

# eMMC Module



- Check the eMMC module compatibility.
- If the OS on your eMMC is corrupted or the eMMC has a wrong boot loader, reinstall a proper boot loader on the eMMC via [eMMC Recovery](#).
- The **Orange** eMMC modules work with ODROID-C0/C1/C1+/C2/C4/XU4/**H2/N2**/M1.
- The Black eMMC modules work with ODROID-C0/C1/C1+/C2/C4/**H2/N2**.
- The **Red** eMMC modules work with ODROID-C0/C1/C1+/C2/C4/XU4/**H2/N2**.

## Kingston 128GB/256GB eMMC Module

A new 128GB and 256GB eMMC module uses the Kingston eMMC 5.1chipset.



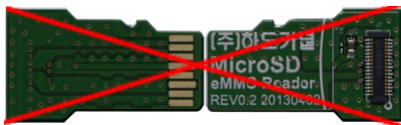
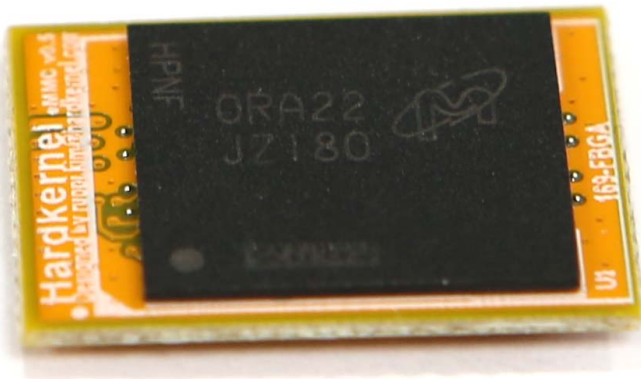
The Kingston eMMC chipset does support the legacy 4bit interface mode and you can use it with the original eMMC-to-MicroSD adapter (reader board).

You can use this eMMC reader to read and write with USB Multi-reader via legacy 4bit interface mode.  
<https://www.hardkernel.com/shop/emmc-module-reader-board-for-os-upgrade/>

You might want this eMMC Writer we have made that can read/write via the native eMMC 8bit interface.  
<https://www.hardkernel.com/shop/usb3-0-emmc-module-writer-2//>

# Micron 128GB eMMC module

A new 128GB eMMC module uses the Micron 128GB eMMC 5.1 chipset.



The Micron eMMC chipset doesn't support the legacy 4bit interface mode and you can't use it with the original eMMC-to-MicroSD adapter (reader board).

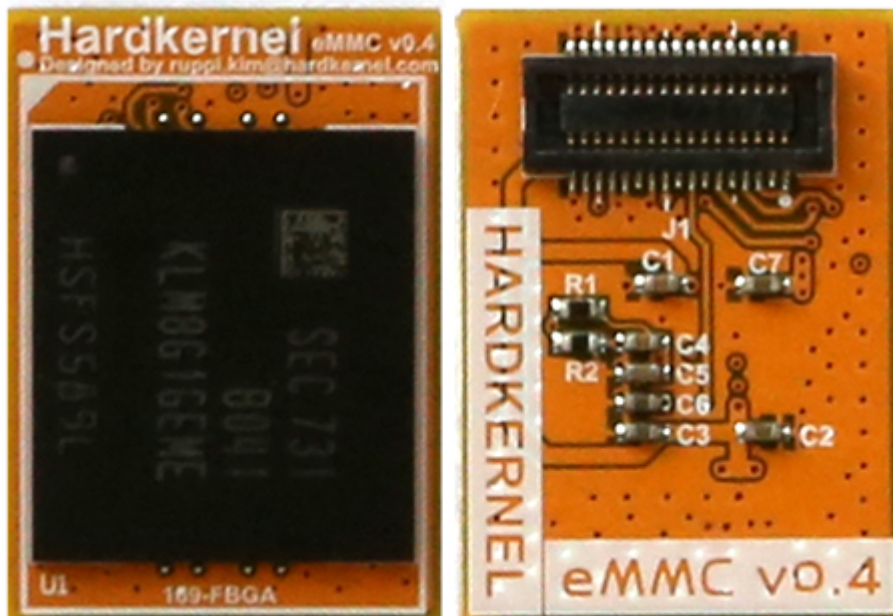
Therefore, you need this specific eMMC WRITER to flash the Micron eMMC via native eMMC 8bit interface mode.

