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MMC-2 DVD-R and DVD-RAM

Content: Annex A of SFF8090-.09 Support for DVD-R and DVD-RAM

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Appendix A - Support for DVD-R and DVD-RAM

There are specific capabilities that are valid for recording of DVD media only. Most of these capabilities are provided by specialized commands and options. This section details these capabilities and commands. The commands in this section are only valid for recording media and will be rejected when TBD.

A-1 Unresolved Issues

This section identifies issues which are still unresolved in reference to support for recordable media. Refer to E-mail on the MTFUJI Reflector (mtfuji@dt.wdc.com) for details on each of the issues identified below:

- Write support commands, Lead-in information and defect management.
- Should partial formats be allowed?

A-2 DVD Recordable Media Organization

The DVD media is currently specified by the Physical section of the DVD Books.

- Defect management for DVD-RAM media is done only by the DVD Drive in the case of DVD-R Drive and/or DVD-RAM Drive. Note that specification of DVD-RAM and DVD-R is still under discussion (not finalized yet), so the command set in this draft is tentative.
- DVD-RAM Media will not contain any addressable blocks until the media has been formatted.
- Only the areas that have been formatted are available for use by the host.
- Although the DVD-RAM media must be written using only 32Kbytes, the interface to the host will use only 2Kbyte blocks. Thus the DVD Device must perform read/modify/write type of operations. This will also require a form of write back cache to provide reasonable performance.
- Write operations may generate deferred errors, due to the write back cache and read/modify/write operations. If deferred errors are generated, then data may have been lost in areas outside those the host has commanded be written.
- The Device shall use some form of defect management to prevent data from being lost during the read/modify/write operations.

A-3 Commands that are supported by DVD-R and DVD-RAM Devices

Table 224 - Addition of Commands Supported by DVD-RAM Drives

Command Description	Opcode	Type	Reference
FORMAT UNIT	0Ah	M	section A-6 on page 267
WRITE (12)	AAh	M	section A-8 on page 273
WRITE and VERIFY (12)	AEnh	O	section A-9 on page 275
Reserved for future use	EFh		
Key: M = command implementation is mandatory. O = command implementation is optional.			

A-4 Recordable Model

DVD Recordable Devices store blocks of data for later retrieval. Each block of data is stored at a unique logical block address. A host issues WRITE commands to store the blocks of data (write operations) and READ commands to retrieve the blocks of data (read operations). Other commands issued by the Host may also cause write and read operations to occur. A write operation causes a block of data to be written on the medium. A read operation causes a block of data to be read from the medium. A verify operation confirms that a block of data can be read without error from the medium.

Blocks of data are stored by a process that causes localized changes or transitions within the medium. The medium may be divided in parts that are used for data blocks, parts that are reserved for defect management, and parts that are reserved for use by the controller for the management of the device.

A-4.1 Medium defects

Any medium has the potential for defects that can cause user data to be lost. Therefore, each logical block may contain information that allows the detection of changes to the user data caused by defects in the medium or other phenomena, and may also allow the data to be reconstructed following the detection of such a change.

Defects may also be detected and managed during execution of the FORMAT UNIT command. The FORMAT UNIT command defines sources of defect information. These defects may be reassigned or avoided during the initialization process so that they do not appear in a logical block.

Note that defects may be automatically reassigned via media access.

A-4.2 Initialization

Some C/DVD media require initialization prior to write operations. This initialization is usually performed by a FORMAT UNIT command. Parameters related to the geometry and performance characteristics can be set with the MODE SELECT command prior to the format operation.

A-4.3 Data cache

Some C/DVD Devices implement cache memory. A cache memory is usually an area of temporary storage in the C/DVD Device with a fast access time that is used to enhance performance. It exists separately from the blocks of data stored and is normally not directly accessible by the Host. Use of cache memory for write or read operations typically reduces the access time to a logical block and can increase the overall data throughput.

During read operations, the C/DVD Device uses the cache memory to store blocks of data that the Host may request at some future time. The algorithm used to manage the cache memory is not part of this specification. However, parameters are provided to advise the C/DVD Device about future requests, or to restrict the use of cache memory for a particular request.

