Technical Note

Micron UFS Memory Health Report for Mobile Devices

Introduction

This technical note describes how to obtain the extended health report information for Micron's UFS devices listed in the table below. The extended health report information is accessed via proprietary vendor-unique (VU) commands issued through the SCSI interface of the UFS device.

Because UFS devices are Managed NAND components, and NAND cells are stressed by the continuous use of UFS devices, it is important to understand how usage affects the device and the device data. The extended health report is a resource that allows customers to monitor a device's media usage and the length of time that the device can be cycled.

The method of obtaining the extended health report information can be applied to the following Micron UFS devices.

Table 1: Micron UFS Devices List

Part Number	Density	Package	Package Code
MT29VZZZAD8FQFSL-046 W.G8K	64GB (2 x B16C) + 32Gb (2 x Z32M)	254-ball VFBGA, 11.5mm x 13.0mm x 0.9mm	SL
MT29VZZZAD9FQFSM-046 W.G9K	128GB (4 x B16C) + 32Gb (2 x Z32M)	254-ball VFBGA, 11.5mm x 13.0mm x 1.0mm	SM
MT29VZZZBD9FQKPR-046 W.G9J	128GB (4 x B16C) + 48Gb (4 x Z2BM)	254-ball TFBGA, 11.5mm x 13.0mm x 1.1mm	PR
MT29VZZZCD9FQKPR-046 W.G9L	128GB (4 x B16C) + 64Gb (4 x Z32M)		
MT29VZZZBDAFQKWL-046 W.G0J	256GB (8 x B16C) + 48Gb (4 x Z2BM)	254-ball TFBGA, 11.5mm x 13.0mm x 1.2mm	WL
MT29VZZZCDAFQKWL-046 W.G0L	256GB (8 x B16C) + 64Gb (4 x Z32M)	254-ball TFBGA, 11.5mm x 13.0mm x 1.2mm	WL
MTFC128GARATEK-WT	128GB (2 x B27B)	153-ball VFBGA, 11.5mm x 13.0mm x 0.9mm	EK
MTFC64GAXAUEA-WT	64GB (1 x B47R)	153-ball WFBGA, 11.5mm x 13.0mm x 0.8mm	EA
MTFC128GAXAUEA-WT	128GB (2 x B47R)		
MTFC256GAXAUEA-WT	256GB (4 x B47R)		
MT29VZZZ7D81SFSL-046 W.22B	64GB (1 x B47R) + 24Gb (2 x Z3BM)	254-ball VFBGA, 11.5mm x 13.0mm x 0.9mm	SL
MT29VZZZAD81SFSL-046 W.22C	64GB (1 x B47R) + 32Gb (2 x Z42M)		
MT29VZZZBD81SLSL-046 W.22D	64GB (1 x B47R) + 32Gb (2 x Z42M)		
MT29VZZZCD91SFSM-046 W.18C	128GB (2 x B47R) + 32Gb (2 x Z42M)	254-ball VFBGA, 11.5mm x 13.0mm x 1.0mm	SM
MT29VZZZBD91SLSM-046 W.17X	128GB (2 x B47R) + 32Gb (2 x Z42N) + 16Gb (1 x Z42M)		
MT29VZZZCD91SKSM-046 W.17Y	128GB (2 x B47R) + 64Gb (4 x Z42N)		
MT29VZZZBD91SKSM-046 W.12N	128GB (2 x B47R) + 48Gb (4 x Z3BM)		

Table 1: Micron UFS Devices List (Continued)

