SSDs:
SATA to mSATA
to "M.2 NVMe SATA"
to "M.2 NVMe PCIe"
to "U.2 NVMe"

by Francis Chao
fchao2@yahoo.com

Web Location for Presentations:

http://aztcs.org

Click on “Meeting Notes”

SUMMARY

- The technology inside hard drives keeps improving:
  SATA mechanical hard drives
  were usurped by SATA SSDs
  were usurped by 2.5-in. SATA SSDs
  were usurped by M.2 SATA SSDs
  were usurped by M.2 NVMe PCIe SSDs
  which will probably be usurped by U.2 PCIe SSDs

TOPICS

- SATA and eSATA legacy interfaces
- SATA has became a bottleneck for SSD technological advances
- NVMe to greater data throughput
- Slots to prevent incorrect insertions of M.2 and U.2 module

SATA AND eSATA BASICS

- "SATA" means "Serial Advanced Technology Attachment"
- "eSATA" means "external Serial Advanced Technology Attachment"
- Serial ATA International Organization (SATA-IO) has a Web site at https://www.sata-io.org/

SATA AND eSATA BASICS (continued)

- Older SATA hard drives conform to standard called "SATA Revision 2" = "SATA II" which runs at 3 Gigabits per second.
- Current SATA hard drives and SSDs conform to standard called "SATA Revision 3" = "SATA III" which runs at 6 Gigabits per second.

SATA AND eSATA BASICS (continued)

- Almost everyone has "SATA III" technology in their computers: SATA hard drives are currently in 99 percent of consumer computers. Most computers purchased since 2005 have SATA hard drives connected to SATA connectors on the motherboard.

SATA AND eSATA BASICS (continued)

- eSATA is essentially SATA with shielding and different tougher connectors
- "SATA" and "eSATA" is a 7-wire/7-pin technology
- eSATA and SATA have the same number of wires/pins and their signal formats are the same

SATA AND eSATA BASICS (continued)

- eSATA was a momentary "flash in the pan" in 2009:
  Almost no one has eSATA in their computers.
  eSATA-only hard drives and enclosures are non-existent.
  Some USB hard drives and enclosures also have an eSATA port.

SATA AND eSATA BASICS (continued)

- Maximum cable length of 39.37 inches for SATA (1 meter)
- Maximum cable length of 6 1/2 feet (2 meters) for eSATA

SATA AND eSATA BASICS (continued)

- SATA and eSATA only works for hard drives:
  Cannot connect keyboard, mice, and other devices.
  SATA only connects to internal hard drives that have a SATA connector.
  eSATA only connects to external hard drives and enclosures that have an eSATA jack

SATA AND eSATA AND BASICS (continued)

- Cheapest technology to add hard drives to an existing computer:
  Use passive SATA cable for SATA connections
  and
  use a passive SATA-to-eSATA bracket or cable for eSATA.

SATA AND eSATA AND BASICS (continued)