During write operations, the C/DVD Device uses the cache memory to store data that is written to the medium at a later time. This is called a write back caching algorithm. Thus the command may complete prior to blocks of data being written to the medium. As a result of using a write back caching algorithm there is a period of time when the data may be lost if a power or a hardware failure occurs. There is also the possibility of an error occurring during the write operation. If an error occurred during the write, it may be reported as a deferred error on a later command. However, the Host can request write through caching to prevent these circumstances from arising.

Sometimes the Host may wish to have the blocks of data read from the medium instead of from the cache memory. The force unit access (FUA) bit is used to indicate that the C/DVD Device shall access the physical medium. For a write operation, setting FUA to one causes the C/DVD Device to complete the data write to the physical medium before completing Page 265 Proposal for a Draft the command. For a read operation, setting FUA to one causes the logical blocks to be retrieved from the physical medium.

With some DVD media there exists a minimum number of blocks that can be written at one time. This could cause some blocks to be written that the host has not yet provided data for. This "Padding" of information is necessary for sequentially written DVD media. The host will need to detect that padding has occurred and remove those blocks from any file system allocation.

When a VERIFY command is executed, a forced unit access is implied, since the blocks of data stored on the medium are being verified. Furthermore, a FLUSH CACHE operation (see below) is also implied to write unwritten blocks of data still in the cache memory. These blocks of data must be stored on the medium before the verify operation can begin. The DPO bit is provided since the VERIFY command may cause the replacement of blocks in the cache. The above also applies to the WRITE AND VERIFY command.

Commands may be implemented by the C/DVD Device that allow the Host to control other behavior of the cache memory:

- FLUSH CACHE forces any pending write data in the requested set of logical blocks to be stored in the physical medium. This command can be used to ensure that the data was written and any errors reported

- The MODE SELECT command defines a page for the control of cache behavior and handles certain basic elements of cache replacement algorithms.

A-4.4 DVD Sector Size

The DVD recordable media make use of an ECC Block that is 32 kilobytes in length. This is the smallest block that can be written to the media. As the logical block size that shall be used by the host is 2kb, the DVD-RAM Device shall make use of read/modify/write operations.

Note that read/modify/write operations may create performance and other issues at the host.

A-5 Recorable DVD Media Command Descriptions

A-6 FORMAT UNIT Command

The FORMAT UNIT command formats the DVD-RAM medium per the Host Computer defined options.

The Device implementation determines the degree of defect management that is to be performed. In addition, the medium may be certified and control structures may be created for the management of the medium and defects. There is no guarantee that medium has or has not been altered.

Certify mode is specified by means of DCRT bit.

Table 225 - Format Unit Command

Byte	Bit	7	6	5	4	3	2	1	0
0		Operation Code (04h)							
1		LUN			FmtData(1)	CmpList(0)	Format Code(111b)		
2		Reserved							
3		MSB							
4		Interleave Value(0)							
5		Vendor-Specific			Reserved			Flag	Link
6		PAD							
7									
8									
9									
10									
11									

A Format Data (FmtData) bit of one indicates that a parameter list shall be transferred from the host. A CmpList bit of zero allows the drive to create a new primary defect list during certification.

The Defect List Format describes what type of descriptor is found in the parameter list transferred from the host.

During the format operation, the Device shall respond to commands as follows:

1. In response to all commands except REQUEST SENSE and INQUIRY, the Device shall return CHECK CONDITION status.
2. In response to the INQUIRY command, the Device shall respond as commanded.
3. In response to the REQUEST SENSE command, unless an error has occurred, the Device shall return a sense key of NOT READY and an additional sense code of LOGICAL UNIT NOT READY FORMAT IN PROGRESS, with the sense key specific bytes set for progress indication. Refer to the description of deferred error handling that may occur during the format operation.
4. In response to an ATA SRST, the Device shall provide the diagnostic results and the ATAPI signature. The format operation shall not be affected.

