
Freescale MQX™ MFS™ User's Guide

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How to Reach Us:

Home Page:

www.freescale.com

E-mail:

support@freescale.com

USA/Europe or Locations Not Listed:

Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

Europe, Middle East, and Africa:

Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
support@freescale.com

Japan:

Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064, Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:

Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 10 5879 8000
support.asia@freescale.com

For Literature Requests Only:

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Revision History

To provide the most up-to-date information, the revision of our documents on the World Wide Web will be the most current. Your printed copy may be an earlier revision. To verify you have the latest information available, refer to <http://www.freescale.com/mqx>.

The following revision history table summarizes changes contained in this document.

Revision Number	Revision Date	Description of Changes
Rev. 0	01/2009	Initial Release coming with MQX 3.0
Rev. 0B	04/2009	Text edited and formatting changed for MQX 3.1 release.
Rev. 2	01/2010	Updated for MQX 3.5. New configuration options described (MFSCFG_READ_ONLY_CHECK and similar).
Rev. 2.1	03/2010	Example for IO_IOCTL_GET_DATE_TIME corrected.
Rev. 2.2	08/2010	Chapter 3.8.1.9 IO_IOCTL_FIND_NEXT_FILE updated.

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Chapter 1 Before You Begin

1.1 About This Book

This book is a guide and reference manual for using the MQX™ MFS™ Embedded File System, which is a part of Freescale MQX Real-Time Operating System distribution.

This *MFS™ User's Guide* is written for experienced software developers who have a working knowledge of the C language and the target processor.

1.2 Where to Look for More Information

- The release notes document accompanying the Freescale MQX release provides information that was not available at the time this user's guide was published.
- The *MQX User's Guide* describes how to create embedded applications that use the MQX RTOS.
- The *MQX Reference Manual* describes prototypes for the MQX API.

1.3 Product Names

In this book, we use MFS as the abbreviation for the Freescale MQX™ MFS™ Embedded File System.

1.4 Typographic Conventions

Throughout this book, we use typographic conventions to distinguish terms.

Font style	Usage	Example
Bold	Function families	The <code>_io_mfs</code> family of functions.
Bold	Function names	<code>_io_mfs_install()</code>
<i>Italic</i>	Data types (simple)	<code><i>uint_32</i></code>
	Data types (complex)	See following example.
Constant-width	Code and code fragments	—
	Data types in prototype definitions	See following example.
	Directives	<code>#include "mfs.h"</code>
	Code and code fragments	
<i>Italic</i>	Filenames and path names	<code><i>part_mgr.h</i></code>
<i>Italic</i>	Symbolic parameters that you substitute with your values.	See following example.
<i>UPPERCASE Italic</i>	Symbolic constants	<code><i>MFS_NO_ERROR</i></code>

1.4.1 Example: Prototype Definition, Including Symbolic Parameters

```
uint_32 _io_mfs_install(  
    FILE_PTR dev_fd,  
    char_ptr identifier,  
    uint_32 partition_num)
```

1.4.2 Example: Complex Data Types and their Field Names

The structure *MFS_DATE_TIME_PARAM* contains the following fields:

- *DATE_PTR*
- *TIME_PTR*

1.5 Other Conventions

1.5.1 Cautions

Cautions tell you about commands or procedures that could have unexpected or undesirable side effects or could be dangerous to your files or your hardware.

CAUTION	If an application calls read and write functions with the partition manager, the file system will be corrupted.
----------------	---

Chapter 2 Using MFS

2.1 MFS at a Glance

MFS provides a library of functions that is compatible with the Microsoft MS-DOS file system. The functions let an embedded application access the file system in a manner that is compatible with MS-DOS Interrupt 21 functions. All the functions guarantee the application tasks mutually exclusive access to the file system.

MFS is a device driver that an application must install over a lower-level device driver. Examples of lower-level drivers are drivers for memory devices, flash disks, floppy disks, or partition-manager devices. MFS uses the lower-level driver to access the hardware device.

MFS functions do the following:

- They traverse MS-DOS directory structure.
- They create and remove subdirectories.
- They find files.
- They create and delete files.
- They open and close files.
- They read from files and write to files.
- They view and modify file characteristics.
- They get the amount of free space in the file system.

2.2 MS-DOS File System Characteristics

2.2.1 Directory Path Names

MFS allows an application to traverse a directory tree. When you specify a directory path, you can use \ and / as directory separators.

You can specify a directory path in one of two ways:

- By starting with a directory separator — the path is assumed to be an absolute path.
- By starting without a directory separator — the path is assumed to be relative to the current directory.

2.2.2 File Attributes

Each file entry in the MS-DOS file system has an attribute byte associated with it. The attribute byte is described in more detail in the following table.

2.2.2.1 Bit Number

7	6	5	4	3	2	1	0	Meaning if bit is set to one.
							x	Read-only file
						x		Hidden file
					x			System file
				x				Volume label
			x					Directory name
		x						Archived file
x	x							RESERVED

The volume-label and directory-name bits are mutually exclusive.

2.2.2.2 Volume Label

A file entry can be marked as a volume label. There can be only one volume label in a file system, and it must reside in the root directory. That label cannot also act as a directory name.

2.2.3 File Time

Each file entry has a 16-bit time field associated with it. In MFS, the time is written into the field when the file entry is created, when the file is closed, and as a result of calling *IO_IOCTL_SET_DATE_TIME*. The format of the time field is as follows:

Element	Bits used	Values
Seconds	0 – 4	0 – 29 (multiply by two for seconds)
Minutes	5 – 10	0 – 60
Hours	11 – 15	0 – 24 (24-hour clock)

2.2.4 File Date

Each file entry has a 16-bit date field associated with it. In MFS, the date is written into the field when the file entry is created, when the file is closed, and as a result of calling *IO_IOCTL_SET_DATE_TIME*. The format of the date field is as follows:

Element	Bits used	Values
Days	0 – 4	1 – 31
Months	5 – 8	1 – 12
Year	9 – 15	0 – 119 (1980 – 2099)

2.2.5 File Allocation Table

The MS-DOS file system can have multiple copies of the file allocation table. MFS updates as many FATs as configured for. It only reads from the first FAT.

2.2.6 Filename Wildcards

The characters * and ? are treated as wildcards in a filename.

2.3 High-Level Formatting

An application can perform high-level formatting on a disk by calling **ioctl()**. The function writes a new boot sector, deallocates all clusters in the file allocation table, and deletes all entries in the root directory.

There is one input/output control command that formats the disk, and one that formats and checks for bad clusters.

The *MFS_IOCTL_FORMAT_PARAM* structure is used:

```
typedef struct mfs_ioctl_format
{
    MFS_FORMAT_DATA_PTR    FORMAT_PTR;
    uint_32_ptr            COUNT_PTR; /* To count bad clusters */
} MFS_IOCTL_FORMAT_PARAM, _PTR_ MFS_IOCTL_FORMAT_PARAM_PTR;
```

The first variable is a pointer to a *MFS_FORMAT_DATA* structure (described below). The second is **uint_32_ptr** that points to the **uint_32** variable that is used to contain the count of bad sectors. It is used only if the *IO_IOCTL_FORMAT_TEST* function is used.

```
typedef struct mfs_format_data
{
    uchar    PHYSICAL_DRIVE;
    uchar    MEDIA_DESCRIPTOR;
    uint_16  BYTES_PER_SECTOR;
    uint_16  SECTORS_PER_TRACK;
    uint_16  NUMBER_OF_HEADS;
    uint_32  NUMBER_OF_SECTORS;
    uint_32  HIDDEN_SECTORS;
    uint_16  RESERVED_SECTORS;
} MFS_FORMAT_DATA, _PTR_ MFS_FORMAT_DATA_PTR;
```

The *MFS_FORMAT_DATA* structure has the following fields:

- *PHYSICAL_DRIVE*
 - 0x00 for floppy disks; 0x80 for hard disks.
- *MEDIA_DESCRIPTOR*
 - 0xFD for 5.25" 360 K diskettes.
 - 0xF9 for 5.25" 1200 K diskettes.
 - 0xF9 for 3.5" 720 K diskettes.
 - 0xF0 for 3.5" 1440 K diskettes and other removable media.
 - 0xF8 for hard disk and other non-removable media.

- **BYTES_PER_SECTOR**
— Size of a block in bytes (usually 512).
- **SECTORS_PER_TRACK**
— Number of sectors in a track.
- **NUMBER_OF_HEADS**
— Number of disk heads.
- **NUMBER_OF_SECTORS**
— Total number of sectors on the disk, including reserved sectors.
- **HIDDEN_SECTORS**
— For hard disks, it is the number of sectors from the beginning of the disk to the beginning of the partition. This is the same number as the *relative sectors* field in a hard disk partition table. For floppy disks, the field is zero.
- **RESERVED_SECTORS**
— Number of sectors from the beginning of the file system to the first FAT sector. It is usually one.

2.4 Version of MFS

The constant `MFS_VERSION` defines the version and revision numbers for MFS.