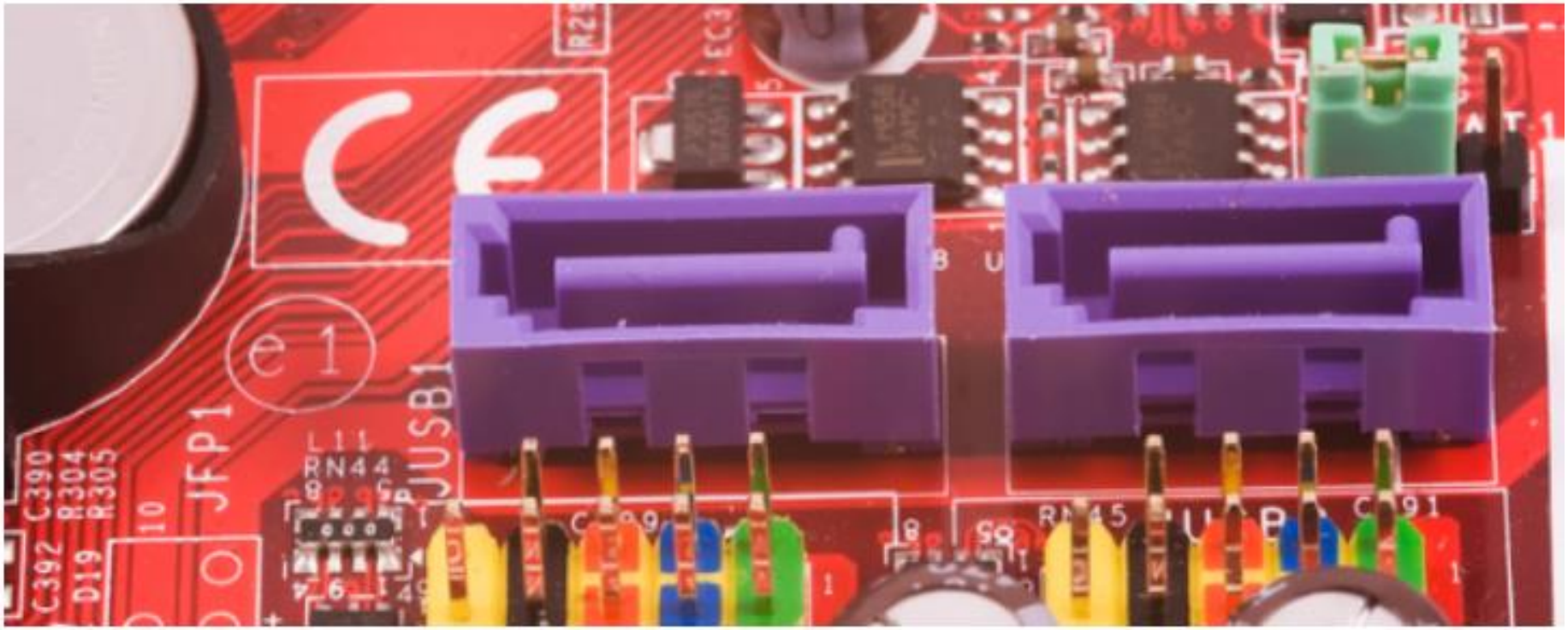
- When purchasing SATA and eSATA cables and connectors, it is easy to confuse the two technologies:

SATA AND eSATA AND BASICS (continued)

- When purchasing SATA and eSATA cables and connectors, it is easy to confuse the two technologies:

SATA AND eSATA AND BASICS (continued)

- Two SATA data connections from motherboard to SATA hard drive:


JFP1
JUSB1
RN44
RN45
C390
R304
R305

Cables Unlimited FLT-6000-18 Cables Unlimited FLT-6000-18 18in Red Serial ATA Cable With Straight Connector - SATA - SATA - 1.5ft - Red

by Cables Unlimited

Be the first to review this item

Price: $6.99 + $2.30 shipping

In Stock.

Get it as soon as Feb. 2 - 7 when you choose **Expedited** at checkout.

