

## NAME

ext2 - the second extended file system  
ext3 - the third extended file system  
ext4 - the fourth extended file system

## DESCRIPTION

The second, third, and fourth extended file systems, or ext2, ext3, and ext4 as they are commonly known, are Linux file systems that have historically been the default file system for many Linux distributions. They are general purpose file systems that have been designed for extensibility and backwards compatibility. In particular, file systems previously intended for use with the ext2 and ext3 file systems can be mounted using the ext4 file system driver, and indeed in many modern Linux distributions, the ext4 file system driver has been configured handle mount requests for ext2 and ext3 file systems.

## FILE SYSTEM FEATURES

A file system formatted for ext2, ext3, or ext4 can have some collection of the following file system feature flags enabled. Some of these features are not supported by all implementations of the ext2, ext3, and ext4 file system drivers, depending on Linux kernel version in use. On other operating systems, such as the GNU/HURD or FreeBSD, only a very restrictive set of file system features may be supported in their implementations of ext2.

### 64bit

Enables the file system to be larger than  $2^{32}$  blocks. This feature is set automatically, as needed, but it can be useful to specify this feature explicitly if the file system might need to be resized larger than  $2^{32}$  blocks, even if it was smaller than that threshold when it was originally created. Note that some older kernels and older versions of e2fsprogs will not support file systems with this ext4 feature enabled.

### bigalloc

This ext4 feature enables clustered block allocation, so that the unit of allocation is a power of two number of blocks. That is, each bit in the what had traditionally been known as the block allocation bitmap now indicates whether a cluster is in use or not, where a cluster is by default composed of 16 blocks. This feature can decrease the time spent on doing block allocation and brings smaller fragmentation, especially for large files. The size can be specified using the **-C option**.

**Warning:** The bigalloc feature is still under development, and may not be fully supported with your kernel or may have various bugs. Please see the web page <http://ext4.wiki.kernel.org/index.php/Bigalloc> for details. May clash with delayed allocation (see **nodelallocmountoption**).

This feature requires that the **extent** features be enabled.

### dir\_index

Use hashed b-trees to speed up name lookups in large directories. This feature is supported by ext3 and ext4 file systems, and is ignored by ext2 file systems.

### dir\_nlink

This ext4 feature allows more than 65000 subdirectories per directory.

### extent

This ext4 feature allows the mapping of logical block numbers for a particular inode to physical blocks on the storage device to be stored using an extent tree, which is a more efficient data structure than the traditional indirect block scheme used by the ext2 and ext3 file

systems. The use of the extent tree decreases metadata block overhead, improves file system performance, and decreases the needed to run [e2fsck\(8\)](#) on the file system. (Note: both **extent** and **extents** are accepted as valid names for this feature for historical/backwards compatibility reasons.)

**extra\_isize**

This ext4 feature reserves a specific amount of space in each inode for extended metadata such as nanosecond timestamps and file creation time, even if the current kernel does not current need to reserve this much space. Without this feature, the kernel will reserve the amount of space for features currently it currently needs, and the rest may be consumed by extended attributes.

For this feature to be useful the inode size must be 256 bytes in size or larger.

**ext\_attr**

This feature enables the use of extended attributes. This feature is supported by ext2, ext3, and ext4.

**filetype**

This feature enables the storage file type information in directory entries. This feature is supported by ext2, ext3, and ext4.

**flex\_bg**

This ext4 feature allows the per-block group metadata (allocation bitmaps and inode tables) to be placed anywhere on the storage media. In addition, **mke2fs** will place the per-block group metadata together starting at the first block group of each flex\_bg group. The size of the flex\_bg group can be specified using the **-G** option.

**has\_journal**

Create a journal to ensure filesystem consistency even across unclean shutdowns. Setting the filesystem feature is equivalent to using the **-j** option. This feature is supported by ext3 and ext4, and ignored by the ext2 file system driver.

**huge\_file**

This ext4 feature allows files to be larger than 2 terabytes in size.

**journal\_dev**

This feature is enabled on the superblock found on an external journal device. The block size for the external journal must be the same as the file system which uses it.