2.5 Customizing MFS

The following constant definitions can be overridden to customize MFS. To override any of these definitions, simply define the desired value in the `/config/<board>/user_config.h` file.

```
#define MFSCFG_MINIMUM_FOOTPRINT 1
— Normally not defined. Define to build MFS for small memory devices.

#define MFSCFG_READ_ONLY 0
— Set to one to build MFS in read-only mode (no create, write, or format capability). This reduces code size and may be useful in certain applications such as boot loaders. Set to one to enable write functionality.

#define MFSCFG_READ_ONLY_CHECK 1
— Enable runtime checking whether or not an underlying device operates in read-only mode. This check is made before any attempt to write to a device and returns gracefully with an appropriate error code. The read-only mode is detected by using the IO_IOCTL_DEVICE_IDENTIFY command once when opening MFS device. The mode detected is used until the device is closed.

#define MFSCFG_READ_ONLY_CHECK_ALLWAYS 0
— When this option is set and MFSCFG_READ_ONLY_CHECK is also set, the read-only mode is checked at the device level allways (by using the IO_IOCTL_DEVICE_IDENTIFY command) and not only during an open call. Use this option with devices where read-only state may change in run-time (e.g. SD Card storage).

#define MFSCFG_ENABLE_FORMAT 1
— Set to one to build MFS with the format command, zero otherwise.

#define MFSCFG_CALCULATE_FREE_SPACE_ON_OPEN 1
```

- Set to one to calculate the available free space on the drive when the drive is mounted. Calculating the available free space is time-consuming on large drives, as the entire FAT must be read. When set to zero, this operation is deferred until the first time the free space is required (which may be never).

```
#define MFSCFG_MINIMUM_FOOTPRINT 1
```

- Set to one to build MFS for small-memory devices, zero otherwise.

```
#define MFSCFG_MAX_READ_RETRIES 1
```

```
#define MFSCFG_MAX_WRITE_RETRIES 1
```

- Number of times MFS attempts to read or write to the device unsuccessfully, before it reports an error.

```
#define MFSCFG_FAT_CACHE_SIZE 2
```

- Maximum number of sectors of the file allocation table that MFS keeps stored in memory. On systems with a lot of memory, increasing this number such that the entire FAT fits in memory will increase the speed of MFS because it performs fewer read and write operations on the disk.

```
#define MFSCFG_NUM_OF_FATS 2
```

- This parameter is only used when formatting, and specifies the number of file allocation tables that will be placed on the drive. A minimum of one is required. The first FAT is the one used by MFS, and the others are backups. Microsoft Windows uses two as its standard. If you choose one, MFS operates somewhat faster when it writes to the disk, because it has half the number of FAT write operations to do.

```
#define MFSCFG_HANDLE_INITIAL 4
```

```
#define MFSCFG_HANDLE_GROW 4
```

```
#define MFSCFG_HANDLE_MAX 0
```

- Number of initial file handles, the amount to raise the file handles by, when none are available, and the maximum number of simultaneous file handles.

```
#define MFSCFG_FIND_TEMP_TRIALS 300
```

- Number of times MFS will attempt to create a unique temporary filename before returning an error.

Sector boundaries determine the cluster size, the root directory size, and the FAT type that is used when formatting a disk. These can be modified in *mfs.h* to customize the formatting of the disk. By default, the following values are used:

	# Sectors	FAT Type	Root directory entries	Cluster size in sectors
<i>SECTOR_BOUND1</i>	2048	FAT12	7 × 32	1
<i>SECTOR_BOUND2</i>	4096	FAT12	14 × 32	1
<i>SECTOR_BOUND3</i>	8192	FAT12	32 × 32	2
<i>SECTOR_BOUND4</i>	16384	FAT12	32 × 32	4
<i>SECTOR_BOUND5</i>	32768	FAT12	32 × 32	2
<i>SECTOR_BOUND6</i>	524288	FAT16	32 × 32	8
<i>SECTOR_BOUND7</i>	1048576	FAT16	32 × 32	16
<i>SECTOR_BOUND7a</i>	2097152	FAT16	32 × 32	32
<i>SECTOR_BOUND8</i>	16777216	FAT32	64 k	8

	# Sectors	FAT Type	Root directory entries	Cluster size in sectors
<i>SECTOR_BOUND9</i>	33554432	FAT32	64 k	16
<i>SECTOR_BOUND10</i>	67108864	FAT32	64 k	32

Table 2-1. Summary: MFS Functions

_io_mfs_install	Installs MFS.
_io_mfs_uninstall	Uninstalls MFS.
fclose	Closes the file or device.
fopen	Opens the file or device.
ioctl	Issues a control command.

Functions are described in “Reference: Functions”

2.6 Partition Manager Device Driver

The partition manager device driver is designed to be installed under the MFS device driver. It lets the MFS work independently of the multiple partitions on a disk. It also enforces mutually exclusive access to the disk, which means that two concurrent write operations from two different MFS devices cannot be in conflict. The partition manager device driver can remove partitions, as well as create new ones.

The partition manager device driver creates multiple primary partitions. It does not support extended partitions.

The partition manager device driver is installed and opened like other devices. It must also be closed and uninstalled when an application no longer needs it.

An application follows these steps to use the partition manager. Functions are described in [Chapter 3, “Reference: Functions.”](#)

1. It installs the partition manager (**_io_part_mgr_install()**).
2. It opens the partition manager (**fopen()**).
3. It issues input/output control commands (**ioctl()**).
4. It closes the partition manager (**fclose()**).
5. It uninstalls the partition manager device driver (**_io_part_mgr_uninstall()**).

CAUTION

If an application calls read and write functions with the partition manager, the file system will be corrupted.

Table 2-2. Summary: Partition Manager Device Driver Functions

<code>_io_part_mgr_install</code>	Installs the partition manager device driver.
<code>_io_part_mgr_uninstall</code>	Uninstalls the partition manager device driver.
<code>fclose</code>	Closes the partition manager.
<code>fopen</code>	Opens the partition manager.
<code>ioctl</code>	Issues a control command to the partition manager.

2.7 Working with Removable Media

Removable-media devices are a class of device, in which the medium, upon which files are written to and read from, can be inserted and removed. Examples include:

- USB mass storage devices (flash drives, and so on)
- ATA PCMCIA (PC card) flash cards
- SD Cards
- removable hard drives
- floppy-disk drives

An application that installs MFS on removable media must take some standard precautions.

2.7.1 Buffering and Caching

MFS maintains three internal buffers, or caches:

- The FAT cache, two or more sectors in size.
- A directory-sector buffer, exactly one sector in size.
- A file-sector buffer, exactly one sector in size.

When writing, an application can control how the buffers are flushed. There are three modes:

- *WRITE_THROUGH* — the buffer contents are immediately written to disk when modified.
- *WRITE_BACK* — the buffer contents are written to disk on application command, or prior to reading a different sector.
- *MIXED_MODE* — the buffer contents are written to disk on application command, prior to reading a different sector, or when a file is closed.

If MFS detects that the lower-layer device is removable, the FAT cache will be placed in write through mode, and the directory and file caches will be placed in mixed mode. If the lower-layer device is not removable, all caches will be placed in write back mode.

An application can modify the cache modes with the appropriate `ioctl()` calls. When using removable media, the application must ensure that all files are closed and the MFS device itself is closed before the media is removed. These steps ensure that the caches are flushed and the media is updated.

2.7.2 Writing to Media

Writing to the media (either to partition the media, format the media, or write a file) must be completed before the media is removed. If the media is removed during a write operation, the media may be corrupted.

2.7.3 Hotswapping

With MFS, an application can implement hotswapping. To properly implement hotswapping, however, the lower-layer device must support a mechanism for notifying the application that the media is removed or inserted.

When an application detects that the media has been inserted, it must do the following:

1. Open the lower-layer device.
2. Optionally install the partition manager on the device.
3. If the partition manager is installed, open the partition manager.
4. Install MFS on the device (or on the partition manager if the partition manager is installed)
5. Open the MFS device.

When an application detects that the media has been removed, it must do the following:

1. Close all files that are open on the device.
2. Close the MFS device.
3. Uninstall the MFS device.
4. If the partition manager is installed, close it.
5. If the partition manager is installed, uninstall it.
6. Close the lower-layer device.

2.7.3.1 Example: Hotswapping

For an example that demonstrates hotswapping with a USB flash drive, see: *mfs\example\mfs_usb*.

Chapter 3 Reference: Functions

3.1 In This Chapter

Alphabetically sorted prototype definitions for MFS and the partition manager device driver.

3.2 `_io_mfs_install`

Install MFS.

Synopsis

```
uint_32 _io_mfs_install(
    /* [IN] the device on which to install MFS */
    FILE_PTR    dev_fd,
    /* [IN] Name to be given to MFS (e.g. "C:", "MFS1:") */
    /* The name must end in a colon ":" */
    char_ptr    identifier,
    /* [IN] Partition number to install MFS on. */
    /* 0 for no partitions */
    uint_32     partition_num)
```

Description

The function initializes MFS and allocates memory for all of the internal MFS data structures. It also reads some required drive information from the disk, on which it is installed. MFS supports FAT12, FAT16, and FAT32 file systems. If the disk has a different file system or if it is unformatted, you can use MFS to format it to one of the supported file systems.