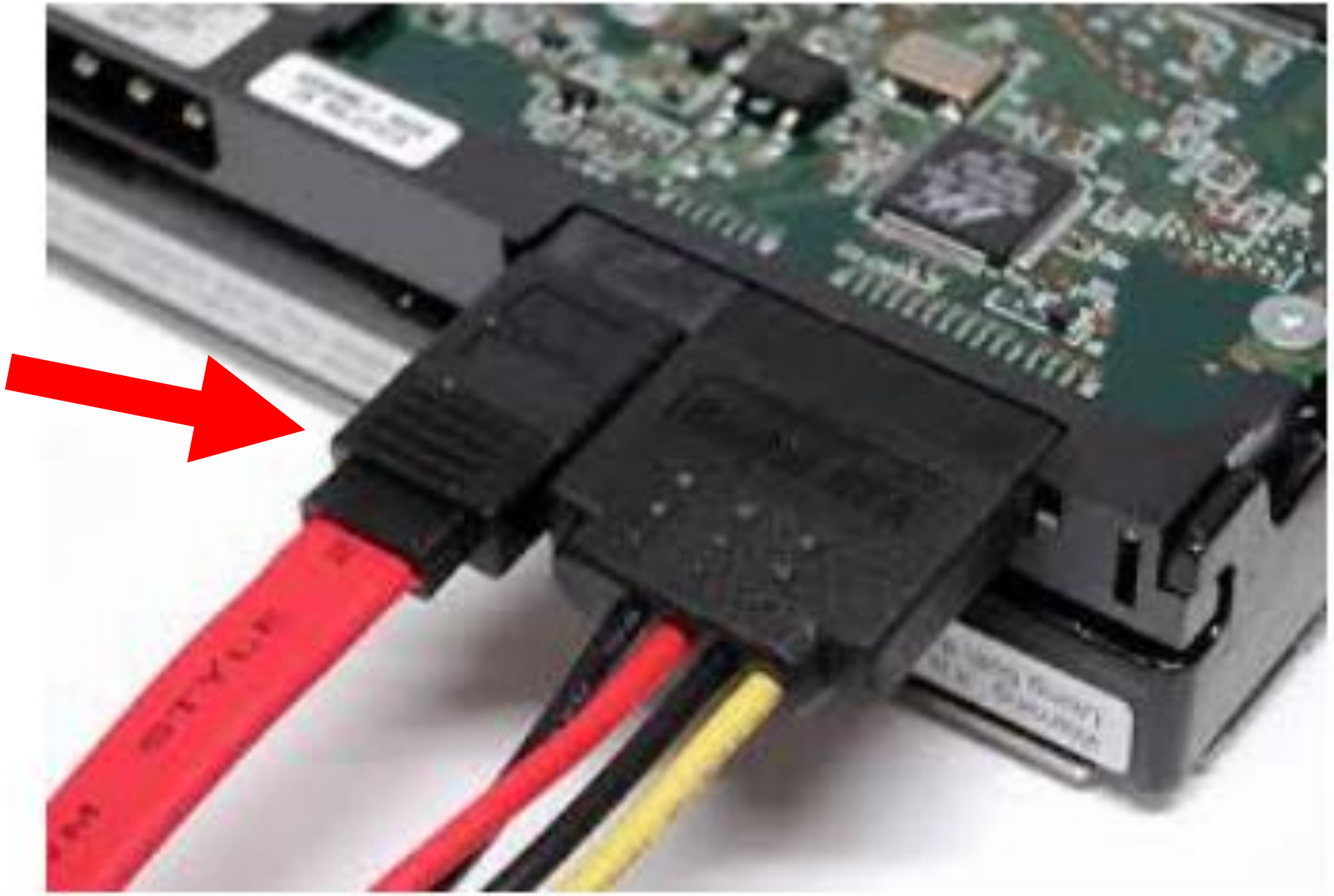
Ships from and sold by cables4computer.

- Retail
- cables unlimited flt-6000-18 cables unlimited flt-6000-18 18in red serial ata cable with straight connector - sata - sata - 1.5ft - red