You might want this eMMC Writer we have made that can read/write via the native eMMC 8bit interface.

<https://www.hardkernel.com/shop/usb3-0-emmc-module-writer/>

## Orange eMMC module

The Orange eMMC module uses Samsung eMMC 5.1 chipset. We started to ship it from October 2017.



It works with C1/C2/C4/XU4/**H2/N2/M1** series with a proper OS. The latest official OS images all work fine.

Orange eMMC module schematics : [eMMC PCB Rev 0.4](#)

The Orange eMMC Module Rev0.5 has been shipped since January 2020.

The Orange eMMC PCB **Rev0.4** and **Rev0.5** have the same schematics.

However, we modified it to reduce PCB defects by increasing the clearance between PCB patterns.

**If you want to use the Orange eMMC with XU4 platforms stably, the Kernel version must be higher than 4.9.58 or 4.14.6.**

## Orange eMMC compatibility status with XU4 series OS images

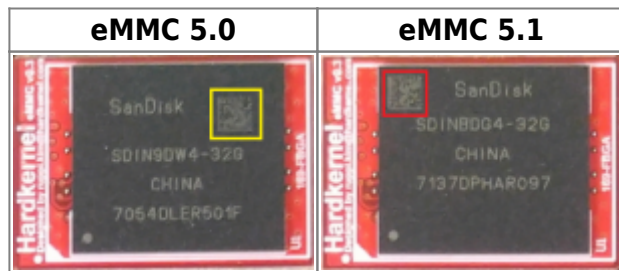
OS image	Image file information	Status
Ubuntu 18.04 Mate	ubuntu-18.04-4.14-mate-odroid-xu4-20180501.img	OK
Ubuntu 18.04 Minimal	ubuntu-18.04-4.14-minimal-odroid-xu4-20180531.img	OK
Ubuntu 16.04 Mate	ubuntu-16.04.3-4.14-mate-odroid-xu4-20171212.img	OK
Ubuntu 16.04 Minimal	ubuntu-16.04.3-4.14-minimal-odroid-xu4-20171213.img	OK
Android 7.1.1	Alpha-1.1_14.11.17	OK
Android TV 7.1.1	Alpha-1.0_20.11.17	OK
Android 4.4.4	Android 4.4.4 (v5.8)	OK
Debian Jessie	Debian-Jessie-1.1.4-20171121-XU3+XU4.img	OK
ODROID Game Station Turbo(OGST)	ODROID-GameStation-Turbo-3.9.5-20171115-XU3+XU4-Jessie.img	OK
Armbian	All Armbian variants starting with version 5.35	OK
OMV	OMV_3_0_92_Odroidxu4_4.9.61	OK
DietPi	DietPi_OdroidXU4-armv7-(Jessie).7z 22-Nov-2017	OK
Yocto project		Untested
Kali-Linux	Kali 2018.2	OK

OS image	Image file information	Status
Arch-Linux		Untested
ROS		Untested
Lakka	Lakka-OdroidXU3.arm-2.1-rc6.img.gz	OK
Batocera	batocera-5.12-xu4-20171214.img.gz	OK
RecalBox	recalbox (17.11.10.2)	OK
RetroPie	ORA(Odroid Retro Arena) 1.5x	OK

## How to distinguish the Sandisk eMMC ver 5.1 from the 5.0

The eMMCs from Sandisk will be version up to 5.1 with slightly faster data transfer speed starting from 20th of July 2017.

As shown in the figure below, the QR code is on the left side of the ver5.1 chipset while eMMC ver 5.0 has it on the right side.



Old Kernel 3.10 should have this patch to make it work with XU4 series properly.

[Github](#)

[Github](#)

[Github](#)

## eMMC modules for year 2016~2019

	Linux	Android
ODROID-C2		
ODROID-C1+ ODROID-C0 ODROID-C1		
ODROID-XU4 ODROID-XU3		


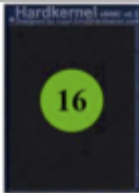


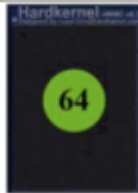














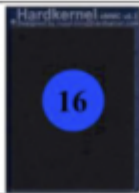








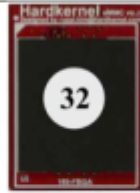
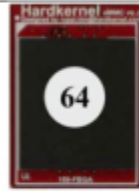




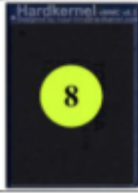

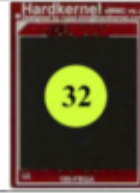



The Black eMMC modules work with only ODROID-C0/C1/C1+/C2/C4/H2/N2. It is not compatible with XU/XU3/XU4/U2/U3/X/X2.  
Other Blue/Red/Orange eMMC modules work with all ODROID boards.