Part Number	Density	Package	Package Code
MT29VZZZBDA1SLPR-046 W.17Z	256GB (4 x B47R) + 32Gb (2 x Z42N) + 16Gb (1 x Z42M)	254-ball TFBGA, 11.5mm x 13.0mm x1.1mm	PR
MT29VZZZCDA1SKPR-046 W.181	256GB (4 x B47R) + 64Gb (4 x Z42N)		
MTFC128GAXATEA-WT	128GB (2 x B47R)	153-ball WFBGA, 11.5mm x 13.0mm x 0.8mm	EA
MTFC128GAXATHF-WT	128GB (2 x B47R)	153-ball WFBGA, 11.0mm x 13.0mm x 0.8mm	HF
MTFC256GAXATEA-WT	256GB (4 x B47R)	153-ball WFBGA, 11.5mm x 13.0mm x 0.8mm	EA
MTFC256GAXATHF-WT	256GB (4 x B47R)	153-ball WFBGA, 11.0mm x 13.0mm x 0.8mm	HF
MTFC512GAXATAM-WT	512GB (8 x B47R)	153-ball VFBGA, 11.5mm x 13.0mm x 1.0mm	AM
MTFC512GAXATHJ-WT	512GB (8 x B47R)	153-ball VFBGA, 11.0mm x 13.0mm x 1.0mm	HJ
MT30AZZZCD9ZTPWL-031 W.165	128GB (2 x B47R) + 64Gb (8 x Y31N)	297-ball TFBGA, 11.5mm x 13.0mm x 1.2mm	WL
MT30AZZZBC9ZTKXM-031 W.20S	128GB (2 x B47R) + 48Gb (4 x Y2BM)	297-ball VFBGA, 11.5mm x 13.0mm x 1.0mm	XM
MT30AZZZCDAZTPWL-031 W.16C	256GB (4 x B47R) + 64Gb (8 x Y31N)	297-ball TFBGA, 11.5mm x 13.0mm x 1.2mm	WL
MT30AZZZCDBZTPEQ-031 W.16D	512GB (8 x B47R) + 64Gb (8 x Y31N)	297-ball LFBGA, 11.5mm x 13.0mm x 1.3mm	EQ
MTFC128GBCAVHF-WT	128GB (2 x B47T)	153-ball WFBGA, 11.0mm x 13.0mm x 0.8mm	HF
MTFC256GBCAVHF-WT	256GB (4 x B47T)		
MTFC512GBCAVHE-WT	512GB (8 x B47T)	153-ball WFBGA, 11.0mm x 13.0mm x 0.9mm	HE
MT30AZZZBD90TKXM-031 W.197	128GB (2 x B47T) + 48Gb (4 x Y4BM)	297-ball VFBGA, 11.5mm x 13.0mm x 1.0mm	XM
MT30AZZZCD90TKXM-031 W.20T	128GB (2 x B47T) + 64Gb (4 x Y42M)	297-ball VFBGA, 11.5mm x 13.0mm x 1.0mm	XM
MT30AZZZCDA0TKQS-031 W.20V	256GB (4 x B47T) + 64Gb (4 x Y42M)	297-ball TFBGA, 11.5mm x 13.0mm x 1.1mm	QS
MT30AZZZDDA0TKQS-031 W.19Q	256GB (4 x B47T) + 96Gb (8 x Y4BM)	297-ball TFBGA, 11.5mm x 13.0mm x 1.1mm	QS
MT30AZZZDDA0TKQS-031 WL.19Q			
MT30AZZZEDA0TPWL-031 W.20W	256GB (4 x B47T) + 128Gb (8 x Y42M)	297-ball TFBGA, 11.5mm x 13.0mm x 1.2mm	WL
MT30AZZZEDA0TPWL-031 WN.20W			
MT30AZZZCDB0TKWL-031 W.20X	512GB (8 x B47T) + 64Gb (4 x Y42M)	297-ball TFBGA, 11.5mm x 13.0mm x 1.2mm	WL
MT30AZZZDDB0TPWL-031 W.19R	512GB (8 x B47T) + 96Gb (8 x Y4BM)	297-ball TFBGA, 11.5mm x 13.0mm x 1.2mm	WL
MT30AZZZDDB0TPWL-031 WL.19R			

Table 1: Micron UFS Devices List (Continued)

Part Number	Density	Package	Package Code
MT30AZZZEDB0TPEQ-031 W.20Z	512GB (8 x B47T) + 128Gb (8 x Y42M)	297-ball TFBGA, 11.5mm x 13.0mm x 1.3mm	EQ
MT30AZZZEDB0TPEQ-031 WN.20Z			
MTFC256GBEAXHF-WT	256GB (4 x B57T)	153-ball WFBGA, 11.0mm x 13.0mm x 0.8mm	HF
MTFC512GAYAXHF-WT	512GB (4 x B58R)	153-ball WFBGA, 11.0mm x 13.0mm x 0.8mm	
MTFC1TAYAXHE-WT	1024GB (8 x B58R)	153-ball VFBGA, 11.0mm x 13.0mm x 0.9mm	HE

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Obtaining Health Report Data

Obtaining the report data requires using the SCSI commands WRITE BUFFER and READ BUFFER with opcodes 0x3B and 0x3C, respectively. The command details are given below, but in short, a VU command request is issued to the device via the WRITE BUFFER command. A READ BUFFER command is then used to retrieve the 512B data burst reply, which contains the health report data.

The table below shows the format for the WRITE BUFFER command. The READ BUFFER command is similar with the opcode 0x3C (byte 0). The VU operation must use the reserved bits of byte 1 in both WRITE and READ commands.