If the application uses a partitioned disk, you must install MFS on a partition manager device driver. The partition manager device driver can create partitions on the disk if there are none; it can also remove partitions.

Return Codes

Returns a **uint_32** error code.

- *IO_EOF*
 - The **FILE_PTR** passed into `_io_mfs_install()` was NULL. The error is returned by the input/output subsystem of the MQX™ Real-Time Operating System.
- *MFS_ERROR_UNKNOWN_FS_VERSION*
 - MFS was installed on a disk using the FAT32 file system, and the FAT32 version is incompatible with the MFS FAT32 version (version zero).
- *MFS_INSUFFICIENT_MEMORY*
 - MFS could not allocate memory for required structures.
- *MFS_NO_ERROR*
 - The function call was successful.
- *MFS_NOT_A_DOS_DISK*
 - The partition, on which MFS installed is not a valid DOS partition. The partition must be formatted (by an input/output control command).
- *MFS_NOT_INITIALIZED*
 - The MFS device name did not end with colon (:).
- *MFS_READ_FAULT*

- The lower-level device driver could not read from the disk. The error is returned from the device, over which MFS is installed.
- *MFS_SECTOR_NOT_FOUND*
 - The error is returned from the device, over which MFS is installed.
- *PGMR_INVALID_PARTITION*
 - The partition number specified was that of an invalid partition. The partition does not exist.

Example

Install MFS on a RAM disk with no partitions.

```

/* Install the memory device: */
error_code = _io_mem_install("mfsram:",
    NULL, MFS_format.BYTES_PER_SECTOR * RAMDISK_LENGTH1);
if ( error_code != MQX_OK ) {
    printf("Error installing device.\nError: %d\n", error_code);
    _mqx_exit(1);
}

/* Open the device on which MFS will be installed: */
dev_handle1 = fopen("mfsram:", 0);
if ( dev_handle1 == NULL ) {
    printf("\nUnable to open RAM disk device");
    _task_block();
}

/* Install MFS: */
error_code = _io_mfs_install(dev_handle1, "MFS1:", 0);
if ((error_code != MFS_NO_ERROR) &&
    (error_code != MFS_NOT_A_DOS_DISK)) {
    printf("FATAL error while initializing: \n");
    _mqx_exit(1);
} else {
    printf("Initialized MFS1%s\n");
}

```

3.3 `_io_mfs_uninstall`

Uninstall MFS.

Synopsis

```
uint_32 _io_mfs_uninstall(  
    /* [IN] String that identifies the device driver */  
    /* to uninstall. Must be identical to the string */  
    /* that was used to install the MFS device driver */  
    char_ptr    identifier)
```

Description

This function uninstalls the MFS device driver and frees the memory allocated for it. Before you call the function, you must close the MFS device driver by calling **fclose()**.

Return Codes

Returns a **uint_32** error code.

- **MFS_INVALID_PARAMETER**
— The identifier passed to the function is invalid.
- **MFS_SHARING_VIOLATION**
— There are files still open on the device, or the MFS device is still open.

Example

```
error_code = _io_mfs_uninstall("MFS1:");
```

3.4 `_io_part_mgr_install`

Installs the partition manager device driver.

Synopsis

```
int_32 _io_part_mgr_install(
    /*[IN] Handle of the device on which to install */
    /* the partition manager */
    FILE_PTR    dev_fd,
    /*[IN] New name of the partition manager device */
    char_ptr    identifier,
    /*[IN] Size of sectors in bytes on the lower level device */
    uint_32     sector_size)
```

Description

This function initializes the partition manager device driver and allocates the memory for its internal structures.

The first parameter is the handle acquired by opening the lower-level device driver using **fopen()** (for example, `dev_fd = fopen("flashdisk", 0)`).

The second parameter is the identifier, under which the partition manager is to be installed.

The third parameter is the sector size of the disk. If you specify zero, the partition manager queries the disk for the sector size. If the query fails, the partition manager uses a default sector size, as defined by *PMGR_DEFAULT_SECTOR_SIZE*. The default is 512 bytes.

Errors

- *PMGR_INSUF_MEMORY*
— Partition manager could not allocate memory for its internal data.
- *PMGR_INVALID_PARTITION*
— Partition manager is installed, but there are no valid partitions on the disk. You must create at least one partition (using *IO_IOCTL_SET_PARTITION*) before you can install the partition manager.

Example

Install the partition manager as "PM:" and let it determine the sector size.

```
error_code = _io_part_mgr_install(dev_fd, "PM:", 0);
```

3.5 `_io_part_mgr_uninstall`

Uninstalls the partition manager.

Synopsis

```
int_32 _io_part_mgr_uninstall(  
    /*[IN] Identifier string of the device */  
    char_ptr identifier)
```

Description

You must close the partition manager before you uninstalled it. The first parameter is the same identifier that is used with `_io_part_mgr_install()`.

Errors

- `IO_EOF`
— Incorrect *identifier*.

Example

```
error_code = _io_part_mgr_uninstall("PM:");
```

3.6 fclose

Closes the device or file.

Synopsis

```
int_32 _io_fclose(
    /* [IN] Stream to close (MFS) */
    /* or file pointer of the partition manager to close */
    FILE_PTR    file_ptr)
```

Description

This function frees the memory allocated for the given *FILE_PTR* (which was returned when the application called **fopen()** on a file). It also updates the date, time, and size of the file on the disk.

When the application no longer needs to use the device driver, it can close the device driver and uninstall it. The function **fclose()** is used to close the device driver if the device driver *FILE_PTR* is passed as a parameter (as opposed to a regular file *FILE_PTR*). The function fails if any files are still open on the device.

Return Codes for MFS

- *IO_EOF*
— *file_ptr* was invalid.
- *MFS_SHARING_VIOLATION*
— Files are open on the device.

Example: MFS

See **fopen()**.

Example: Partition Manager Device Driver

```
pmgr_fd_ptr = fopen("PM:", NULL);
...
...
/* End of application. */
fclose(pmgr_fd_ptr);
_io_part_mgr_uninstall("PM:");
```

3.7 fopen

Opens the device or file.

Synopsis

```
FILE_PTR _io_fopen(
    /* [IN] Name of the device or file to open      */
    /* Must be identical to the name that was used */
    /* to install the device driver */
    char _PTR_ open_type_ptr,
    /* [IN] I/O parameter to pass to device initialization */
    /* This parameter is for extra parameters. It is only */
    /* used when opening files */
    /* Must be NULL for the partition manager */
    char _PTR_ open_mode_ptr)
```

Description

This function opens the specified device driver (for MFS or the partition manager). You must install the device driver before you call the function. Opening the device returns a *FILE_PTR* for the device that can be used in input/output control commands (see [Section 3.8, “ioctl”](#)).

The first time **fopen()** is called on the device driver, it opens the device driver. Each subsequent call is used to open a file. This means that you must first call **fopen()** with the device name (just once to open the device) with NULL as the *open_mode_ptr*, and then every other call will be to open a file. Each of these other calls should include the device name, along with a specific flag for the *open_mode_ptr*.

The function is also used to open files on the device. Opening a file returns a *FILE_PTR* for that file. This is used to read and write to the file. All the standard read and write functions work on files (**write()**, **read()**, **fscanf()**, **fputc()**, and so on). All the other standard input/output functions also work on devices (for example, **fseek()** changes the position within a file).

Here is a list of the standard MQX functions that can be used:

```
_io_clearerr(), _io_fclose(), _io_feof(), _io_ferror(), _io_fflush(), _io_fgetc(), _io_fgetline(),  
_io_fgets(), _io_fopen(), _io_fprintf(), _io_fputc(), _io_fputs(), _io_scanf(), _io_fseek(), _io_fstatus(),  
_io_ftell(), _io_fungetc(), _io_ioctl(), _io_printf(), _io_putc(), _io_read(), _io_scanf(), _io_sprintf(),  
_io_sscanf(), _io_vprintf(), _io_vfprintf(), _io_vsprintf(), _io_write().
```

To open a file, you must pass the name of the device followed by the name of the file. To open the file *data.txt* in the current directory:

```
fd_ptr = fopen("MFS1:data.txt", "w");
To open the file March2000results.data in the MFS1:\data\march directory:
fd_ptr = fopen("MFS1:\data\march\March2000results.data");
```


Here is a list of different options for the second parameter:

Option	Description
NULL	Open the device (either MFS or the partition manager).
"w"	Open a new file in "write-only" mode; overwrite an existing file.
"w+"	Open a new file in "read-write" mode; overwrite an existing file.
"r"	Open an existing file in "read-only" mode.
"r+"	Open an existing file in "read-write" mode.
"a"	Open a file at EOF in "write" mode; create the file if it does not exist.
"a+"	Open a file at EOF in "read-write" mode; create the file if it does not exist.
"n"	Open a new file in "write-only" mode; do nothing if the file already exists.
"n+"	Open a new file in "read-write" mode; do nothing if the file already exists.
"x"	Create a temporary file. MFS or the partition manager assigns the filename and appends it to the end of the <i>char_PTR</i> passed into the function. This means that you must have at least 15 bytes of unused space at the end of the <i>open_type_ptr</i> string, and its last used byte cannot be a directory separator.