## eMMC modules for old products



**eMMC Module Reference Chart**

	eMMC V4.5	eMMC V4.5	eMMC V5.0	eMMC V5.0	eMMC V4.5	eMMC V5.0
<b>Android for U2/U3 Green</b>						
	8GB	16GB	16GB	32GB	64GB	64GB
<b>Ubuntu For U2/U3 Red</b>						
	8GB	16GB	16GB	32GB	64GB	64GB
<b>Android For X2 Yellow</b>						
	8GB	16GB	16GB	32GB	64GB	64GB
<b>Android For XU Blue</b>						
	8GB	16GB	16GB	32GB	64GB	64GB
<b>Ubuntu for XU3 Light Blue</b>						
			16GB	32GB		64GB
<b>Android For XU3 White</b>						
			16GB	32GB		64GB
<b>Ubuntu for C1 Pink</b>						
	8GB		16GB	32GB		64GB
<b>Android for C1 Light Green</b>						
	8GB		16GB	32GB		64GB

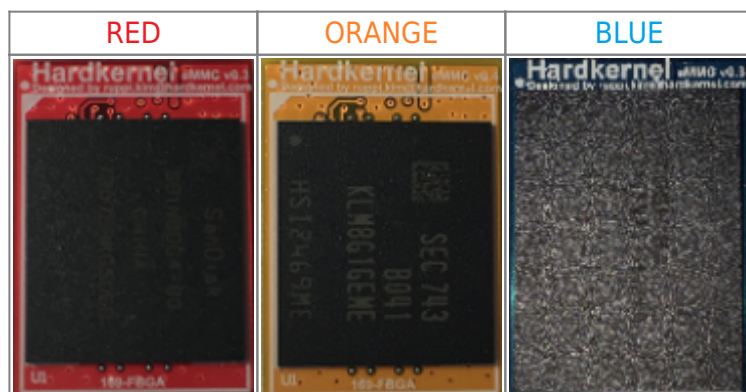
Note: XU4 and XU3 have software compatibility each other.

# Compatibility with USB3.0 to eMMC Reader



It is not related to their version or capacity but color.

Listed all kind of eMMC are **compatible** with USB3.0 to eMMC Reader.



This black PCB based eMMC module is **NOT compatible** with USB3.0 to eMMC Reader.



## Reference

### eMMC Module & eMMC Reader Schematics

[Download old eMMC module Revision 0.3 schematics](#)

[Download Orange eMMC module Revision 0.4 schematics](#)

[eMMC reader board schematics](#)

eMMC board dimensions : 18.5mm x 13.5mm

Gap between the PCBs : 1.1mm (Height of assembled B2B connectors)

### eMMC connector specification

The connector is made by LS-Mtron Korea.

On the eMMC module, we've used the GB042-34S-H10 (Socket-34pin).  
On the host board, we've used the GB042-34P-H10 (Plug-34pin).

[The connector specification is here](#)

### Information about Sandisk eMMC (iDisk Extreme)

<http://www.sandisk.com/products/embedded/inand/inand-extreme>

### Information about Samsung eMMC

<http://www.samsung.com/semiconductor/products/flash-storage/emmc/>

### Information about Essencore eMMC (This 8GB eMMC was used for XU4 long time ago)

<http://www.the-aio.com/emmcfeature>

### Information about Toshiba eMMC

<https://toshiba.semicon-storage.com/us/product/memory/nand-flash/mlc-nand/emmc.html>

## eMMC Read/Write test on ODROID-C4

ODROID-C4 + Orange eMMC Performance Test of File I/O

Test condition

OS : ubuntu 20.04

kernel version : Linux odroid 4.9.218-25

Test tool : iozone revision 3.489

iozone install & performance test

[target](#)

```
$ sudo apt install iozone3
$ iozone -e -I -a -s 100M -r 4k -r 16k -r 512k -r 1024k -r 16384k -i 0
-i 1 -i 2
```