Command Sequence

Step 1

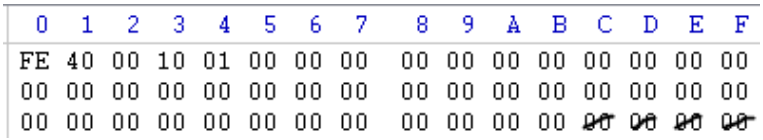
1. VU WRITE BUFFER command to request the Health Report information
2. Command descriptor block (CDB) for WRITE BUFFER: 3B E1 00 00 00 00 00 00 2C 00
3. VU parameter list data (0x2C == 44B)

Table 2: WRITE BUFFER Command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation code (3Bh)							
1	Reserved			Mode				
2	Buffer ID							
3	(MSB)	Buffer offset						(LSB)
4								
5								
6	(MSB)	Parameter list length						(LSB)
7								
8								
9	Control							

Table 3: WRITE BUFFER Command Data

Byte	Data
0	0xFE
1	0x40
2	0x00
3	0x10
4	0x01
5–43	0x00



0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
FE	40	00	10	01	00	00	00	00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

Step 2

1. VU READ BUFFER command to read the Health Report information
2. Command descriptor block (CDB) for READ BUFFER: 3C C1 00 00 00 00 00 02 00 00

Table 4: READ BUFFER Command Data

Byte	Bit							
	7	6	5	4	3	2	1	0
0	Operation code (3Ch)							
1	Reserved			Mode				
2	Buffer ID							
3	(MSB)	Buffer offset						(LSB)
4								
5								
6	(MSB)	Parameter list length						(LSB)
7								
8								
9	Control							

Understanding Health Report Data

512B of data is acquired by the READ BUFFER command (0x200B).

Use the byte decode from Table below to evaluate the data.

Table 5: Health Report Output format for B16C- and B27B-based devices

HR Output Offset (bytes)	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0x00	Factory bad block count		Run-time bad block count		Spare block count		Reserved block count for SLC		Reserved block count for TLC		Exhausted life for:		Meta data corruption		Write amplification factor	
											SLC	TLC				
0x10	Minimum block erase for TLC				Maximum block erase for TLC				Average block erase for TLC				Reserved			
0x20	Minimum block erase for SLC				Maximum block erase for SLC				Average block erase for SLC				Reserved			
0x30	Initialization count (success)				Initialization count (failure)				Read reclaim count for SLC				Read reclaim count for TLC			
0x40	Read data size (unit: 100MB)				Written data size (unit: 100MB)				SPOR write fail count				SPOR recovery count			
0x50	VDET count				UECC count				Read retry count				Highest temperature history	Lowest temperature history	Power on highest temp hist	Power on lowest temp hist
0x60	UIC error count				SER DED count				SEC count				Reserved			
0x70	Reserved				Reserved				Reserved				Reserved			
...	...				...				...				...			
...	Reserved				Reserved				Reserved				Reserved			

Note: 1. Block counts are given in virtual blocks, not in discrete NAND blocks.

Table 6: Health Report Output format for B47R-, B47T-, B57T-, B58R-based devices

HR Output Offset (bytes)	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0x00	Factory bad block count		Run-time bad block count		Spare block count		Reserved block count for SLC		Reserved block count for TLC		Exhausted life for: SLC	TLC	Meta data corruption		Write amplification factor	
0x10	Minimum block erase for TLC				Maximum block erase for TLC				Average block erase for TLC				Reserved			
020	Minimum block erase for SLC				Maximum block erase for SLC				Average block erase for SLC				Reserved			
030	Initialization count (success)				Initialization count (failure)				Read reclaim count for SLC				Read reclaim count for TLC			
040	Read data size (unit: 100MB)				Written data size (unit: 100MB)				SPOR write fail count				SPOR recovery count			
050	VDET count				UECC count				Read retry count				Highest temperature history	Lowest temperature history	Power on highest temp hist	Power on lowest temp hist
060	Reserved block count for EM1		Exhausted life for EM1	Reserved	WA factor for EM1		Reserved		Read data size for EM1 (unit: 100MB)				Write data size for EM1 (unit: 100MB)			
070	Minimum block erase for EM1				Maximum block erase for EM1				Average block erase for EM1				Read reclaim count for EM1			
080	Reserved				Reserved				Reserved				Reserved			
090	UIC error count				SER DED count				SEC count				Reserved			
0A0	Reserved				Reserved				Reserved				Reserved			
...	...				...				...				...			
...	Reserved				Reserved				Reserved				Reserved			

Note: 1. Block counts are given in virtual blocks, not in discrete NAND blocks.