Returns

Returns a *FILE_PTR* to the new file or to the device on success.

Returns NULL on failure and calls `_task_set_error()` to set the task error code.

Example: MFS

Open the MFS device driver and open a file on the device.

```
char buffer[100] = "This a test file";
char buffer2[100];
/* Open the MFS device driver: */
mfs_fd_ptr = fopen("MFS1:", NULL);
if (mfs_fd_ptr == NULL) {
    printf("Error opening the MFS device driver!");
    _mqx_exit(1);
}
/* Open file on disk in the current directory and write to it: */
fd_ptr = fopen("MFS1:myfile.txt", "w+");
write(fd_ptr, buffer, strlen(buffer));
read(fd_ptr, buffer2, strlen(buffer));

/* Close the file: */
error_code = fclose(fd_ptr);

/* Open other files, create directories, and so on. */

/* The application has done all it needs. */
/* Close the MFS device driver and uninstall it: */
error_code = fclose(mfs_fd_ptr);
```

Reference: Functions

```
if (!error_code) {
    error_code = _io_mfs_uninstall("MFS1:");
} else if (error_code == MFS_SHARING_VIOLATION) {
    printf("There are open files on the device. Call fclose on their
        handles before attempting to fclose the device driver");
}
```

Example: Partition Manager Device Driver

The example assumes that the partition manager is already installed.

```
pmgr_fd_ptr = fopen("PM:",NULL);
```

3.8 ioctl

Issues a control command.

Synopsis

```
int_32 _io_ioctl(
    /* [IN] Stream to perform the operation on */
    FILE_PTR    file_ptr,
    /* [IN] I/O control command */
    uint_32     cmd,
    /* [IN] I/O control-command parameters */
    uint_32_ptr param_ptr)
```

Description

The first parameter is a *FILE_PTR* (returned by calling **fopen()** for the device driver), which can either be the handle of a specific file, or the handle of the device driver itself. It varies, depending on which command is used. The third parameter is a *uint_32_ptr*. Depending upon the input/output control command, it is usually a different kind of pointer cast to a *uint_32_ptr*. For example, it might be a *char_ptr*, a pointer to a structure, or even just a NULL pointer.

CAUTION

MFS_io_ioctl calls do not always follow the standard of returning data as the third parameter and the result as the function return. In many cases, data is returned as the function return, and an error code is not available. Care must be taken to ensure that the *_io_ioctl* call is used correctly for the specified control command.

3.8.1 Input/Output Control Commands for MFS

As well as the MQX input/output control commands, MFS includes the following input/output control commands.

3.8.1.1 IO_IOCTL_BAD_CLUSTERS

Gets the number of bad clusters on the drive.

```
num_of_bad_clusters = ioctl(mfs_fd_ptr,
                            IO_IOCTL_BAD_CLUSTERS,
                            NULL);
```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver. The *mfs_fd_ptr* must correspond to the disk, on which the bad clusters are to be counted. The third parameter is a NULL pointer.

3.8.1.2 IO_IOCTL_CHANGE_CURRENT_DIR

Change the current directory.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_CHANGE_CURRENT_DIR,
                  (uint_32_ptr) pathname);
```

If *pathname* begins with a directory separator, it is assumed that *pathname* represents the complete directory name. If *pathname* does not begin with a directory separator, *pathname* is assumed to be relative to the current directory. The third parameter is a *char_ptr* (to a directory name) cast to a *uint_32_ptr*.

The directory path must exist for the change to succeed.

Errors

- *MFS_INVALID_LENGTH_IN_DISK_OPERATION*
— Path name is too long. The full path name (including the filename) can be no longer than 260 characters.

Example

```
char pathname = "\\docs";
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_CHANGE_CURRENT_DIR,
                  (uint_32_ptr) pathname);
```

3.8.1.3 IO_IOCTL_CREATE_SUBDIR

Creates a subdirectory in the current directory.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_CREATE_SUBDIR,
                  (uint_32_ptr) "\\temp\newdir");
```

A path name can be specified to create the subdirectory in a different directory. The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver corresponding to the disk, on which to operate. The third parameter is a *char_ptr* (to a directory name) cast to a *uint_32_ptr*.

All directories in the path, except the last one, must exist. The last directory in the path must not exist as either a directory or a file.

Errors

- *MFS_CANNOT_CREATE_DIRECTORY*
— There was an error creating the subdirectory.

3.8.1.4 IO_IOCTL_DEFAULT_FORMAT

Format the drive using default parameters.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_DEFAULT_FORMAT,
                  NULL);
```

The command deletes all files and subdirectories on the drive. The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver, which corresponds to the disk, on which to operate. The default parameters are:

- *PHYSICAL_DRIVE* = 0x80
- *MEDIA_DESCRIPTOR* = 0xf8
- *BYTES_PER_SECTOR* = device sector size
- *SECTORS_PER_TRACK* = 0x00

- *NUMBER_OF_HEADS* = 0x00
- *NUMBER_OF_SECTORS* = number of device sectors - *RESERVED_SECTORS*
- *HIDDEN_SECTORS* = 0
- *RESERVED_SECTORS* = 1 if *NUMBER_OF_SECTORS* < 2097152, 32 otherwise

Errors

- *MFS_SHARING_VIOLATION*
— Some files are open on the drive.

Example

```
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_FORMAT, NULL);
```

3.8.1.5 IO_IOCTL_DELETE_FILE

Deletes a file on the disk. Wildcard characters are not valid in the filename.

```
error_code = _io_ioctl(mfs_fd_ptr,
                      IO_IOCTL_DELETE_FILE,
                      (uint_32_ptr) "filename");
```

The *mfs_fd_ptr* is the *FILE_PTR* returned from **fopen()** that opened the MFS device. The third parameter points to a filename, which can include a path (for example *\backup\oldfiles\myfile.txt*). Long filenames and long path names are supported. The file must reside on the drive that corresponds to *mfd_fd_ptr*.

Any currently open handles to this file become invalid; that is, subsequent file operations using a file handle of a deleted file result in an error.

Errors

- *MFS_OPERATION_NOT_ALLOWED*

3.8.1.6 IO_IOCTL_FAT_CACHE_OFF

3.8.1.7 IO_IOCTL_FAT_CACHE_ON

Deprecated: use *IO_IOCTL_SET_FAT_CACHE_MODE*.

Set the FAT cache mode to write through (OFF) or write back (ON).

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_FAT_CACHE_OFF,
                  NULL);
```

The first parameter is the *FILE_PTR* of the MFS device driver that corresponds to the disk, on which the operation is to take place. The third parameter is a NULL pointer.

3.8.1.8 IO_IOCTL_FIND_FIRST_FILE

3.8.1.9 IO_IOCTL_FIND_NEXT_FILE

Searches for a file on the disk.

If a file is found, use the input/output control command *IO_IOCTL_FIND_NEXT_FILE* to keep searching for files with the same criteria as the first. The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver. The third parameter is a pointer to the *MFS_SEARCH_PARAM* structure cast to a *uint_32_ptr*. The three fields of the structure must be initialized. See structure definitions for details.

The third parameter for the *IO_IOCTL_FIND_NEXT_FILE* is a pointer to the *MFS_SEARCH_DATA* structure used in the *IO_IOCTL_FIND_FIRST_FILE* command. It must be cast to a **uint_32_ptr**.

The filename can include wildcard search characters.

When searching for long filenames, only one * is allowed. Everything after the one * is assumed to be wildcard characters.

When searching for files, the file path search string that is passed (in the *MFS_SEARCH_PARAM* structure) is used, so it must not be freed or changed if you plan to subsequently use *IO_IOCTL_FIND_NEXT_FILE*.

The search criteria for the attribute field of the *MFS_SEARCH_PARAM* structure are defined in the following table:

Attribute:	Value:	Return these types of entries:
MFS_SEARCH_NORMAL	0x00	Non-hidden non-system files and directories
MFS_SEARCH_READ_ONLY	0x01	Read only files and directories
MFS_SEARCH_HIDDEN	0x02	Hidden files and directories
MFS_SEARCH_SYSTEM	0x04	System files and directories
MFS_SEARCH_VOLUME	0x08	Volume label only
MFS_SEARCH_SUBDIR	0x10	Non-hidden non-system directories
MFS_SEARCH_ARCHIVE	0x20	Archive files and directories
MFS_SEARCH_EXCLUSIVE	0x40	Match exactly all remaining attributes
MFS_SEARCH_ANY	0x80	All files and directories

The search bit mask can be a combination of all search attributes. The evaluation of the bit mask is done in the following order:

1. If mask includes *MFS_SEARCH_ANY*, then all disk entries match.
2. If mask includes *MFS_SEARCH_VOLUME*, then only the volume label entry matches.
3. If mask includes *MFS_SEARCH_EXCLUSIVE*, then there must be an exact match of the remaining attributes.