Data
connector
Power
connector
600 × 450 - biblelife.org

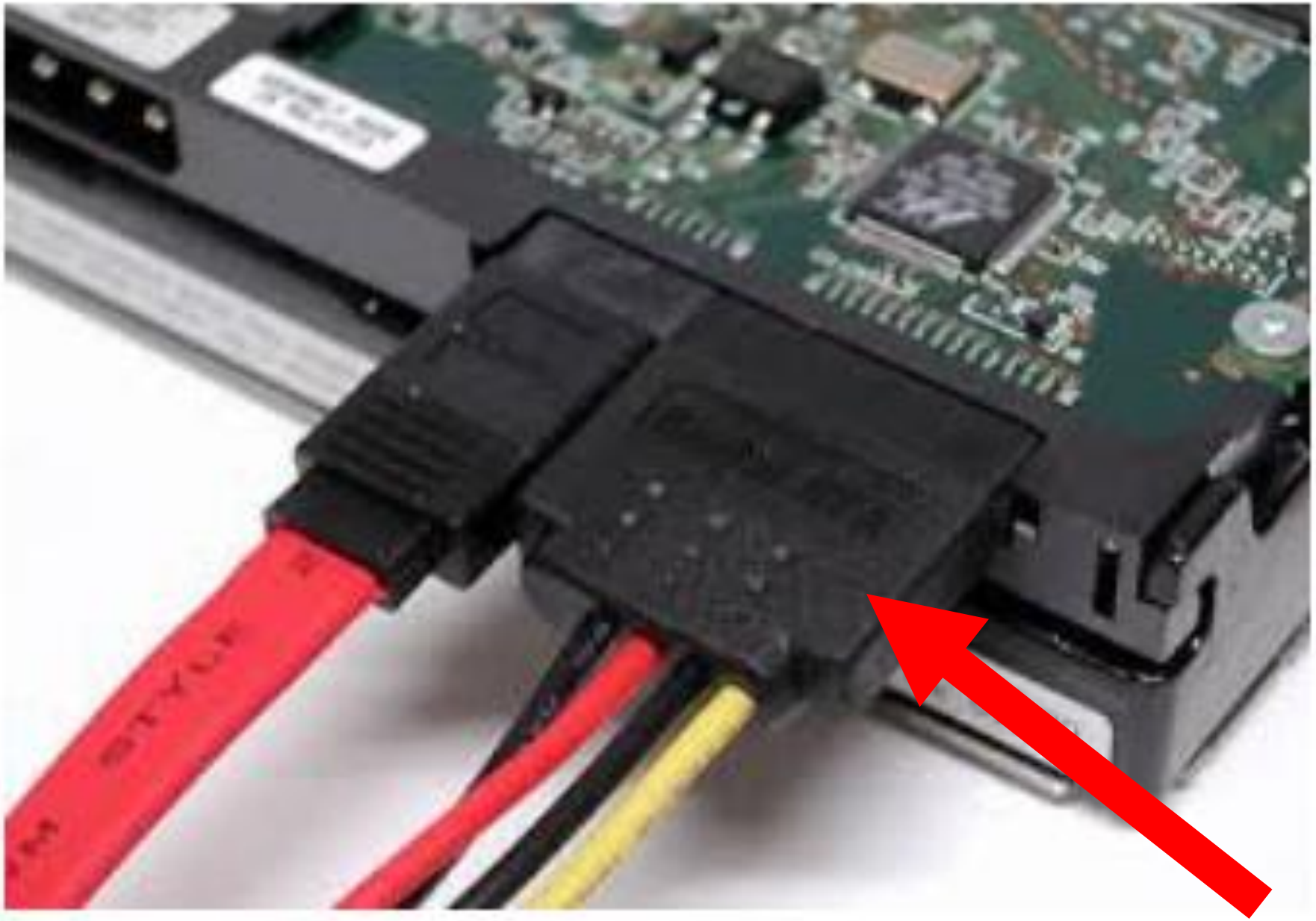
SATA AND eSATA AND BASICS (continued)

- SATA data connection from motherboard to an internal SATA hard drive:



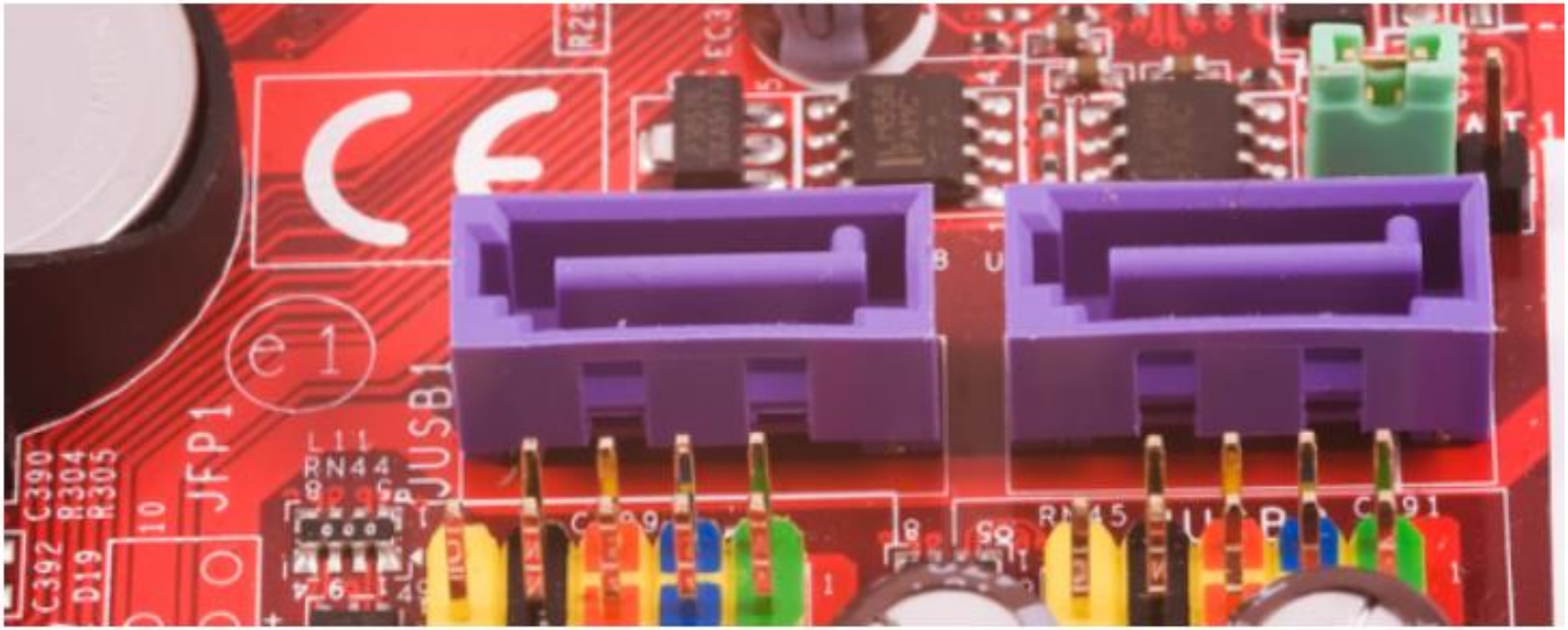
SATA AND eSATA AND BASICS (continued)

- SATA power cable from power supply of a desktop computer to an internal SATA hard drive:



SATA AND eSATA AND BASICS (continued)

- eSATA connection :
  motherboard's SATA port
  connects to an
  SATA-to-eSATA adapter bracket
  which connects to an
  eSATA cable
  to which connects to an
  eSATA external hard drive
  enclosure:


JFP1
JUSB1
RN44
RN45
C390
R304
R305

"M.2 SATA III" SSD EXAMPLE

- http://www.dignited.com/26742/m2-ssd-sata-vs-pcie-ssd-nvme/
- Requires an M.2 socket that has printed circuit board traces that go to one but only one of the SATA lanes of the processor chip set
- Has both B and M keys:

Samsung SSD
850 EVO
M.2
Powered by
3D
V-NAND
TECHNOLOGY
SAMSUNG

"M.2 NVMe PCIe" TO MATCH SPEEDIER SSD'S

- SATA became a bottleneck for advancing SSD technology during the past 4 years
- "M.2" is a form factor
- "NVMe" is a communications format that can use up to 4+ PCIe lanes. (It will be able to use more PCIe lanes in the future.)