Table 7: Health Report Decode

Name	Description
Factory bad block count	These counters indicate the total number of bad blocks produced during manufacturing (factory bad block count), the total number of bad blocks generated after manufacturing (run-time bad block count), and the number of remaining spare blocks to allow bad blocks replacement. Block counts are given in virtual blocks
Run-time bad block count	
Spare block count	
Reserved block count for SLC	Blocks reserved for system bad blocks replacement (Note 2)
Reserved block count for TLC	Blocks reserved for user bad blocks replacement (Note 3)
Exhausted life for SLC	SLC block life time used
Exhausted life for TLC	TLC block life time used
Meta data corruption	This field indicates if there is meta data corruption. If value is 0: no meta data corruption If value is 1–FFFFh: corruption error code
Write amplification factor	WA= (SLC EC + TLC EC*3)*100/ (Write Data Size/SLC VB size) EA= (SLC EC + TLC EC)*300/ (Write Data Size/SLC VB size) (Note 4)
Minimum/Maximum/Average block erase In TLC	These counters return the minimum/maximum/average number of block erases in host data area
Minimum/Maximum/Average block erase In SLC	These counters return the minimum/maximum/average number of block erases in system area
Initialization count (success)	The counter indicates the number of successful initializations; the increment is triggered by clean power down (or PON). The increment is visible after the next successful power on
Initialization count (failure)	The counter indicates the number of successful initializations; the increment is triggered by dirty power down (or SPOR). The increment is visible after the next successful power on
Read reclaim count for SLC	This count increases whenever NAND reliability features are triggered on system blocks
Read reclaim count for TLC	This count increases whenever NAND reliability features are triggered on user blocks
Read data size (presentation unit: 100MB)	This counter indicates the host cumulative read data size (units of 100MB). Read data is calculated as host cumulative read data x 100MB
Written data size (presentation unit: 100MB)	This counter indicates the host cumulative written data size (units of 100MB). Written data is calculated as host cumulative written data x 100MB
SPOR write fail count	The counter indicates the number of write operations interrupted by sudden power off (SPOR). The increment is visible after the next successful power on
SPOR recovery count	The counter indicates the cumulative number of dirty power down (or SPOR)
VDET count	The counter indicates the number of low voltage detections (Note 5)
UECC count	The counter indicates the cumulative number of UECC events
Read retry count	The counter indicates the cumulative number of read retry events
History highest temperature	This field indicates the maximum temperature (in Celsius degrees) recorded in the device after previous reset
History lowest temperature	This field indicates the minimum temperature (in Celsius degrees) recorded in the device after previous reset
Power-on highest temperature	This field indicates the maximum temperature (in Celsius degrees) recorded in the device after being used

Table 7: Health Report Decode (Continued)

Name	Description
Power-on lowest temperature	This field indicates the minimum temperature (in Celsius degrees) recorded in the device after being used
Reserved block count for EM1	Same as reserved block count for SLC
Exhausted life for EM1	EM1 block life time used
Write amplification factor for EM1	WA= EM1 EC*100/ (Write Data Size/SLC VB size) EA= EM1 EC*100/ (Write Data Size/SLC VB size)
Read data size for EM1 (presentation unit: 100MB)	This counter indicates the cumulative read data size for EM1 (units of 100MB). Read data is calculated as cumulative read data x 100MB
Minimum/Maximum/Average block erase for EM1	These counters return the minimum/maximum/average number of block erases in enhanced memory area
Read reclaim count for EM1	This count increases whenever NAND reliability features are triggered on blocks of enhanced memory area
UIC error count	This count indicates the number of UFS interconnect layer errors. The increment is triggered by link error recorded by the controller
SER DED Count	This count indicates the number of SRAM failures that cannot be recovered
SEC count	This count indicates the number of SRAM failures that can be recovered

Notes: 1. Fields data have to be read from the most significant byte to the less significant byte
2. Not used for UFS 4.0 compatible devices
3. Reserved blocks are used for both system and user bad blocks replacement for UFS 4.0 compatible devices
4. Write amplification factor must be decimalized and then divided by 100. Starting from B47T-based devices onwards, this fields records EA
5. V_{CCQ} low voltage detection count is supported by UFS 3.1 and UFS 4.0 compatible devices; V_{CCQ2} low voltage detection count is supported by UFS 2.2 compatible devices

Revision History

Rev. E – 05/2023

- Removed obsolete part numbers from Micron UFS Devices List table
- Health Report Output format tables differentiated on the NAND-based devices
- Tables Health Report: initial values and Health Byte Report Details replaced by Health Report Decode table

Rev. D – 05/2022

- Updated Table format and latest Health Report byte definitions

Rev. C – 05/2019

- Added the table Health Report: Initial Values

Rev. B – 12/2017

- Added in additional health decode byte description

Rev. A – 11/2017

- Initial release

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