4. If mask is `MFS_SEARCH_NORMAL`, then all non-system, non-hidden files and directories match.
5. If mask is `MFS_SEARCH_SUBDIR`, then all non-system, non-hidden directories match.
6. Otherwise mask must be subset of disk entry attributes to produce a match.

The search results are written into the `MFS_SEARCH_DATA` structure addressed by `search_data`. If the `IO_IOCTL_FIND_NEXT` command is used, its results are written over the previous results.

The results of file searches are written into this data structure.

```
typedef struct MFS_search_data
{
    uchar    RESERVED[25];
    uchar    ATTRIBUTE;
    uint_16  TIME;
    uint_16  DATE;
    uint_32  FILE_SIZE;
    char     NAME[13];
} MFS_SEARCH_DATA,
  _PTR_ MFS_SEARCH_DATA_PTR;
```

See also `IO_IOCTL_FIND_FIRST_FILE`, `IO_IOCTL_FIND_NEXT_FILE`, and `IO_IOCTL_GET_DATE_TIME`.

The results of `IO_IOCTL_FIND_FIRST_FILE` and `IO_IOCTL_FIND_NEXT_FILE` are written into a data structure of type `MFS_SEARCH_DATA`.

MFS_SEARCH_DATA Fields

ATTRIBUTE

File entry attribute byte.

TIME

File entry time, as described in `IO_IOCTL_GET_DATE_TIME`.

DATE

File entry date, as described in `IO_IOCTL_GET_DATE_TIME`.

FILE_SIZE

Size of the file in bytes.

NAME[13]

ASCII name of the file in the format *filename.filetype*.

Errors

- `MFS_INVALID_MEMORY_BLOCK_ADDRESS`
— The `MFS_SEARCH_DATA_PTR` in the `MFS_SEARCH_PARAM` is invalid.

Example

```
List all files and subdirectories in a directory.
```

```

MFS_SEARCH_DATA      search_data;
MFS_SEARCH_PARAM     search;
char                 filepath = " *.*";

search.ATTRIBUTE = MFS_SEARCH_ANY;
search.WILDCARD = filepath;
search.SEARCH_DATA_PTR = &search_data;

error_code = ioctl(mfs_fd_ptr, IO_IOCTL_FIND_FIRST_FILE,
                  (uint_32_ptr) &search);

while (error_code == MFS_NO_ERROR) {
    printf ("%12.12s %6lu %02lu-%02lu-%04lu %02lu:%02lu:%02lu
            \n", search_data.NAME, search_data.FILE_SIZE,
            (uint_32)(search_data.DATE & MFS_MASK_MONTH) >>
            MFS_SHIFT_MONTH,
            (uint_32)(search_data.DATE & MFS_MASK_DAY) >>
            MFS_SHIFT_DAY,
            (uint_32)((search_data.DATE & MFS_MASK_YEAR) >>
            MFS_SHIFT_YEAR) + 1980,
            (uint_32)(search_data.TIME & MFS_MASK_HOURS) >>
            MFS_SHIFT_HOURS,
            (uint_32)(search_data.TIME & MFS_MASK_MINUTES) >>
            MFS_SHIFT_MINUTES,
            (uint_32)(search_data.TIME & MFS_MASK_SECONDS) << 1);

    error_code = ioctl(mfs_fd_ptr, IO_IOCTL_FIND_NEXT_FILE,
                      (uint_32_ptr) &search_data);
}

```

3.8.1.10 IO_IOCTL_FIND_NEXT_FILE

See *IO_IOCTL_FIND_FIRST_FILE*.

3.8.1.11 IO_IOCTL_FLUSH_FAT

If the file allocation table has been modified and not yet written to disk, it will be written to disk.

```

error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_FLUSH_FAT,
                  NULL);

```

The first parameter is the *FILE_PTR* of the MFS device driver that corresponds to the disk, on which the operation is to take place. The third parameter is a NULL pointer.

3.8.1.12 IO_IOCTL_FORMAT

Format the drive according to the given specifications.

```

error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_FORMAT,
                  (uint_32_ptr) &format_struct);

```


The command deletes all files and subdirectories on the drive. The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver, which corresponds to the disk, on which to operate. The third parameter is a pointer to the *MFS_IOCTL_FORMAT_PARAM* structure cast to the *uint_32_ptr*. The only field in the *MFS_IOCTL_FORMAT_PARAM* structure that must be initialized is the *FORMAT_PTR* field. See the structure descriptions for details.

Errors

- *MFS_SHARING_VIOLATION*
— Some files are open on the drive.

Example

```
MFS_IOCTL_FORMAT_PARAM    format_struct;
MFS_FORMAT_DATA MFS_format =
{
    /* PHYSICAL_DRIVE;    */    PHYSICAL_DRI,
    /* MEDIA_DESCRIPTOR; */    MEDIA_DESC,
    /* BYTES_PER_SECTOR;  */    BYTES_PER_SECT,
    /* SECTORS_PER_TRACK; */    SECTS_PER_TRACK,
    /* NUMBER_OF_HEADS;   */    NUM_OF_HEADS,
    /* NUMBER_OF_SECTORS; */    1000, /* depends on drive */
    /* HIDDEN_SECTORS;    */    HIDDEN_SECTS,
    /* RESERVED_SECTORS;  */    RESERVED_SECTS
};
format_struct.FORMAT_PTR = &MFS_format;
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_FORMAT,
                  (uint_32_ptr) &format_struct);
```

3.8.1.13 IO_IOCTL_FORMAT_TEST

Formats the drive and counts the bad clusters on disk.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_FORMAT_TEST,
                  (uint_32_ptr) &format_struct);
```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver, which corresponds to the device, on which to operate. The third parameter is a pointer to the *MFS_IOCTL_FORMAT_PARAM* structure cast to the *uint_32_ptr*. Both fields of the *MFS_IOCTL_FORMAT_PARAM* structure must be initialized (*FORMAT_PTR* and *COUNT_PTR*). See structure descriptions for details.

Errors

- *MFS_SHARING_VIOLATION*
— Files are open on the drive.

Example

```
uint_32                bad_cluster_count;
MFS_IOCTL_FORMAT_PARAM format_struct;
MFS_FORMAT_DATA        MFS_format =
{
```

```

    /* PHYSICAL_DRIVE; */ PHYSICAL_DRIVE,
    /* MEDIA_DESCRIPTOR; */ MEDIA_DESC,
    /* BYTES_PER_SECTOR; */ BYTES_PER_SECT,
    /* SECTORS_PER_TRACK; */ SECTS_PER_TRACK,
    /* NUMBER_OF_HEADS; */ NUM_OF_HEADS,
    /* NUMBER_OF_SECTORS; */ 1000, /* depends on disk */
    /* HIDDEN_SECTORS; */ HIDDEN_SECTS,
    /* RESERVED_SECTORS; */ RESERVED_SECTS
};
format_struct.FORMAT_PTR = &MFS_format;
format_struct.COUNT_PTR = &bad_cluster_count;
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_FORMAT,
                  (uint_32_ptr) &format_struct);
if (!error_code)
    printf("The count of bad clusters is: %d\n", bad_cluster_count);

```

3.8.1.14 IO_IOCTL_FREE_CLUSTERS

3.8.1.15 IO_IOCTL_FREE_SPACE

Get the count of free space in clusters or in bytes.

```

space = ioctl(mfs_fd_ptr,
              IO_IOCTL_FREE_SPACE,
              NULL);

```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver. It should correspond to the disk, on which the free space is to be calculated. The third parameter is a NULL pointer.

Note that for drives that are 4G or more, *IO_IOCTL_FREE_SPACE* may not work, and a combination of *IO_IOCTL_FREE_CLUSTERS* and *IO_IOCTL_GET_CLUSTER_SIZE* must be used to determine the free space size of the drive in bytes, using long (64-bit) arithmetic.

3.8.1.16 IO_IOCTL_GET_CLUSTER_SIZE

Gets the size of clusters in bytes.

```

result = ioctl(mfs_fd_ptr,
               IO_IOCTL_GET_CLUSTER_SIZE,
               &cluster_size);

```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver. It should correspond to the disk, for which the cluster size should be returned. The third parameter is a pointer to a *uint_32_ptr* to pre-allocated space, in which to store the cluster size.

3.8.1.17 IO_IOCTL_GET_CURRENT_DIR

Gets the path name of the current directory on the MFS device.