The external journal device can be used by a file system by specifying the **-J device=<external-device>** option to [mke2fs\(8\)](#) or [tune2fs\(8\)](#)

**large\_file**

This feature flag is set automatically by modern kernels when a file larger than 2 gigabytes is created. Very old kernels could not handle large files, so this feature flag was used to prohibit those kernels from mounting file systems that they could not understand.

**sparse\_super2**

This feature indicates that there will only at most two backup superblock and block group descriptors. The block groups used to store the backup superblock and blockgroup descriptors are stored in the superblock, but typically, one will be located at the beginning of block group #1, and one in the last block group in the file system.

This feature is essentially a more extreme version of `sparse_super` and is designed to allow the a much larger percentage of the disk to have contiguous blocks available for data files.

**meta\_bg**

This ext4 feature allows file systems to be resized on-line without explicitly needing to reserve space for growth in the size of the block group descriptors. This scheme is also used to resize file systems which are larger than  $2^{32}$  blocks. It is not recommended that this feature be set when a file system is created, since this alternate method of storing the block group descriptor will slow down the time needed to mount the file system, and newer kernels can automatically set this feature as necessary when doing an online resize and no more reserved space is available in the resize inode.

**mmp**

This ext4 feature provides multiple mount protection (MMP). MMP helps to protect the filesystem from being multiply mounted and is useful in shared storage environments.

**quota**

Create quota inodes (inode #3 for userquota and inode #4 for group quota) and set them in the superblock. With this feature, the quotas will be enabled automatically when the filesystem is mounted.

Causes the quota files (i.e., `user.quota` and `group.quota` which existed in the older quota design) to be hidden inodes.

**resize\_inode**

This file system feature indicates that space has been reserved so the block group descriptor table can be extended by the file system is resized while the file system is mounted. The online resize operation is carried out by the kernel, triggered, by [resize2fs\(8\)](#). By default **mke2fs** will attempt to reserve enough space so that the filesystem may grow to 1024 times its initial size. This can be changed using the **resize** extended option.

This feature requires that the **sparse\_super** feature be enabled.

**sparse\_super**

This file system feature is set on all modern ext2, ext3, and ext4 file system. It indicates that backup copies of the superblock and block group descriptors be present only on a few block groups, and not all of them.

**uninit\_bg**

This ext4 file system feature indicates that the block group descriptors will be protected using checksums, making it safe for [mke2fs\(8\)](#) to create a file system without initializing all of the block groups. The kernel will keep a high watermark of unused inodes, and initialize inode tables and block lazily. This feature speeds up the time to check the file system using [e2fsck\(8\)](#), and it also speeds up the time required for [mke2fs\(8\)](#) to create the file system.

## MOUNT OPTIONS

This section describes mount options which are specific to ext2, ext3, and ext4. Other generic mount options may be used as well; see [mount\(8\)](#) for details.

## Mount options for ext2

The ‘ext2’ filesystem is the standard Linux filesystem. Since Linux 2.5.46, for most mount options the default is determined by the filesystem superblock. Set them with [tune2fs\(8\)](#).

### **acl|noacl**

Support POSIX Access Control Lists (or not).

### **bsddf|minixdf**

Set the behavior for the *statfs* system call. The **minixdf** behavior is to return in the *f\_blocks* field the total number of blocks of the filesystem, while the **bsddf** behavior (which is the default) is to subtract the overhead blocks used by the ext2 filesystem and not available for file storage. Thus

```
% mount /k -o minixdf; df /k; umount /k
```

Filesystem	1024-blocks	Used	Available	Capacity	Mounted on
/dev/sda6	2630655	86954	2412169	3%	/k

```
% mount /k -o bsddf; df /k; umount /k
```

Filesystem	1024-blocks	Used	Available	Capacity	Mounted on
/dev/sda6	2543714	13	2412169	0%	/k

(Note that this example shows that one can add command line options to the options given in */etc/fstab*.)