## Samsung eMMC v5.1

/\* 8G \*/

random random



kB	reclen	write	rewrite	read	reread	read	write
102400	4	32835	39198	30593	30638	30064	37580
102400	16	55605	55864	77602	77210	77025	55587
102400	512	56324	56335	167658	167931	155491	55992
102400	1024	56388	56402	168213	168464	156691	56366
102400	16384	56307	56508	170166	170325	169964	56772

/\* 16G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	34479	40603	30540	30163	30095	37737
102400	16	54340	54432	77096	77102	76993	53930
102400	512	54444	54501	166421	166753	151607	54232
102400	1024	54343	54479	167804	168047	158466	54213
102400	16384	54346	54524	170215	170685	170251	54439

/\* 32G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	34659	40006	30456	30653	30585	40189
102400	16	81093	89477	77379	77343	77078	88657
102400	512	111766	112174	167889	168013	153708	112190
102400	1024	112247	112418	168818	169020	157981	112252
102400	16384	111973	111996	170058	170593	170312	112344

/\* 64G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	32720	39823	30021	30005	29905	39021
102400	16	77273	83613	75869	76174	75637	82888
102400	512	138202	136923	161642	162313	149562	138764
102400	1024	137274	138298	163043	163388	152816	138989
102400	16384	148874	148710	167319	167598	167464	149640

/\* 128G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	28836	33497	27364	27063	26278	29271
102400	16	72122	77892	70063	70047	69312	77770
102400	512	137289	136301	165930	166323	149172	136535
102400	1024	137023	135748	166734	166979	153839	136675
102400	16384	140365	139800	167435	168381	167079	141673

## Micron eMMC v5.1

/\* 128G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	33584	40215	51154	51199	23919	39794

102400	16	80918	90055	108995	109129	36437	88810
102400	512	146965	150420	169497	169657	142405	147800
102400	1024	149453	150958	170611	170811	155329	148850
102400	16384	151633	153443	172487	172802	171909	151536

## Kingston eMMC v5.1

/* 32G */							
	kB	reclen	write	rewrite	read	reread	random read      random write
102400		4	33499	39214	29557	26563	26518      38483
102400		16	73302	79872	58255	55327	50313      79033
102400		512	125537	126293	159396	155847	135211      124753
102400		1024	128047	131522	162144	158665	148982      129675
102400		16384	142979	143819	167963	164524	164166      143706
/* 64G */							
	kB	reclen	write	rewrite	read	reread	random read      random write
102400		4	32278	37995	34007	30566	27503      39874
102400		16	77734	85481	63120	59560	54822      84799
102400		512	130740	134064	159775	158516	143590      133448
102400		1024	139269	138432	162351	162441	154119      140247
102400		16384	150996	150280	167234	167523	167148      151845
/* 128G */							
	kB	reclen	write	rewrite	read	reread	random read      random write
102400		4	33622	40040	51308	51370	28990      39711
102400		16	81102	90909	109770	110064	44338      89445
102400		512	143862	146391	169909	170235	153661      144544
102400		1024	146351	146557	171018	171335	163848      145926
102400		16384	147127	149564	173078	173382	172763      147816
/* 256G */							
	kB	reclen	write	rewrite	read	reread	random read      random write
102400		4	35343	41892	53301	53512	29539      41368
102400		16	82616	89965	109957	110096	45359      88753
102400		512	139487	145019	170448	170577	156325      143786
102400		1024	143326	147521	171274	171498	163135      143271
102400		16384	146234	141246	172988	173438	172876      147867

## eMMC Read/Write test on ODROID-N2/N2Plus

ODROID-N2Plus + Orange eMMC Performance Test of File I/O  
Test condition

OS : ubuntu 20.04 minimal  
 kernel version : Linux odroid 4.9.230-88  
 Test tool : iotzone revision 3.489  
 iotzone install & performance test

target

```
$ sudo apt install iotzone3
$ iotzone -e -I -a -s 100M -r 4k -r 16k -r 512k -r 1024k -r 16384k -i 0
-i 1 -i 2
```

## Samsung eMMC v5.1

/\* 8G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	37518	44227	33183	33089	33049	46391
102400	16	56351	56539	80518	80424	80258	56310
102400	512	56655	56766	160631	161022	148955	56375
102400	1024	56627	56751	161111	161364	150157	56585
102400	16384	56471	56684	163643	163909	163668	56274