"M.2 NVMe PCIe" TO MATCH SPEEDIER SSD'S (continued)

- See https://www.laptopmag.com/articles/install-m2-ssd-lenovo-t440s

"M.2 NVMe PCIe" TO MATCH SPEEDIER SSD'S (continued)

- https://photographylife.com/nvme-vs-ssd-vs-hdd-performance

"M.2 NVMe" TO MATCH SPEEDIER SSD'S (continued)

- https://en.wikipedia.org/wiki/M.2

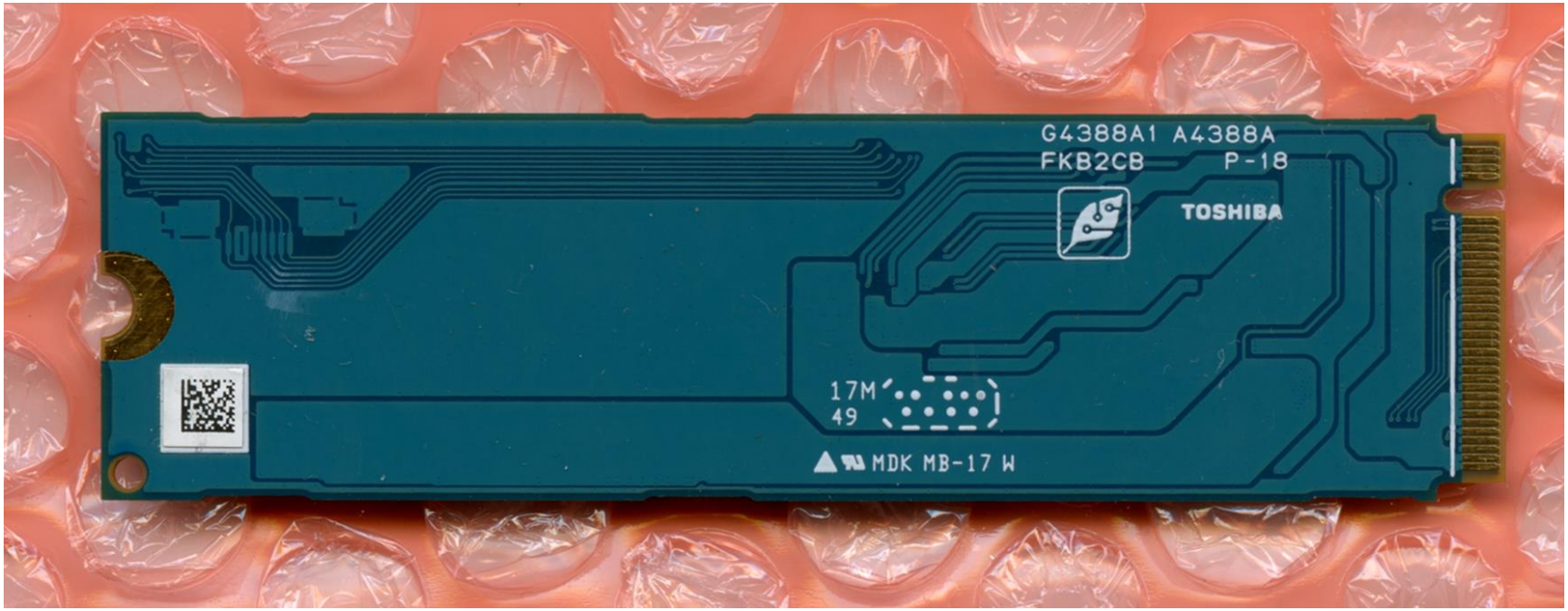
"M.2 NVMe" TO MATCH SPEEDIER SSD'S (continued)

- https://superuser.com/questions/1066540/connect-a-m-2-b-m-key-ssd-into-a-b-socket?utm_medium=organic&utm_source=google_rich_qa&utm_campaign=google_rich_qa

"M.2 NVMe PCIe" SSD EXAMPLE

- Has only an M key:
- Requires an M.2 socket that has printed circuit board traces that go back to 4 separate PCIe lanes of the processor chip set

TOSHIBA MEMORY CORPORATION Model KXG50ZNV1T02 XG5 NVMe™ CAN ICES-3(B) / NMB-3(B)
HP P/N: 934102-001
DC+3.3V 1.8A
E319571
D3B817
RoHS
HW: 01
FW AAHA4102
CT: UGPUK01P5A40EH
14NOV2017
1746KBZ
TÜVRheinland
CERTIFIED
MSIP-REM-TSD-KXG5AZNV1T02
EUI64 00080D0200366068
S/N Y7ES10EHTP8T
PSID: Q29LNGOF MEWEP23R QKXMGN35 9F39V5A0
MADE IN PHILIPPINES


