 20 20 10 00 68 8D 44 73 4A 73 4A 00 00 8D 44 73 4A D3 17 00 00 00 00  FOLDERA     ..h.DsJsJ...DsJ......
41 2E 00 54 00 72 00 61 00 73 00 0F 00 25 68 00 65 00 73 00 00 00 FF FF FF FF 00 00 FF FF FF FF  A..T.r.a.s...%h.e.s.............
54 52 41 53 48 45 7E 31 20 20 20 12 00 1B 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 59 19 00 00 00 00  TRASHE~1    ....czJzJ...czJY.....
E5 31 20 20 20 20 20 20 54 45 4D 22 00 19 12 46 73 4A 79 4A 00 00 12 46 73 4A 50 19 00 10 00 00  .1      TEM"...FsJyJ...FsJP.....
41 66 00 61 00 74 00 73 00 70 00 0F 00 44 65 00 63 00 2E 00 70 00 64 00 66 00 00 00 00 00 FF FF  Af.a.t.s.p...De.c...p.d.f.......
46 41 54 53 50 45 43 20 50 44 46 20 00 64 38 8F 6F 3E 7A 4A 00 00 38 8F 6F 3E 0C 15 8A 4E 05 00  FATSPEC PDF .d8.o>zJ..8.o>...N..
41 2E 00 66 00 73 00 65 00 76 00 0F 00 DA 65 00 6E 00 74 00 73 00 64 00 00 00 00 00 FF FF FF FF  A..f.s.e.v....e.n.t.s.d.........
46 53 45 56 45 4E 7E 31 20 20 20 12 00 20 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 62 19 00 00 00 00  FSEVEN~1    .. .czJzJ...czJb.....
2E 20 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E 03 00 00 00 00 00  .           ..dy.o>o>..y.o>......
2E 2E 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E C0 17 00 00 00 00  ..          ..dy.o>o>..y.o>......
E5 66 00 30 00 00 00 FF FF FF FF 0F 00 C7 FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  .f.0............................
E5 30 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A6 10 00 02 00 00  .0          ....o>WE....o>......
E5 66 00 31 00 00 00 FF FF FF FF 0F 00 4A FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  .f.1.........J..................
E5 31 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A7 10 00 02 00 00  .1          ....o>WE....o>......
E5 66 00 32 00 00 00 FF FF FF FF 0F 00 CA FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  .f.2............................
E5 32 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A8 10 00 02 00 00  .2          ....o>WE....o>......
E5 66 00 33 00 00 00 FF FF FF FF 0F 00 47 FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  .f.3.........G..................
E5 33 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A9 10 00 02 00 00  .3          ....o>WE....o>......
E5 66 00 34 00 00 00 FF FF FF FF 0F 00 C9 FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  .f.4............................
E5 34 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E AA 10 00 02 00 00  .4          ....o>WE....o>......
E5 66 00 35 00 00 00 FF FF FF FF 0F 00 3C FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  .f.5.........<..................
E5 35 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E AB 10 00 02 00 00  .5          ....o>WE....o>......
E5 66 00 36 00 00 00 FF FF FF FF 0F 00 BC FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  .f.6............................
E5 36 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E AC 10 00 02 00 00  .6          ....o>WE....o>......
2E 20 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E 04 00 00 00 00 00  .           ..dy.o>o>..y.o>......
2E 2E 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E C0 17 00 00 00 00  ..          ..dy.o>o>..y.o>......
41 67 00 72 00 65 00 65 00 6E 00 0F 00 CA 31 00 00 00 FF FF FF FF FF FF FF FF 00 00 FF FF FF FF  Ag.r.e.e.n....1.................
47 52 45 45 4E 31 20 20 20 20 20 10 00 00 8A 8D 6F 3E 6F 3E 00 00 8A 8D 6F 3E 06 00 00 00 00 00  GREEN1      .....o>o>....o>......
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................................
```

FAT32 Layout

Logical Block Address of this file