During the execution of the FORMAT UNIT command, the Device shall perform a medium defect management algorithm. The Format Unit command for DVD-RAM media does not provide a method to receive defect location information from the Host. The Plist, Clist, Dlist and Glist shall not supported. A format data (FmtData) bit of one indicates that the FORMAT UNIT parameter list (See "Table 226 - Format Unit Parameter List" on page 268) shall be transferred to the device. The data sent to the Device consists of a Format List Header, followed by an initialization pattern descriptor, followed by zero or one Format descriptor. The Format descriptor is used by the C/DVD device to select a capacity point as reported by the Read Formatted Capacity command.

Table 226 - Format Unit Parameter List

Bit Byte	7	6	5	4	3	2	1	0
	Format List Header							
	Initialization Pattern Descriptor (Reserved)							
	Format Descriptor (only 1 is allowed)							
0	Format Descriptor 0							
7								

The Format list header provides several format control bits. Devices that implement these bits give the Host additional control over the formatting operation. If the Host attempts to select any function not implemented by the Device, the Device shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

Table 227 - Format List Header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	FOV	DPRY	DCRT	STPF	IP	DSP	Immed	VS
2	Defect List Length							
3	LSB							

The interleave field specifies the interleave that is used when performing the format operation. For DVD Media this field shall be reserved.

A format options valid (FOV) bit of zero indicates that the Device shall use its default settings for the DPRY, DCRT, STPF, IP and DSP bits (see below). The Host shall set these bits to zero. If any of these bits are not zero, the Device shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN PARAMETER LIST.

A FOV bit of one indicates that the Device shall examine the setting of the DPRY, DCRT, STPF, IP and DSP bits. When the FOV bit is one, the DPRY, DCRT, STPF, IP and DSP bits are defined as follows.

A disable primary (DPRY) bit of zero indicates that the Device shall not use portions of the medium identified as defective in the primary defect Plist for Host addressable logical blocks. If the Device cannot locate the Plist or it cannot determine whether a Plist exists, it shall perform the action specified by the STPF bit. A DPRY bit of one indicates that the Device shall not use the Plist to identify defective areas of the medium. The Plist is not deleted.

A disable certification (DCRT) bit of zero indicates that the Device shall perform a vendor specific medium certification operation to generate a Clist. A DCRT bit of one indicates that the Device shall not perform any vendor specific medium certification process or format verification operation while executing the FORMAT UNIT command.

The stop format (STPF) bit controls the behavior of the Device when one of the following events occurs:

1. The Device has been requested to use the primary defect list (DPRY is set to zero), or the grown defect list (CmpLst is set to zero) and the Device cannot locate the list nor determine whether the list exists.
2. The Device has been requested to use the primary defect list (DPRY is set to zero) or the grown defect list (CmpLst is set to zero), and the Device encounters an error while accessing the defect list.

A STPF bit of zero indicates that, if one or both of the above conditions occurs, the Device shall continue to execute the FORMAT UNIT command. The Device shall return CHECK CONDITION status at the completion of the FORMAT UNIT command. The sense key shall be set to RECOVERED ERROR and the additional sense code shall be set to either DEFECT LIST NOT FOUND if the first condition occurred, or DEFECT LIST ERROR if the second condition occurred.

A STPF bit of one indicates that, if one or both of the above conditions occurs, the Device shall terminate the FORMAT UNIT command with CHECK CONDITION status. The sense key shall be set to MEDIUM ERROR and the additional sense code shall be set to either DEFECT LIST NOT FOUND if the first condition occurred, or DEFECT LIST ERROR if the second condition occurred.

An initialization pattern (IP) bit of one indicates that an initialization pattern descriptor is included in the FORMAT UNIT parameter list immediately following the defect list header. An IP bit of zero indicates that an initialization pattern descriptor is not included and that the Device shall use its default initialization pattern.

A disable saving parameters (DSP) bit of one specifies that the Device shall not save the MODE SELECT savable parameters to nonvolatile memory during the format operation. A DSP bit of zero specifies that the Device shall save all the MODE SELECT savable parameters for all Hosts to nonvolatile memory during the format operation. Pages that are not reported as savable are not affected by the DSP bit (i.e. if pages 03h & 04h are not returned with the PS bit set they may be saved even if DSP is cleared).