```

error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_GET_CURRENT_DIR,
                  (uint_32_ptr) pathname);

```

The drive and drive separator are not included in the filename (for example, "d:" is not returned). The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver corresponding to the disk, on which to operate. The third parameter is a *char_ptr* (to pre-allocated space, in which to store the current directory) cast to a *uint_32_ptr*.

Example

```
char pathname[261];
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_GET_CURRENT_DIR,
                  (uint_32_ptr) pathname);
printf("The current directory is: %s\n", pathname);
```

3.8.1.18 IO_IOCTL_GET_DATE_TIME

Gets the current date and time associated with the file.

```
error_code = ioctl(fd_ptr,
                  IO_IOCTL_GET_DATE_TIME,
                  (uint_32_ptr) &date);
```

The first parameter is the **FILE_PTR** of the file for which the date or time is to be retrieved. The third parameter is a pointer to a **MFS_DATE_TIME_PARAM** structure that is cast to a **uint_32_ptr**. Both fields of the structure must be filled in. See structure definitions for details.

The bits of the date and time words are defined as follows:

Time word		Date word	
Bits	Meaning	Bits	Meaning
4 – 0	0 – 29, 2 second increments	4 – 0	1 – 31 days
10 – 5	0 – 59 minutes	8 – 5	1 – 12 month
15 – 11	0 – 23 hours	15 – 9	0 – 119 year (1980 – 2099)

Example

```
uint_32          error_code;
uint_16          date_word, time_word;
MFS_DATE_TIME_PARAM date;

date.DATE_PTR = &date_word;
date.TIME_PTR = &time_word;

error_code = ioctl(fd_ptr, IO_IOCTL_GET_DATE_TIME,
                  (uint_32_ptr) &date);

if (!error_code )
printf ("%02lu-%02lu-%04lu  %02lu:%02lu:%02lu \n",
        (uint_32)(date_word & MFS_MASK_MONTH) >> MFS_SHIFT_MONTH,
        (uint_32)(date_word & MFS_MASK_DAY) >> MFS_SHIFT_DAY,
        (uint_32)((date_word & MFS_MASK_YEAR) >> MFS_SHIFT_YEAR)
```

Reference: Functions

```
+ 1980,  
(uint_32)(time_word.TIME & MFS_MASK_HOURS) >>  
MFS_SHIFT_HOURS,  
(uint_32)(time_word.TIME & MFS_MASK_MINUTES) >>  
MFS_SHIFT_MINUTES,  
(uint_32)(time_word.TIME & MFS_MASK_SECONDS) << 1);
```

3.8.1.19 IO_IOCTL_GET_DEVICE_HANDLE

Gets the handle of the low-level device, which this instance of the file system is operating on.

```
result = ioctl(mfs_fd_ptr,
              IO_IOCTL_GET_DEVICE_HANDLE,
              &handle);
```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver. The third parameter is a pointer to a *FILE_PTR* (cast to a *uint_32_ptr*), which points to pre-allocated space, in which to store the device handle.

3.8.1.20 IO_IOCTL_GET_FAT_CACHE_MODE

3.8.1.21 IO_IOCTL_SET_FAT_CACHE_MODE

Get or set the current mode of the FAT cache.

```
result = ioctl(mfs_fd_ptr,
              IO_IOCTL_GET_FAT_CACHE_MODE,
              &mode);
```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver. The third parameter is a *_mfs_cache_policy* pointer (cast to a *uint_32_ptr*), which points to pre-allocated space, in which to store (when using get) or obtain (when using set) the FAT cache mode.

3.8.1.22 IO_IOCTL_GET_FILE_ATTR

3.8.1.23 IO_IOCTL_SET_FILE_ATTR

Get or set the attribute byte from a file on disk.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_GET_FILE_ATTR,
                  (uint_32_ptr) &attr);
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_SET_FILE_ATTR,
                  (uint_32_ptr) &attr);
```

An application cannot set the volume or directory bits of the attribute **char**. The first parameter is the **FILE_PTR** of the MFS device driver that corresponds to the disk on which the file whose attributes are to be read or written is located. The third parameter is a pointer to a **MFS_FILE_ATTR_PARAM** structure that is cast to a **uint_32_ptr**. Both fields of the structure must be filled in. See the structure definitions for details.

Example

```
MFS_FILE_ATTR_PARAM attr;
uint_32 error_code;
char filepath = "\\temp\\myfile.txt";
uchar attribute;

attr.ATTRIBUTE_PTR = &attribute;
```

```

attr.PATHNAME = filepath;

/* Get the attribute: */
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_GET_FILE_ATTR,
                  (uint_32_ptr) &attr);

if (error_code == MFS_NO_ERROR) {
    printf ("Attributes of %s: %s%s%s%s%s%s\n",
           filepath,
           (attribute & MFS_ATTR_READ_ONLY) ? "R/O ":"",
           (attribute & MFS_ATTR_HIDDEN_FILE) ? "HID ":"",
           (attribute & MFS_ATTR_SYSTEM_FILE) ? "SYS ":"",
           (attribute & MFS_ATTR_VOLUME_NAME) ? "VOL ":"",
           (attribute & MFS_ATTR_DIR_NAME) ? "DIR ":"",
           (attribute & MFS_ATTR_ARCHIVE) ? "ARC ":"");
}
/* Set file's attributes: */
if (!error_code) {
    attribute = MFS_ATTR_READ_ONLY | MFS_ATTR_HIDDEN_FILE;
    error_code = ioctl(mfs_fd_ptr, IO_IOCTL_SET_FILE_ATTR,
                    (uint_32_ptr) &attr);
}

```

3.8.1.24 IO_IOCTL_GET_LFN

Gets the long filename, where the path name is in 8.3 representation.

```

error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_GET_LFN,
                  (uint_32_ptr) &lfn_struct);

```

The first parameter is the *FILE_PTR* of the MFS device driver that corresponds to the disk, on which the operation is to take place. The third parameter is the *char_ptr* to the path name of the of file, which we want the long filename of. It is cast to the *uint_32_ptr*.

Example

```

MFS_GET_LFN_STRUCT    lfn_struct;
char                  lfn[FILENAME_SIZE + 1];
char                  filepath = "\\temp\\longfi~1.txt";
uint_32               error_code;

lfn_struct.PATHNAME = filepath;
lfn_struct.LONG_FILENAME = lfn;

error_code = ioctl(mfs_fd_ptr, IO_IOCTL_GET_LFN,
                  (uint_32_ptr) &lfn_struct);

if (!error_code) {
    printf("%s\n", lfn);
}

```

3.8.1.25 IO_IOCTL_GET_VOLUME

Gets the volume label.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_GET_VOLUME,
                  (uint_32_ptr) label);
```

The first parameter is the **FILE_PTR** of the MFS device driver that corresponds to the disk on which the operation is to take place. The third parameter is a **char_ptr** to an allocated space with 12 free bytes in which the volume label will be written. It is cast into a **uint_32_ptr**.

Example

```
charlabel[12];
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_GET_VOLUME,
                  (uint_32_ptr) label);
if (!error_code) {
printf("The volume label is: %d\n", label);

/* Now set the volume label */
strcpy(label, "newlabel");
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_SET_VOLUME,
                  (uint_32_ptr) label);
}
```

3.8.1.26 IO_IOCTL_GET_WRITE_CACHE_MODE

3.8.1.27 IO_IOCTL_SET_WRITE_CACHE_MODE

Get or set the current mode of the data and directory caches.

```
result = ioctl(mfs_fd_ptr,
               IO_IOCTL_GET_WRITE_CACHE_MODE,
               &mode);
```

The parameter *mfs_fd_ptr* is the **FILE_PTR** returned when **fopen()** was called on the MFS device driver. The third parameter is a **_mfs_cache_policy** pointer (cast to a **uint_32_ptr**) which points to pre-allocated space in which to store (when using get) or obtain (when using set) the mode of the write caches.

3.8.1.28 IO_IOCTL_LAST_CLUSTER

Gets the number of clusters on a drive.

```
last_cluster = ioctl(mfs_fd_ptr,
                    IO_IOCTL_LAST_CLUSTER,
                    NULL);
```

The parameter *mfs_fd_ptr* is the **FILE_PTR** returned when **fopen()** was called on the MFS device driver. It should correspond to the disk, on which the free space is to be calculated. The third parameter is a **NULL** pointer.

3.8.1.29 IO_IOCTL_REMOVE_SUBDIR

Remove a the subdirectory in the current directory.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_REMOVE_SUBDIR,
                  (uint_32_ptr) "\temp\delmdir");
```

A path name can be specified to remove the subdirectory in a different directory. The subdirectory must be empty and cannot be the current directory or the root directory. The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver corresponding to the disk, on which to operate. The third parameter is the *char_ptr* (to a directory name) cast into the *uint_32_ptr*.

Errors

- *MFS_ATTEMPT_TO_REMOVE_CURRENT_DIR*
— The directory specified is the current directory. No changes took place.