### **check=none** or **nocheck**

No checking is done at mount time. This is the default. This is fast. It is wise to invoke [e2fsck\(8\)](#) every now and then, e.g. at boot time. The non-default behavior is unsupported (check=normal and check=strict options have been removed). Note that these mount options don’t have to be supported if ext4 kernel driver is used for ext2 and ext3 filesystems.

**debug** Print debugging info upon each (re)mount.

### **errors={continue|remount-ro|panic}**

Define the behavior when an error is encountered. (Either ignore errors and just mark the filesystem erroneous and continue, or remount the filesystem read-only, or panic and halt the system.) The default is set in the filesystem superblock, and can be changed using [tune2fs\(8\)](#).

### **grpuid|bsdgroups** and **nogrpuid|sysvgroups**

These options define what group id a newly created file gets. When **grpuid** is set, it takes the group id of the directory in which it is created; otherwise (the default) it takes the fsgid of the current process, unless the directory has the setgid bit set, in which case it takes the gid from the parent directory, and also gets the setgid bit set if it is a directory itself.

### **grpquota|noquota|quota|usrquota**

The **usrquota** (same as **quota**) mount option enables user quota support on the filesystem. **grpquota** enables group quotas support. You need the quota utilities to actually enable and manage the quota system.

### **noid32**

Disables 32-bit UIDs and GIDs. This is for interoperability with older kernels which only store and expect 16-bit values.

### **oldalloc** or **orlov**

Use old allocator or Orlov allocator for new inodes. Orlov is default.

**resgid=*n* and resuid=*n***

The ext2 filesystem reserves a certain percentage of the available space (by default 5%, see [mke2fs\(8\)](#) and [tune2fs\(8\)](#)). These options determine who can use the reserved blocks. (Roughly: whoever has the specified uid, or belongs to the specified group.)

**sb=*n*** Instead of block 1, use block *n* as superblock. This could be useful when the filesystem has been damaged. (Earlier, copies of the superblock would be made every 8192 blocks: in block 1, 8193, 16385, ... (and one got thousands of copies on a big filesystem). Since version 1.08, **mke2fs** has a **-s** (sparse superblock) option to reduce the number of backup superblocks, and since version 1.15 this is the default. Note that this may mean that ext2 filesystems created by a recent **mke2fs** cannot be mounted r/w under Linux 2.0.\*) The block number here uses 1 k units. Thus, if you want to use logical block 32768 on a filesystem with 4 k blocks, use **sb=131072**.

**user\_xattr|nouser\_xattr**

Support user. extended attributes (or not).

**Mount options for ext3**

The ext3 filesystem is a version of the ext2 filesystem which has been enhanced with journaling. It supports the same options as ext2 as well as the following additions:

**journal=update**

Update the ext3 filesystem's journal to the current format.

**journal=inum**

When a journal already exists, this option is ignored. Otherwise, it specifies the number of the inode which will represent the ext3 filesystem's journal file; ext3 will create a new journal, overwriting the old contents of the file whose inode number is *inum*.

**journal\_dev=devnum|journal\_path=path**

When the external journal device's major/minor numbers have changed, these options allow the user to specify the new journal location. The journal device is identified either through its new major/minor numbers encoded in devnum, or via a path to the device.

**norecovery|noload**

Don't load the journal on mounting. Note that if the filesystem was not unmounted cleanly, skipping the journal replay will lead to the filesystem containing inconsistencies that can lead to any number of problems.

**data={journal|ordered|writeback}**

Specifies the journaling mode for file data. Metadata is always journaled. To use modes other than **ordered** on the root filesystem, pass the mode to the kernel as boot parameter, e.g. *rootflags=data=journal*.

**journal**

All data is committed into the journal prior to being written into the main filesystem.

**ordered**

This is the default mode. All data is forced directly out to the main file system prior to its metadata being committed to the journal.

**writeback**

Data ordering is not preserved – data may be written into the main filesystem after its metadata has been committed to the journal. This is rumoured to be the highest-throughput option. It guarantees internal filesystem integrity, however it can allow old data to appear in files after a crash and journal recovery.

**data\_err=ignore**

Just print an error message if an error occurs in a file data buffer in ordered mode.