An immediate (IMMED) bit of zero indicates that status shall be returned after the format operation has completed. An IMMED bit value of one indicates that the Device shall return status as soon as the command descriptor block has been validated, and the entire defect list has been transferred.

The list length field in the Format list header specifies the total length in bytes of the Format descriptors that follow and does not include the initialization pattern descriptor or initialization pattern, if any.

Table 228 - Format Descriptor - From Read Formatted Capacities

Bit Byte	7	6	5	4	3	2	1	0
	MSB							
	Number of Blocks from Capacity Descriptor							
	LSB							
	Value from byte 4 of the Capacity Descriptor							
	MSB							
	Block Length from Capacity Descriptor							
	LSB							

Each Format descriptor specifies a eight byte entry. The size in blocks and the block size to use for the format operation are specified. These values shall come from one of the values returned from the READ FORMATTED CAPACITIES command, with one exception. When a partial format is to be done, the Number of Blocks from Capacity Descriptor can be reduced.

The list length is equal to eight.

The initialization pattern option specifies that the logical blocks contain the specified initialization pattern. The initialization pattern descriptor (See "Table 229 - Initialization Pattern Descriptor" on page 270) is sent to the Device as part of the FORMAT UNIT parameter list.

Table 229 - Initialization Pattern Descriptor

Bit Byte	7	6	5	4	3	2	1	0
	Reserved		Reserved					
	Reserved							
	Reserved							

The initialization pattern type field is reserved and not used by the DVD Device. It is recommended that this descriptor not be sent to the device.

Table 230 - Recommended Sense Key, ASC and ASCQ for Format Command Errors

Sense Key	ASC	ASCQ	Description of Error
05	24		INVALID FIELD IN COMMAND PACKET
06	28		NOT READY TO READY TRANSITION - MEDIA CHANGED
06	29		POWER ON RESET OR BUS DEVICE RESET OCCURRED
05	26		ILLEGAL FIELD IN PARAMETER LIST
07	27		WRITE PROTECTED MEDIA
02	3A	00	MEDIUM NOT PRESENT
03	03	00	WRITE FAULT
03	31	01	FORMAT COMMAND FAILED
03	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD

A-7 VERIFY (12) Command

The VERIFY command requests that the Logical Unit verify the data on the medium.

Table 231 - VERIFY (12) Command

Byte	Bit	7	6	5	4	3	2	1	0	
0		Operation code (Afh)								
1		LUN			DFC (0)	Reserved	BlkVfy	BytChk	RelAdr	
2		MSE Logical Block Address								
3										
4										
5										LSB
6										MSE Verification Length
7										
8										
9										LSB
10		Reserved								
11		Vendor-Specific		Reserved			NACA	Flag	Lmk	

If the MODE SELECT Verify Error Recovery Parameters page is implemented, then the current settings in that page define the verification criteria. If the Verify Error Recovery Parameters page is not implemented, then the verification criteria is vendor specific.

The RelAdr bit is only used for SCSI Logical Units. For information on this bit See “Use of the RelAdr bit” on page 257.

A byte check (BytChk) bit of zero causes a medium verification to be performed with no data comparison. A BytChk bit of one causes a byte by byte compare of the data written on the medium and the data transferred from the Host. The data shall be transferred as it would be for a WRITE command. If the compare is unsuccessful, for any reason, the Logical Unit shall return CHECK CONDITION status and the sense key shall be set to MISCOMPARE.

A blank verify (BlkVfy) bit of one causes a verification that the blocks are blank.

If the BytChk is one when the BlkVfy bit is one, this shall be considered an error. The Logical Unit shall return CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

The Disable Page Out (DPO) bit is not used by C/DVD Logical Units and shall be set to zero. A DPO bit of zero indicates the priority shall be determined by the retention priority fields in the cache page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vendor specific.

The verification length specifies the number of contiguous logical blocks of data or blanks that shall be verified. A verification length of zero indicates that no logical blocks shall be verified. This condition shall not be considered as an error. Any other value indicates the number of logical blocks that shall be verified.