3.8.1.30 IO_IOCTL_RENAME_FILE

Rename a file or move a file if path names are specified.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_RENAME_FILE,
                  (uint_32_ptr) &rename_struct);
```

No wildcard characters are allowed in the path names. The parameter *mfs_fd_ptr* is the *FILE_PTR* returned, when **fopen()** was called on the MFS device driver corresponding to the drive, on which to operate. The third parameter is a pointer to the *MFS_RENAME_PARAM* structure cast to the *uint_32_ptr*. Both fields in this structure must be filled out. See structure definitions for details.

A file is moved, if the directory paths are different and the file names are the same. A file is renamed, if the directory paths are the same and the file names are different.

A directory can be renamed, but cannot be moved.

Example

```
MFS_RENAME_PARAM  rename_struct;
char              oldpath[PATHNAME_SIZE + 1],
                 newpath[PATHNAME_SIZE + 1];
uint_32          error_code;

rename_struct.OLD_PATHNAME = oldpath;
rename_struct.NEW_PATHNAME = newpath;

/* Rename a file: */
strcpy(oldpath, "myfile.txt");
strcpy(newpath, "myfile.bak");
error_code = ioctl(mfs_fd_ptr, IO_IOCTL_RENAME_FILE,
                  (uint_32_ptr) &rename_struct);

/* Move the file: */
if (!error_code) {
strcpy(oldpath, "myfile.bak");
    strcpy(newpath, "\temp\temp.tmp");
    error_code = ioctl(mfs_fd_ptr, IO_IOCTL_RENAME_FILE,
                      (uint_32_ptr) &rename_struct);
```



```
}
```

3.8.1.31 IO_IOCTL_SET_DATE_TIME

Sets the time and date of an open file.

```
error_code = ioctl(fd_ptr,
                  IO_IOCTL_SET_DATE_TIME,
                  (uint_32_ptr) &date);
```

The first parameter is the *FILE_PTR* of the file, for which to set the date. The third parameter is a pointer to the *MFS_DATE_TIME_PARAM* structure that is cast to the *uint_32_ptr*. Both fields of the structure must be filled in. See the structure definitions for more information.

Example

See *IO_IOCTL_GET_DATE_TIME* for details.

```
MFS_DATE_TIME_PARAM  date_time;
uint_32              error_code;
uint_16              date_word, time_word;

date.DATE_PTR = &date_word;
date.TIME_PTR = &time_word;

error_code = ioctl(fd_ptr, IO_IOCTL_GET_DATE_TIME,
                  (uint_32_ptr) &date);
```

3.8.1.32 IO_IOCTL_SET_FAT_CACHE_MODE

See *IO_IOCTL_GET_FAT_CACHE_MODE*.

3.8.1.33 IO_IOCTL_SET_FILE_ATTR

See *IO_IOCTL_GET_FILE_ATTR*.

3.8.1.34 IO_IOCTL_SET_VOLUME

Sets the volume label.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_SET_VOLUME,
                  (uint_32_ptr) label);
```

The first parameter is the *FILE_PTR* of the MFS device driver that corresponds to the disk, on which the operation is to take place. The third parameter is the *char_ptr* to the new volume name to be set with a maximum of 11 characters. It is cast to the *uint_32_ptr*.

3.8.1.35 IO_IOCTL_SET_WRITE_CACHE_MODE

See *IO_IOCTL_GET_WRITE_CACHE_MODE*.

3.8.1.36 IO_IOCTL_TEST_UNUSED_CLUSTERS

Test the unused clusters on the drive for bad clusters.

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_TEST_UNUSED_CLUSTERS,
                  &count_of_unused_clusters);
```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver corresponding to the drive, on which to test the unused clusters. The third parameter is the *uint_32_ptr* to a variable, in which the count of bad clusters is stored. The bad clusters are marked in the file allocation table so that they will not be used to store data.

3.8.1.37 IO_IOCTL_WRITE_CACHE_OFF

3.8.1.38 IO_IOCTL_WRITE_CACHE_ON

Deprecated: use *IO_IOCTL_SET_WRITE_CACHE_MODE*.

Set the data and directory cache modes to write through (OFF) or write back (ON).

```
error_code = ioctl(mfs_fd_ptr,
                  IO_IOCTL_WRITE_CACHE_OFF,
                  NULL);
```

The parameter *mfs_fd_ptr* is the *FILE_PTR* returned when **fopen()** was called on the MFS device driver. The third parameter is a NULL pointer.

3.8.2 Input/Output Control Commands for the Partition Manager Device Driver

As well as the MQX input/output control commands, the partition manager device driver includes the following.

3.8.2.1 IO_IOCTL_CLEAR_PARTITION

Removes a partition from the disk.

The third **ioctl()** parameter is a pointer to the *uint_32* variable, and contains the number of the partition to remove.

Example

Remove the third partition from the disk.

```
uint_32 part_num;
part_num = 3;
error_code = ioctl(pmgr_fd_ptr, IO_IOCTL_CLEAR_PARTITION,
                  &part_num);
```

3.8.2.2 IO_IOCTL_GET_PARTITION

Get partition information to the disk.

The third `ioctl()` parameter is the `PMGR_PART_INFO_STRUCT` pointer that is cast to `uint_32_ptr`. The only field in the structure that must be filled in is the `SLOT` field. It must contain a value between one and four and represents the partition number, for which information is requested. The other fields are overwritten with the retrieved data (`HEADS`, `CYLINDERS`, and `SECTORS` are set to zero, because the information cannot be retrieved from the disk).

3.8.2.3 IO_IOCTL_SET_PARTITION

Sets partition information to the disk.

The third `ioctl()` parameter is the `PMGR_PART_INFO_STRUCT` pointer that is cast to `uint_32_ptr`.

```
typedef struct pmgr_part_info_struct
{
    /* Partition slot (1 to 4) */
    uchar    SLOT;
    /* Heads per Cylinder */
    uchar    HEADS;
    /* Sectors per head */
    uchar    SECTORS;
    /* Cylinders on the device */
    uint_16  CYLINDERS;
    /* Partition type (0 not used, 1 FAT 12 bit, 4 FAT 16 bit, */
    /* 5 extended, 6 huge - DOS 4.0+, other = unknown OS) */
    uchar    TYPE;
    /* Start sector for partition, relative to beginning of disk */
    uint_32  START_SECTOR;
    /* Partition length in sectors */
    uint_32  LENGTH;
} PMGR_PART_INFO_STRUCT, _PTR_ PMGR_PART_INFO_STRUCT_PTR;
```

The `SLOT` field must be filled in with the partition number to set.

The `HEADS`, `SECTORS`, and `CYLINDERS` fields are optional. They represent data that the partition manager uses to write the partition, but the data is used only by MS-DOS operating systems. Because Microsoft Windows does not use the fields on the disk, fill in the fields only if the disk is to be used with the MS-DOS operating system.

The `TYPE` field must be set to one of the following. Types that are marked with + are recommended when you create a partition.

+	PMGR_PARTITION_FAT_12_BIT	
	PMGR_PARTITION_FAT_16_BIT	Old FAT16 (MS-DOS 3.3 and previous)
	PMGR_PARTITION_HUGE	Modern FAT16 (MS-DOS 3.3 and later)
	PMGR_PARTITION_FAT32	Normal FAT32

+	PMGR_PARTITION_FAT32_LBA	FAT32 with LBA
+	PMGR_PARTITION_HUGE_LBA	FAT16 with LBA

The *START_SECTOR* field must be filled in. It is the physical sector on the device, where the partition should start. For the first partition, it is generally sector 32 (for FAT32) or sector one (for FAT16 and FAT12). For partitions other than the first, it is the next sector after the end of the previous partition. You can leave unused sectors between partition, but they amount to wasted space.

The *LENGTH* field must be filled in. It contains the length (in sectors) of the new partition that is to be created.

Example

Create two partitions on a disk. The example assumes that the partition manager is installed and open.

```
PMGR_PART_INFO_STRUCT    part_info;

/* Create a 42-Megabyte partition: */
part_info.SLOT = 1;
part_info.TYPE = PMGR_PARTITION_HUGE_LBA;
part_info.START_SECTOR = 32;
part_info.LENGTH = 84432;

error_code = ioctl(pm_fd_ptr, IO_IOCTL_SET_PARTITION,
                  (uint_32_ptr) &part_info);

if ( error_code ) {
    printf("\nError creating partition %d!\n Error code: %d",
          1, error_code);
    _mqx_exit(1);
}/* Endif */