/\* 16G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	38035	44223	33210	33195	32748	43092
102400	16	54323	54679	80294	80418	80284	54355
102400	512	54737	54791	159582	159578	145576	54473
102400	1024	54801	54726	159838	160316	149142	54484
102400	16384	54651	54767	163614	163968	163703	54684

/\* 32G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	39049	44400	32450	32448	32287	43891
102400	16	83239	92206	78486	78843	78234	90928
102400	512	111459	111460	161389	161604	148190	111381
102400	1024	111436	111550	162192	162440	152001	111355
102400	16384	111336	111311	163861	164100	163658	111236

/\* 64G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	37627	44375	32477	32488	32597	45050
102400	16	83902	94060	78950	78706	78827	93485
102400	512	149500	151792	161603	161924	148691	153336
102400	1024	152307	152700	162246	162556	152416	153682

102400	16384	155768	154567	163946	164153	163931	156139	
/* 128G */								
	kB	reclen	write	rewrite	read	reread	random read	random write
102400		4	30385	33826	27532	27596	27405	32611
102400		16	78443	86788	72825	72707	71967	86350
102400		512	138058	138790	160191	160835	141309	138554
102400		1024	140770	141342	160935	161193	146787	142336
102400		16384	142275	141434	163060	163184	162785	145041

## Micron eMMC v5.1

/* 128G */								
	kB	reclen	write	rewrite	read	reread	random read	random write
	102400	4	38240	44133	53719	52943	25436	44345
	102400	16	88212	96926	113783	114007	36505	96138
	102400	512	148050	150385	163130	163342	136156	148508
	102400	1024	149211	151129	163721	163949	151700	148553
	102400	16384	153910	153899	166749	167014	166324	152890

## Kingston eMMC v5.1

/\* 32G \*/

	kB	reclen	write	rewrite	read	reread	random read	random write
	102400	4	33675	37850	29913	26874	26944	38551
	102400	16	78886	87606	58931	56032	50331	84679
	102400	512	138449	142123	158449	155095	134292	135856
	102400	1024	140674	141172	160065	156586	147072	137302
	102400	16384	142514	143227	162002	158654	158130	142928

/\* 64G \*/

	kB	reclen	write	rewrite	read	reread	random read	random write
	102400	4	34965	41055	35466	31419	28407	43139
	102400	16	83070	94327	65219	61588	56948	93766
	102400	512	146947	150413	156439	158819	143337	148538
	102400	1024	148779	149973	159754	159896	152491	151143
	102400	16384	150929	151739	161511	161777	161433	153665

/\* 128G \*/

	kB	reclen	write	rewrite	read	reread	random read	random write
	102400	4	37671	46277	56919	57037	32146	43280
	102400	16	80835	91312	112741	112976	46705	92198

```

102400    512    130581    131476    159061    159155    145623    127750
102400    1024    133857    137538    160437    160596    153578    134203
102400    16384    147215    147702    166812    166948    166501    147470

```

```
/* 256G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		37214	44290	56372	54960	30135	40862
102400	16		79444	86377	104849	105027	44122	85813
102400	512		126402	131088	157322	157489	145196	129783
102400	1024		131284	131438	157716	157956	152170	129575
102400	16384		148843	147986	166830	166951	166351	147346

## eMMC Read/Write test on ODROID-M1

ODROID-M1 + Orange eMMC Performance Test of File I/O

Test condition

OS : ubuntu 20.04.5 LTS

kernel version : 4.19.219-odroid-arm64

Test tool : iotzone revision 3.489

iotzone install & performance test

target

```

$ sudo apt install iotzone3
$ iotzone -e -I -a -s 100M -r 4k -r 16k -r 512k -r 1024k -r 16384k -i 0
-i 1 -i 2

```

## Samsung eMMC v5.1