Table 232 - Recommended Sense Key, ASC and ASCQ for Verify (10) Command Errors

Sense Key	ASC	ASCQ	Description of Error
01	17	01	RECOVERED DATA WITH RETRIES
01	18	01	RECOVERED DATA WITH ERROR CORRECTION & RETRIES APPLIED
01	18	04	RECOVERED DATA WITH L-EC (CD Media only)
01	5D	01	FAILURE PREDICTION THRESHOLD EXCEEDED - Predicted Media Failure
02	04	00	LOGICAL DRIVE NOT READY - CAUSE NOT REPORTABLE
02	04	01	LOGICAL DRIVE NOT READY - IN PROGRESS OF BECOMING READY
02	04	02	LOGICAL DRIVE NOT READY - INITIALIZING COMMAND REQUIRED
02	04	03	LOGICAL DRIVE NOT READY - MANUAL INTERVENTION REQUIRED
02	06	00	NO REFERENCE POSITION FOUND (media may be upside down)
02	30	01	CANNOT READ MEDIUM - UNKNOWN FORMAT
02	30	02	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT
02	3A	00	MEDIUM NOT PRESENT
03	02	00	NO SEEK COMPLETE
03	11	05	L-EC UNCORRECTABLE ERROR
03	11	06	CIRC UNRECOVERED ERROR (CD Media only)
05	20	00	INVALID COMMAND OPERATION CODE
05	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
05	24	00	INVALID FIELD IN COMMAND PACKET
05	6F	02	COPY PROTECTION KEY EXCHANGE FAILURE - KEY NOT ESTABLISHED
06	28	00	NOT READY TO READY TRANSITION
05	64	00	ILLEGAL MODE FOR THIS TRACK OR INCOMPATIBLE MEDIUM
06	28	00	NOT READY TO READY TRANSITION
06	29	00	POWER ON OR HARD RESET OCCURRED
06	2E	00	INSUFFICIENT TIME FOR OPERATION
06	3F	00	DEVICE OPERATING CONDITIONS HAVE CHANGED
06	3F	01	MICROCODE HAS BEEN CHANGED

A-8 WRITE (12) Command

The WRITE(12) command requests that the Device write the data transferred from the Host to the medium.

Table 233 - WRITE (12) Command

Byte	Bit	7	6	5	4	3	2	1	0
0		Operation code (AAh)							
1		LUN			DPO (0)	FUA	EBP	Reserved	Rel Adr
2		MSE Logical Block Address							
3									
4									
5									
6		MSE Transfer Length							
7									
8									
9									
10		Reserved							
11		Vendor-Specific			Reserved			Flag	Link

The RelAdr bit is only used for SCSI devices. For information on this bit See “Use of the RelAdr bit” on page 257.

An erase bypass (EBP) bit of zero indicates that the device will default to the normal write operation. An EBP bit of one indicates that the Device is allowed to bypass the erase operation prior to writing the data. When accessing write once media, the EBP bit shall be considered reserved.

The Disable Page Out (DPO) bit is not used by C/DVD devices and shall be set to zero. A DPO bit of zero indicates the priority shall be determined by the retention priority fields in the cache page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vender specific.

A Force Unit Access (FUA) bit of one indicates that the C/DVD device shall access the media in performing the command. Write commands shall access the specified logical blocks on the media In the case where the cache contains a more recent version of a logical block than the media, the logical block shall first be written to the media.

An FUA bit of zero indicates that the C/DVD device may satisfy the command by writing to the cache memory.

The transfer length specifies the number of contiguous logical blocks of data that shall be transferred. A transfer length of zero indicates that no data shall be transferred. This condition shall not be considered an error and no data shall be written. Any other value indicates the number of logical blocks that shall be transferred.