**data\_err=abort**

Abort the journal if an error occurs in a file data buffer in ordered mode.

**barrier=0 / barrier=1**

This disables / enables the use of write barriers in the jbd code. barrier=0 disables, barrier=1 enables (default). This also requires an IO stack which can support barriers, and if jbd gets an error on a barrier write, it will disable barriers again with a warning. Write barriers enforce proper on-disk ordering of journal commits, making volatile disk write caches safe to use, at some performance penalty. If your disks are battery-backed in one way or another, disabling barriers may safely improve performance.

**commit=nrsec**

Sync all data and metadata every *nrsec* seconds. The default value is 5 seconds. Zero means default.

**user\_xattr**

Enable Extended User Attributes. See the **attr(5)** manual page.

**acl** Enable POSIX Access Control Lists. See the **acl(5)** manual page.**usrjquota=aquota.user|grpjquota=aquota.group|jqfmt=vfsv0**

Apart from the old quota system (as in ext2, jqfmt=vfsold aka version 1 quota) ext3 also supports journaled quotas (version 2 quota). jqfmt=vfsv0 enables journaled quotas. For journaled quotas the mount options usrjquota=aquota.user and grpjquota=aquota.group are required to tell the quota system which quota database files to use. Journaled quotas have the advantage that even after a crash no quota check is required.

**Mount options for ext4**

The ext4 filesystem is an advanced level of the ext3 filesystem which incorporates scalability and reliability enhancements for supporting large filesystem.

The options **journal\_dev**, **norecovery**, **noload**, **data**, **commit**, **orlov**, **oldalloc**, **[no]user\_xattr** **[no]acl**, **bsddf**, **minixdf**, **debug**, **errors**, **data\_err**, **grpquota**, **usrquota**, **usrjquota**, **grpjquota** and **jqfmt** are backwardly compatible with ext3 or ext2.

**journal\_checksum**

Enable checksumming of the journal transactions. This will allow the recovery code in e2fsck and the kernel to detect corruption in the kernel. It is a compatible change and will be ignored by older kernels.

**journal\_async\_commit**

Commit block can be written to disk without waiting for descriptor blocks. If enabled older kernels cannot mount the device. This will enable 'journal\_checksum' internally.

**barrier=0 / barrier=1 / barrier / nobarrier**

These mount options have the same effect as in ext3. The mount options barrier and nobarrier are added for consistency with other ext4 mount options.

The ext4 filesystem enables write barriers by default.

**inode\_readahead\_blks=n**

This tuning parameter controls the maximum number of inode table blocks that ext4's inode table readahead algorithm will pre-read into the buffer cache. The value must be a power of 2. The default value is 32 blocks.

**stripe=n**

Number of filesystem blocks that mballocc will try to use for allocation size and alignment. For RAID5/6 systems this should be the number of data disks \* RAID chunk size in filesystem blocks.

**delalloc**

Deferring block allocation until write-out time.

**nodelalloc**

Disable delayed allocation. Blocks are allocated when data is copied from user to page cache.

**max\_batch\_time=*usec***

Maximum amount of time ext4 should wait for additional filesystem operations to be batch together with a synchronous write operation. Since a synchronous write operation is going to force a commit and then a wait for the I/O complete, it doesn't cost much, and can be a huge throughput win, we wait for a small amount of time to see if any other transactions can piggyback on the synchronous write. The algorithm used is designed to automatically tune for the speed of the disk, by measuring the amount of time (on average) that it takes to finish committing a transaction. Call this time the commit time. If the time that the transaction has been running is less than the commit time, ext4 will try sleeping for the commit time to see if other operations will join the transaction. The commit time is capped by the `max_batch_time`, which defaults to 15000µs (15 ms). This optimization can be turned off entirely by setting `max_batch_time` to 0.

**min\_batch\_time=*usec***

This parameter sets the commit time (as described above) to be at least `min_batch_time`. It defaults to zero microseconds. Increasing this parameter may improve the throughput of multi-threaded, synchronous workloads on very fast disks, at the cost of increasing latency.