/* Create a 5-Megabyte partition: */
part_info.SLOT = 2;
part_info.TYPE = PMGR_PARTITION_FAT_12_BIT;
part_info.START_SECTOR = 84464;
part_info.LENGTH = 10000;

error_code = ioctl(pm_fd_ptr, IO_IOCTL_SET_PARTITION,
                  (uint_32_ptr) &part_info);

if ( error_code ) {
    printf("\nError creating partition %d!\n Error code: %d",
          2, error_code);
    _mqx_exit(1);
}/* Endif */
```

3.8.3 Return Codes for MFS

- *MFS_ACCESS_DENIED*
 - Application attempted to modify a read-only file or a system file.

- *MFS_ALREADY_ASSIGNED*
- *MFS_ATTEMPT_TO_REMOVE_CURRENT_DIR*
- *MFS_BAD_DISK_UNIT*
 - Operation on a file failed because that file is corrupted.
- *MFS_BAD_LFN_ENTRY*
 - MFS failed to find a complete long file name within two clusters.
- *MFS_CANNOT_CREATE_DIRECTORY*
 - MFS was unable to create the requested long directory name, usually because an invalid (illegal) directory name was specified.
- *MFS_DISK_FULL*
 - Disk is full.
- *MFS_DISK_IS_WRITE_PROTECTED*
 - Disk is write protected and could not be written to.
- *MFS_EOF*
 - End of the file has been reached during a read. This is not a failure, it is only a warning.
- *MFS_ERROR_INVALID_DRIVE_HANDLE*
 - The MFS *FILE_PTR* was invalid.
- *MFS_ERROR_INVALID_FILE_HANDLE*
 - The MFS *FILE_PTR* was invalid.
- *MFS_ERROR_UNKNOWN_FS_VERSION*
 - The drive contains an advanced FAT32 version. The MFS FAT32 version is not compatible. (There is currently only one FAT32 version, but this could change in the future.)
- *MFS_FAILED_TO_DELETE_LFN*
 - MFS failed to completely delete a long file name. This results when MFS can not locate all of the long file name entries associated with a file.
- *MFS_FILE_EXISTS*
 - File already exists with the specified name.
- *MFS_FILE_NOT_FOUND*
 - File specified does not exist.
- *MFS_INSUFFICIENT_MEMORY*
 - MFS memory allocation failed. (MQX is out of memory or it has a corrupted memory pool.)
- *MFS_INVALID_CLUSTER_NUMBER*
 - A cluster number was detected that exceeds the maximum number of clusters on the drive (or partition). This may be a result of a corrupted directory entry.
- *MFS_INVALID_DEVICE*
 - The underlying block mode driver does not support the block size command, or the block size is not legal (not one of 512, 1024, 2048 or 4096 bytes).
- *MFS_INVALID_FUNCTION_CODE*

- Not currently used.
- *MFS_INVALID_HANDLE*
 - One of the fields in a given *FILE_PTR* structure was invalid.
- *MFS_INVALID_LENGTH_IN_DISK_OPERATION*
 - Requested directory exceeds maximum in change-directory operation.
- *MFS_INVALID_MEMORY_BLOCK_ADDRESS*
 - *SEARCH_DATA_PTR* is NULL on find-first or fine-next file operation.
- *MFS_INVALID_PARAMETER*
 - One or more of the parameters passed to *_io_ioctl()* is invalid.
- *MFS_LOST_CHAIN*
 - This is not a critical error. It means there is a lost cluster chain, which results in some wasted space. Operations on the drive continue normally.
- *MFS_NO_ERROR*
 - Function call was successful.
- *MFS_NOT_A_DOS_DISK*
 - Disk is not formatted at a FAT12, FAT16, or FAT32 file system.
- *MFS_NOT_INITIALIZED*
 - Not currently returned.
- *MFSOPERATION_NOT_ALLOWED*
 - Returned when attempting a write operation when MFS is built in read-only mode, or a format operation when MFS is built without format functionality, or an attempt to rename a file to the same name.
- *MFS_PATH_NOT_FOUND*
 - Path name specified does not exist.
- *MFS_READ_FAULT*
 - An error occurred reading from the disk.
- *MFS_ROOT_DIR_FULL*
 - Root directory on the drive has no more free entries for new files.
- *MFS_SECTOR_NOT_FOUND*
 - An error occurred while writing to the disk. The drive was formatted with incorrect parameters, or the partition table specified incorrect values.
- *MFS_SHARING_VIOLATION*
 - Produced by one of:
 - An attempt to close or format a drive that currently has files open.
 - An attempt to open a file to write that is already opened.
- *MFS_WRITE_FAULT*
 - An error occurred while writing to the disk.

3.8.4 Return Codes for the Partition Manager Device Driver

- *PMGR_INVALID_PARTITION*
 - The specified partition slot does not describe a valid partition.
- *PMGR_INSUF_MEMORY*
 - Attempt to allocate memory failed. MQX is out of memory or it has a corrupt memory pool.

3.8.5 Other Error Codes

An error was returned from the lower-level device driver.

Chapter 4 Reference: Data Types

4.1 In This Chapter

Alphabetically sorted data-type descriptions for MFS.

4.2 `_mfs_cache_policy`

```
typedef enum {  
    MFS_WRITE_THROUGH_CACHE=0,    // No write caching (only read caching)  
    MFS_MIXED_MODE_CACHE=1,       // Write Caching allowed on file write only  
    MFS_WRITE_BACK_CACHE=2        // Write Caching fully enabled  
} _mfs_cache_policy;
```

4.3 MFS_DATE_TIME_PARAM

```
typedef struct mfs_date_time_param
{
    uint_16_ptr          DATE_PTR;
    uint_16_ptr          TIME_PTR;
} MFS_DATE_TIME_PARAM, _PTR_ MFS_DATE_TIME_PARAM_PTR;
```

A pointer to the structure is used in *IO_IOCTL_GET_DATE_TIME* and *IO_IOCTL_SET_DATE_TIME* commands.

The first field is the *uint_16_ptr* to *uint_16* variable, in which the date is to be stored (for get) or read from (for set). The second field is the *uint_16_ptr* to *uint_16* variable, in which the time is to be stored (for get) or read from (for set). See the **ioctl** description for details.

4.4 MFS_FILE_ATTR_PARAM

```
typedef struct mfs_file_attr_param
{
    char_ptr    PATHNAME;
    /* Path name and filename of the file */
    uchar_ptr   ATTRIBUTE_PTR;
    /* Pointer to the attribute variable */
} MFS_FILE_ATTR_PARAM, _PTR_ MFS_FILE_ATTR_PARAM_PTR;
```

A pointer to the structure is used in *IO_IOCTL_GET_FILE_ATTR* and *IO_IOCTL_SET_FILE_ATTR* commands.

The first field is the *char_ptr* to the path name and filename of the file, for which you want to get or set the attribute. The second field is the *uchar_ptr* to the *char* variable, in which the attribute is read from (for set), or in which the attribute is stored (for get).

4.5 MFS_GET_LFN_STRUCT

```
typedef struct mfs_get_lfn_struct
{
    char_ptr    PATHNAME;
    /* Path name of the 8.3 name */
    char_ptr    LONG_FILENAME;
    /* Pointer to memory block in which to store the long name */
} MFS_GET_LFN_STRUCT, _PTR_ MFS_GET_LFN_STRUCT_PTR;
```

A pointer to this structure is used in *IO_IOCTL_GET_LFN* commands.

The first field is the *char_ptr* to the path name or file name of the file that we want to get the long file name of. The second field is the *char_ptr* to pre-allocated space, in which to store the long file name of the requested file.

4.6 MFS_IOCTL_FORMAT_PARAM

```
typedef struct mfs_ioctl_format
{
    MFS_FORMAT_DATA_PTR  FORMAT_PTR; /* Points to format data */
    uint_32_ptr          COUNT_PTR;  /* Count the bad clusters */
} MFS_IOCTL_FORMAT_PARAM, _PTR_ MFS_IOCTL_FORMAT_PARAM_PTR;
```

A pointer to the structure is used in calls to *IO_IOCTL_FORMAT* and *IO_IOCTL_FORMAT_TEST* commands.

The first field is a pointer to the *MFS_FORMAT_DATA* structure, which is explained at the beginning of this document. The second field is used only for the *IO_IOCTL_FORMAT_TEST* command. It is a pointer to the *uint_32* variable, in which the count of bad clusters is stored.

4.7 MFS_RENAME_PARAM

```
typedef struct mfs_rename_param
{
    char_ptr          OLD_PATHNAME;
    char_ptr          NEW_PATHNAME;
} MFS_RENAME_PARAM, _PTR_ MFS_RENAME_PARAM_PTR;
```

A pointer to the structure used in *IO_IOCTL_RENAME_FILE* commands.

The first field is the *char_ptr* to a string that contains the path name and file name of the file to move or rename. The second field is the *char_ptr* to the new path name or filename.

4.8 MFS_SEARCH_PARAM

```
typedef struct mfs_search_param
{
    uchar            ATTRIBUTE;
    /* Attribute of the wanted file */
    char_ptr        WILDCARD;
    /* Wildcard representation of the file */
    MFS_SEARCH_DATA_PTR    SEARCH_DATA_PTR;
    /* Points to search data */
} MFS_SEARCH_PARAM, _PTR_ MFS_SEARCH_PARAM_PTR;
```

A pointer to the structure is used in *IO_IOCTL_FIND_FIRST_FILE* commands.

The first field is the *uchar* variable that contains the attribute of the file that you are searching for. The second field is the *char_ptr* to a string containing the file name (including the path name) of the file that you are searching for. It can include wildcard characters. The third parameter is a pointer to the *MFS_SEARCH_DATA* structure. See the *IO_IOCTL_FIND_FIRST_FILE* command explanation for details.

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