Table 234 - Recommended Sense Key, ASC and ASCQ for Verify (10) Command Errors

Sense Key	ASC	ASCQ	Description of Error
02	04	00	LOGICAL DRIVE NOT READY - CAUSE NOT REPORTABLE
02	04	01	LOGICAL DRIVE NOT READY - IN PROGRESS OF BECOMING READY
02	04	02	LOGICAL DRIVE NOT READY - INITIALIZING COMMAND REQUIRED
02	04	03	LOGICAL DRIVE NOT READY - MANUAL INTERVENTION REQUIRED
02	06	00	NO REFERENCE POSITION FOUND (media may be upside down)
02	3A	00	MEDIUM NOT PRESENT
03	02	00	NO SEEK COMPLETE
03	11	00	UNRECOVERED READ ERROR
03	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD
03	14	00	RECORDED ENTITY NOT FOUND
03	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD
05	20	00	INVALID COMMAND OPERATION CODE
05	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
05	24	00	INVALID FIELD IN COMMAND PACKET
06	28	00	NOT READY TO READY TRANSITION
06	29	00	POWER ON, RESET OR BUS DEVICE RESET OCCURRED

A-9 WRITE and VERIFY (12) Command

The WRITE AND VERIFY (12) command requests that the device write the data transferred from the Host to the medium and then verify that the data is correctly written.

Table 235 - WRITE and VERIFY (12) Command

Byte	Bit	7	6	5	4	3	2	1	0	
0		Operation code (A12h)								
1		LUN			DPO(0)	Reserved		BytChk	RelAdr	
2		Logical Block Address								
3										
4										
5										LSB
6										Verification Length
7										
8										
9										LSB
10		Reserved								
11		Vendor-Specific			Reserved		Flag	Link		

If the MODE SELECT Verify Error Recovery Parameters page is implemented, then the current settings in that page define the verification criteria. If the Verify Error Recovery Parameters page is not implemented, then the verification criteria is vendor specific.

The RelAdr bit is only used for SCSI devices. For information on this bit See “Use of the RelAdr bit” on page 257.

A byte check (BytChk) bit of zero causes a medium verification to be performed with no data comparison. A BytChk bit of one causes a byte by byte compare of the data written on the medium and the data transferred from the Host. If the compare is unsuccessful, for any reason, the Device shall return CHECK CONDITION status and the sense key shall be set to MISCOMPARE.

If the BytChk is one when the BlkVfy bit is one, this shall be considered an error. The Device shall return CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

The Disable Page Out (DPO) bit is not used by C/DVD devices and shall be set to zero. A DPO bit of zero indicates the priority shall be determined by the retention priority fields in the cache page if supported. All other aspects of the algorithm implementing the cache memory replacement strategy are vendor specific.

The transfer length specifies the number of contiguous logical blocks of data or blanks that shall be verified. A transfer length of zero indicates that no logical blocks shall be verified. This condition shall not be considered as an error. Any other value indicates the number of logical blocks that shall be verified.

Table 236 - Recommended Sense Key, ASC and ASCQ for Verify (10) Command Errors

Sense Key	ASC	ASCQ	Description of Error
05	20		INVALID COMMAND OPERATION CODE
05	24		INVALID FIELD IN COMMAND PACKET
06	28		NOT READY TO READY TRANSITION
06	29		POWER ON, RESET OR BUS DEVICE RESET OCCURRED
02	04	00	LOGICAL DRIVE NOT READY - CAUSE NOT REPORTABLE
02	04	01	LOGICAL DRIVE NOT READY - IN PROGRESS OF BECOMING READY
02	04	02	LOGICAL DRIVE NOT READY - INITIALIZING COMMAND REQUIRED
02	04	03	LOGICAL DRIVE NOT READY - MANUAL INTERVENTION REQUIRED
02	06	00	NO REFERENCE POSITION FOUND (media may be upside down)
02	3A		MEDIUM NOT PRESENT
03	02		NO SEEK COMPLETE
05	21		LOGICAL BLOCK ADDRESS OUT OF RANGE
03	11		UNRECOVERED READ ERROR
03	12		ADDRESS MARK NOT FOUND FOR ID FIELD
03	14		RECORDED ENTITY NOT FOUND
03	12		ADDRESS MARK NOT FOUND FOR ID FIELD