**journal\_ioprio=*prio***

The I/O priority (from 0 to 7, where 0 is the highest priority) which should be used for I/O operations submitted by `kjournald2` during a commit operation. This defaults to 3, which is a slightly higher priority than the default I/O priority.

**abort** Simulate the effects of calling `ext4_abort()` for debugging purposes. This is normally used while remounting a filesystem which is already mounted.

**auto\_da\_alloc|noauto\_da\_alloc**

Many broken applications don't use `fsync()` when replacing existing files via patterns such as

```
fd = open(foo.new)/write(fd,...)/close(fd)/ rename(foo.new, foo)
```

or worse yet

```
fd = open(foo, O_TRUNC)/write(fd,...)/close(fd).
```

If `auto_da_alloc` is enabled, ext4 will detect the `replace-via-rename` and `replace-via-truncate` patterns and force that any delayed allocation blocks are allocated such that at the next journal commit, in the default `data=ordered` mode, the data blocks of the new file are forced to disk before the `rename()` operation is committed. This provides roughly the same level of guarantees as ext3, and avoids the zero-length problem that can happen when a system crashes before the delayed allocation blocks are forced to disk.

**noinit\_itable**

Do not initialize any uninitialized inode table blocks in the background. This feature may be used by installation CD's so that the install process can complete as quickly as possible; the inode table initialization process would then be deferred until the next time the filesystem is mounted.

**init\_itable=*n***

The lazy itable init code will wait *n* times the number of milliseconds it took to zero out the previous block group's inode table. This minimizes the impact on system performance while the filesystem's inode table is being initialized.

**discard/nodiscard**

Controls whether ext4 should issue discard/TRIM commands to the underlying block device when blocks are freed. This is useful for SSD devices and sparse/thinly-provisioned LUNs, but it is off by default until sufficient testing has been done.

**nouid32**

Disables 32-bit UIDs and GIDs. This is for interoperability with older kernels which only store and expect 16-bit values.

**block\_validity/noblock\_validity**

This options allows to enables/disables the in-kernel facility for tracking filesystem metadata blocks within internal data structures. This allows multi-block allocator and other routines to quickly locate extents which might overlap with filesystem metadata blocks. This option is intended for debugging purposes and since it negatively affects the performance, it is off by default.

**dioread\_lock/dioread\_nolock**

Controls whether or not ext4 should use the DIO read locking. If the dioread\_nolock option is specified ext4 will allocate uninitialized extent before buffer write and convert the extent to initialized after IO completes. This approach allows ext4 code to avoid using inode mutex, which improves scalability on high speed storages. However this does not work with data journaling and dioread\_nolock option will be ignored with kernel warning. Note that dioread\_nolock code path is only used for extent-based files. Because of the restrictions this options comprises it is off by default (e.g. dioread\_lock).

**max\_dir\_size\_kb=n**

This limits the size of the directories so that any attempt to expand them beyond the specified limit in kilobytes will cause an ENOSPC error. This is useful in memory-constrained environments, where a very large directory can cause severe performance problems or even provoke the Out Of Memory killer. (For example, if there is only 512 MB memory available, a 176 MB directory may seriously cramp the system's style.)

**i\_version**

Enable 64-bit inode version support. This option is off by default.

**FILE ATTRIBUTES**

The ext2, ext3, and ext4 filesystems support setting the following file attributes on Linux systems using the [chattr\(1\)](#) utility:

**a** - append only

**A** - no atime updates

**d** - no dump

**D** - synchronous directory updates

**i** - immutable

**S** - synchronous updates

**u** - undeletable

In addition, the ext3 and ext4 filesystems support the following flag:

**j** - data journaling

Finally, the ext4 filesystem also supports the following flag:

**e** - extents format

For descriptions of these attribute flags, please refer to the [chattr\(1\)](#) man page.



**SEE ALSO**

[mke2fs\(8\)](#), [mke2fs.conf\(5\)](#), [e2fsck\(8\)](#), [dumpe2fs\(8\)](#), [tune2fs\(8\)](#), [debugfs\(8\)](#), [mount\(8\)](#), [chattr\(1\)](#)