```
/* 8G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		12781	14724	27185	27196	26994	15087
102400	16		39546	44489	65722	64090	63876	43310
102400	512		54796	55694	142812	142812	139994	55361
102400	1024		53200	53829	152548	153155	149090	53484
102400	16384		55365	55533	168597	168597	168657	55558

```
/* 16G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		12511	14866	27384	27378	27097	14888
102400	16		39683	44396	69166	68928	68758	44284
102400	512		54457	54683	166031	166403	162883	54289
102400	1024		54748	54757	168311	168813	164991	54533

102400	16384	54490	54535	171904	172295	171928	54475	
/* 32G */								
	kB	reclen	write	rewrite	read	reread	random read	random write
102400		4	11688	13934	22917	22941	22492	13767
102400		16	37928	42574	61203	61250	60694	39506
102400		512	129207	131694	160140	156886	151860	133913
102400		1024	114330	119817	153728	162792	154863	133347
102400		16384	135599	134033	161777	166293	162166	136565
/* 64G */								
	kB	reclen	write	rewrite	read	reread	random read	random write
102400		4	12581	15031	27424	27444	27360	15175
102400		16	40424	45807	66086	69139	69742	45549
102400		512	145118	146547	165990	166719	163334	146866
102400		1024	147290	148161	168163	168813	164621	148442
102400		16384	150467	150748	171864	172218	172210	150434
/* 128G */								
	kB	reclen	write	rewrite	read	reread	random read	random write
102400		4	12455	14532	23625	23727	23693	14266
102400		16	39370	43703	64408	64145	64474	41431
102400		512	134825	136966	163891	164631	160786	136636
102400		1024	136700	138199	166730	167139	163357	137507
102400		16384	139529	138618	168881	169709	170494	138767

## Kingston eMMC v5.1

/\* 32G \*/

	kB	reclen	write	rewrite	read	reread	random read	random write
102400		4	12827	15294	26729	23937	23819	15131
102400		16	38869	43866	49198	49047	46194	43633
102400		512	131408	134415	166711	166146	152235	131249
102400		1024	131413	134780	169308	168776	154753	132851
102400		16384	136694	137721	173302	172761	172059	136574

/\* 64G \*/

	kB	reclen	write	rewrite	read	reread	random read	random write
102400		4	12761	15030	31094	27549	24529	15138
102400		16	40143	44790	56516	53963	48802	44233
102400		512	140701	143524	166189	165234	157067	143421
102400		1024	142326	144598	168329	167424	158990	143770
102400		16384	146664	147160	171947	172381	171705	147012



/\* 128G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	12861	15450	44637	44628	26412	15268
102400	16	38990	44013	93566	93756	42981	43585
102400	512	136507	137121	167479	167817	162001	135979
102400	1024	133648	138500	170097	170526	163593	138287
102400	16384	141362	142644	173823	174237	173824	143183

/\* 256G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	13082	15381	44688	44660	26430	15264
102400	16	40221	45389	97250	97448	43249	45281
102400	512	136241	138718	166644	166948	160342	137122
102400	1024	138889	140111	169056	169614	163135	134994
102400	16384	143255	142462	173167	173681	173050	142114

## eMMC Read/Write test on ODROID-C2

# eMMC Modules

Unit : MByte/sec

		Samsung	Toshiba	Sandisk
8G	Write	45.4	21.9	N/A
8G	Read	113	148	N/A
16G	Write	80.1	N/A	25.6
16G	Read	126	N/A	153
32G	Write	124	N/A	98.7
32G	Read	125	N/A	153
64G	Write	124	83.7	107
64G	Read	124	153	153

Note 1: Write/Read command for the eMMC benchmark.

```
$ dd if=/dev/zero of=test.tmp oflag=direct bs=1M count=1024
```

```
$ dd if=test.tmp of=/dev/null iflag=direct bs=1M
```

ODROID-C2 + Black eMMC Performance Test of File I/O

Test condition

ubuntu 16.04

kernel version : Linux odroid64 3.14.79-115

Test tool : iotzone revision 3.429

iotzone install & performance test

target

```
$ sudo apt install iotzone3
$ iotzone -e -I -a -s 100M -r 4k -r 16k -r 512k -r 1024k -r 16384k -i 0
-i 1 -i 2
```

```
/* 8G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		9290	13582	13570	13568	11900	8787
102400	16		10934	15680	27511	27484	25976	7699
102400	512		14943	23761	42163	42121	41361	15122
102400	1024		15140	28564	41951	41915	41196	16743
102400	16384		16559	24001	42308	42267	42287	28604

```
/* 16G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		14602	14622	18102	17953	16768	14421
102400	16		49363	49279	52902	52808	47450	48389
102400	512		49779	49993	138268	138315	137171	48836
102400	1024		50005	49870	137522	137709	136958	49027
102400	16384		49861	50058	139358	139154	139299	50024