```
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
42 41 52 20 20 20 20 20 54 58 54 20 18 64 9B 8D 6F 3E 79 4A 00 00 9B 8D 6F 3E 11 00 08 00 00 00   BAR     TXT .d..o>yJ....o>......
4E 55 4D 20 20 20 20 20 54 58 54 20 18 34 8D 63 7A 4A 7A 4A 00 00 8D 63 7A 4A 30 1C 00 0A 00 00   NUM     TXT .4.czJzJ...czJ0.....
44 45 41 44 42 45 45 46 54 58 54 20 18 75 55 5A 7A 4A 7A 4A 00 00 55 5A 7A 4A 29 1D 31 10 00 00   DEADBEEFTXT .uUZzJzJ..UZzJ).1...
41 2E 00 5F 00 2E 00 54 00 72 00 0F 00 7F 61 00 73 00 68 00 65 00 73 00 00 00 00 00 FF FF FF FF   A.._...T.r....a.s.h.e.s.........
7E 31 20 20 20 20 20 20 54 52 41 22 00 1B 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 5A 19 00 10 00 00   ~1      TRA"...czJzJ...czJZ.....
E5 52 41 53 48 45 7E 31 4C 5A 4B 12 00 1B 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 59 19 00 00 00 00   .RASHE~1LZK....czJzJ...czJY.....
46 4F 4F 20 20 20 20 20 54 58 54 20 18 64 99 8D 6F 3E 79 4A 00 00 99 8D 6F 3E 10 00 08 00 00 00   FOO     TXT .d..o>yJ....o>......
41 46 00 6F 00 6C 00 64 00 65 00 0F 00 03 72 00 41 00 00 00 FF FF FF FF FF FF 00 00 FF FF FF FF   AF.o.l.d.e....r.A...............
46 4F 4C 44 45 52 41 20 20 20 20 10 00 68 8D 44 73 4A 73 4A 00 00 8D 44 73 4A D3 17 00 00 00 00   FOLDERA    ..h.DsJsJ...DsJ......
41 2E 00 54 00 72 00 61 00 73 00 0F 00 25 68 00 65 00 73 00 00 00 FF FF FF FF 00 00 FF FF FF FF   A..T.r.a.s...%h.e.s.............
54 52 41 53 48 45 7E 31 20 20 20 12 00 1B 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 59 19 00 00 00 00   TRASHE~1   ....czJzJ...czJY.....
E5 31 20 20 20 20 20 20 54 45 4D 22 00 19 12 46 73 4A 79 4A 00 00 12 46 73 4A 50 19 00 10 00 00   .1      TEM"...FsJyJ...FsJP.....
41 66 00 61 00 74 00 73 00 70 00 0F 00 44 65 00 63 00 2E 00 70 00 64 00 66 00 00 00 00 00 FF FF   Af.a.t.s.p...De.c...p.d.f.......
46 41 54 53 50 45 43 20 50 44 46 20 00 64 38 8F 6F 3E 7A 4A 00 00 38 8F 6F 3E 0C 15 8A 4E 05 00   FATSPEC PDF .d8.o>zJ..8.o>...N..
41 2E 00 66 00 73 00 65 00 76 00 0F 00 DA 65 00 6E 00 74 00 73 00 64 00 00 00 00 00 FF FF FF FF   A..f.s.e.v....e.n.t.s.d.........
46 53 45 56 45 4E 7E 31 20 20 20 12 00 20 87 63 7A 4A 7A 4A 00 00 87 63 7A 4A 62 19 00 00 00 00   FSEVEN~1   .. .czJzJ...czJb.....
2E 20 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E 03 00 00 00 00 00   .          ..dy.o>o>..y.o>......
2E 2E 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E C0 17 00 00 00 00   ..         ..dy.o>o>..y.o>......
E5 66 00 30 00 00 00 FF FF FF FF 0F 00 C7 FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   .f.0............................
E5 30 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A6 10 00 02 00 00   .0          ....o>WE....o>......
E5 66 00 31 00 00 00 FF FF FF FF 0F 00 4A FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   .f.1.........J..................
E5 31 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A7 10 00 02 00 00   .1          ....o>WE....o>......
E5 66 00 32 00 00 00 FF FF FF FF 0F 00 CA FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   .f.2............................
E5 32 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A8 10 00 02 00 00   .2          ....o>WE....o>......
E5 66 00 33 00 00 00 FF FF FF FF 0F 00 47 FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   .f.3.........G..................
E5 33 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E A9 10 00 02 00 00   .3          ....o>WE....o>......
E5 66 00 34 00 00 00 FF FF FF FF 0F 00 C9 FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   .f.4............................
E5 34 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E AA 10 00 02 00 00   .4          ....o>WE....o>......
E5 66 00 35 00 00 00 FF FF FF FF 0F 00 3C FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   .f.5.........<..................
E5 35 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E AB 10 00 02 00 00   .5          ....o>WE....o>......
E5 66 00 36 00 00 00 FF FF FF FF 0F 00 BC FF FF FF FF FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   .f.6............................
E5 36 20 20 20 20 20 20 20 20 20 20 00 00 D8 8E 6F 3E 57 45 00 00 D8 8E 6F 3E AC 10 00 02 00 00   .6          ....o>WE....o>......
2E 20 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E 04 00 00 00 00 00   .          ..dy.o>o>..y.o>......
2E 2E 20 20 20 20 20 20 20 20 20 10 00 64 79 8D 6F 3E 6F 3E 00 00 79 8D 6F 3E C0 17 00 00 00 00   ..         ..dy.o>o>..y.o>......
41 67 00 72 00 65 00 65 00 6E 00 0F 00 CA 31 00 00 00 FF FF FF FF FF FF FF FF 00 00 FF FF FF FF   Ag.r.e.e.n....1.................
47 52 45 45 4E 31 20 20 20 20 20 10 00 00 8A 8D 6F 3E 6F 3E 00 00 8A 8D 6F 3E 06 00 00 00 00 00   GREEN1     .....o>o>....o>......
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................................
```

FAT32 Layout

- How do we get the root directory information?
- fseek to the root directory address.
- Loop from i = 0 to i < 16
  - fread 32 bytes into your directory entry array

FAT32 Layout

```
/*
 *Function    : LBAToOffset
 *Parameters  : The current sector number that points to a block of data
 *Returns     : The value of the address for that block of data
 *Description : Finds the starting address of a block of data given the sector number
 *corresponding to that data block.
 */
int LBAToOffset(int32_t sector){
    return (( sector - 2 ) * BPB_BytesPerSec) + (BPB_BytesPerSec * BPB_RsvdSecCnt) +  (BPB_NumFATs * BPB_FATSz32 * BPB_BytesPerSec);
}
```

FAT32 Layout

```
/*
 Name: NextLB
 Purpose: Given a logical block address, look up into the first FAT and
 return the logical block address of the block in the file.  If
 there is no further blocks then return -1
 */
int16_t NextLB( uint32_t sector )
{
  uint32_t FATAddress =  ( BPB_BytsPerSec * BPB_RsvdSecCnt ) + ( sector * 4 );
  int16_t val;
  fseek( fp, FATAddress, SEEK_SET );
  fread( &val, 2, 1, fp );
  return val;
}
```

FAT32 Layout

- Files to help debug on the fat32.img
- num.txt - 5 512-byte blocks of consecutive numbers. 512 0's followed by 512 1's … etc
- deadbeef.txt - 4145 bytes file of DEADBEEF repeating
- foo.txt - "1 2 3 4"
- bar.txt - "5 6 7 8"