```
/* 32G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		14608	14670	18333	18343	17935	14624
102400	16		58393	66157	56412	56766	55744	56371
102400	512		80356	81074	136828	137132	137503	79224
102400	1024		80464	81036	137368	137278	136896	79191
102400	16384		80388	81070	139486	139612	139446	80560

```
/* 64G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		14240	14299	17619	17548	16012	14216
102400	16		49991	57484	53245	53405	50001	59302
102400	512		132316	135079	134154	134016	134208	129755
102400	1024		132476	134966	133753	133840	133677	130054
102400	16384		135772	139140	136133	136019	135821	135107

```
/* 128G */
```

	kB	reclen	write	rewrite	read	reread	random read	random write
102400	4		14162	14152	18161	18184	17833	14200
102400	16		56527	64906	55057	55684	54492	66525
102400	512		131327	131444	137307	137040	137358	132500
102400	1024		131908	131896	137570	137495	136844	132365
102400	16384		136418	134070	139940	133304	121160	134002

Note 2:

Black eMMC module is made with Samsung eMMC chipset.

Red/Blue(normal) eMMC module is made with Sandisk or Toshiba or AIO chipset.

C1/C0/C1+/C2 works with Black and Red eMMC modules.

**XU4/XU3/U3/X2/U2 do NOT work with Black eMMC module.**

## Micron eMMC v5.1

/\* 128G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	32874	36867	50214	50341	25392	36501
102400	16	74732	79623	107393	107390	36511	79352
102400	512	135281	137200	164775	164973	139135	133858
102400	1024	135909	137954	165426	165360	149826	132427
102400	16384	141450	142561	169225	169295	168458	137902

## Kingston eMMC v5.1

/\* 32G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	31773	35594	28970	28975	28194	35193
102400	16	74099	81195	81017	81017	54209	74104
102400	512	124345	128423	159007	158716	131953	122613
102400	1024	124830	130742	160064	160086	137279	125592
102400	16384	132372	136467	164411	164750	163113	133211

/\* 64G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	33524	37231	34295	34152	30185	36985
102400	16	78771	83978	77718	77885	57565	79458
102400	512	135834	137782	155622	155641	132819	132577
102400	1024	135879	135265	156631	156588	137693	131499
102400	16384	142370	142884	160526	160649	159443	137578

/\* 128G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	31062	34176	48180	48353	26918	34223
102400	16	70050	74981	101402	103518	39782	73712
102400	512	120868	122795	160083	154529	144161	121567
102400	1024	122158	123736	161075	155506	150165	123052
102400	16384	130579	127729	165457	165434	164230	129500

/\* 256G \*/

kB	reclen	write	rewrite	read	reread	random read	random write
102400	4	32701	37377	53711	52818	29092	35576
102400	16	72568	77136	104471	104206	44905	76810
102400	512	127924	125988	164116	164219	148316	129120
102400	1024	129910	130725	164955	164970	158150	129831
102400	16384	135255	135654	169691	169697	169012	136947

## New 8GB eMMC test on XU4 Ubuntu

New 8GB eMMC Red PCB for XU4 model is based on Essencore/AIO's eMMC 5.0 technology.

Sequential speed with "dd" test

dd write : 15.1 MB/s

dd read : 104 MB/s

Random access(IOPS) speed test with 4k block.

Random write : io=993228KB, bw=9928.2KB/s, iops=2482

Random read : io=1479.1MB, bw=15149KB/s, iops=3787

## eMMC vs SD card performance comparison on C2 Android

16GB eMMC Black PCB

16GB UHS-1 SDHC Card (Sandisk SDSDQAD-016G UHS-I 50 OEM model)

Cleanly flashed Android 5.1 V2.8 image and installed GApps Pico package.

eMMC booting time from power on event : 18~20 seconds

SDHC booting time from power on event : 32~35 seconds

## Check points for system software developers

\* Do not overwrite the hidden eMMC boot partition. If you have, go here to recover: [How to recover the eMMC boot loader](#).

\* eMMC must be partitioned like so;

—FAT16 partition with UUID 6E35-5356 (boot)

—EXT4 partition with UUID e139ce78-9841-40fe-8823-96a304a09859 (linux)

\* Copy contents from Ubuntu image partitions to the boot and linux partitions using "cp -afpv source destination"

\* Insert eMMC and boot normally.

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