G4388A1 A4388A
FKB2CB P-18
TOSHIBA
17M
49
MDK MB-17 W

"M.2 NVMe PCIe" SSD INSTALLATION

- Insert at 25 degree angle relative to motherboard or add-on board
- Push down so that it is parallel to the plane of the motherboard or add-on board
- Install a hold-down screw that is provided by the motherboard or add-on board manufacturer

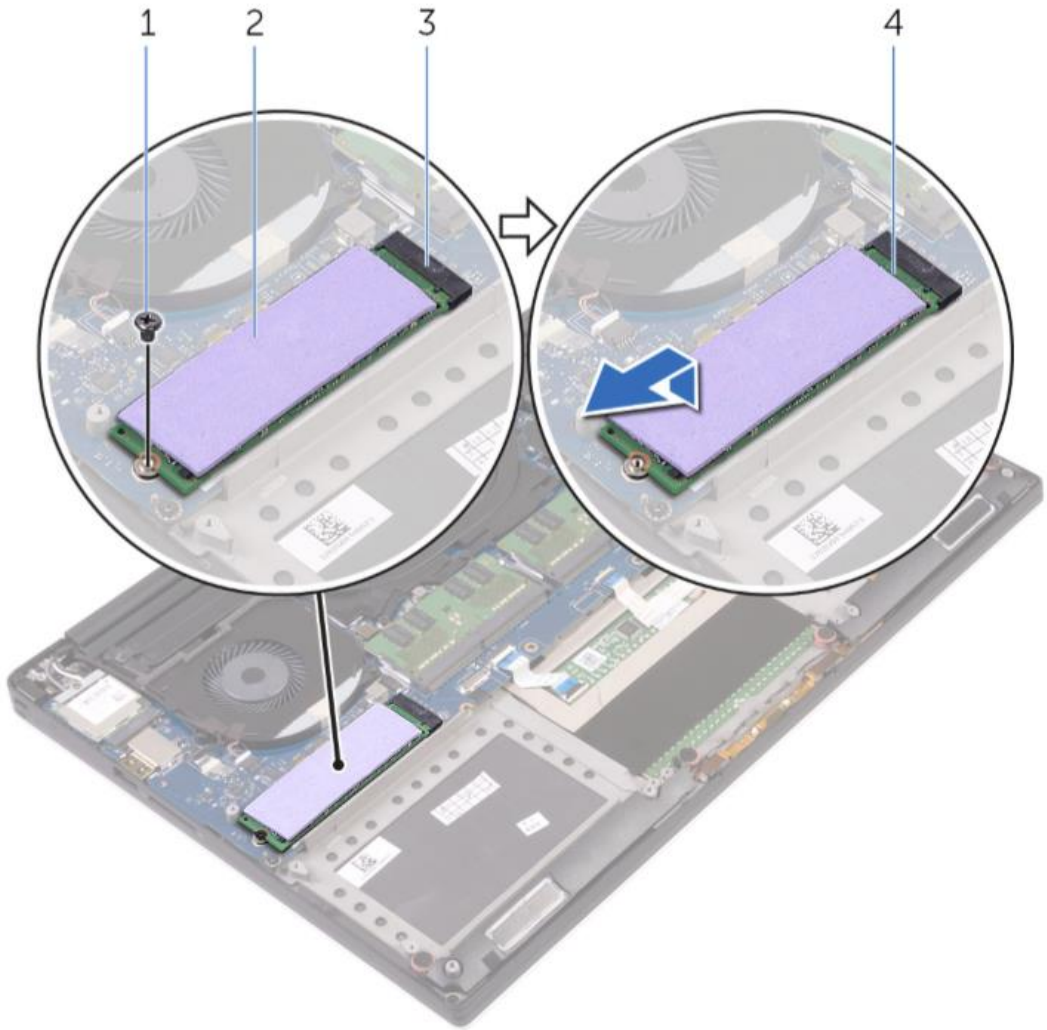
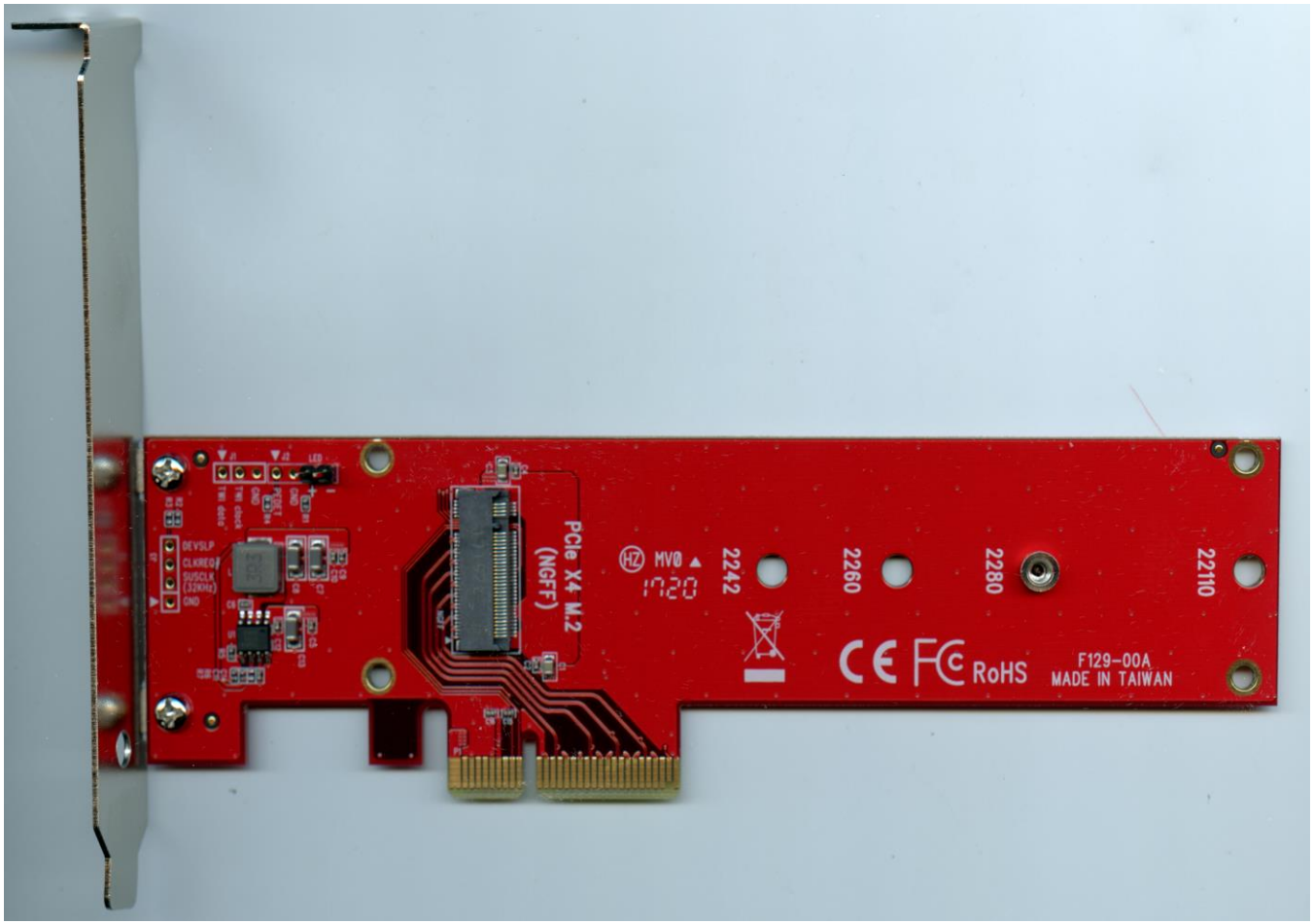


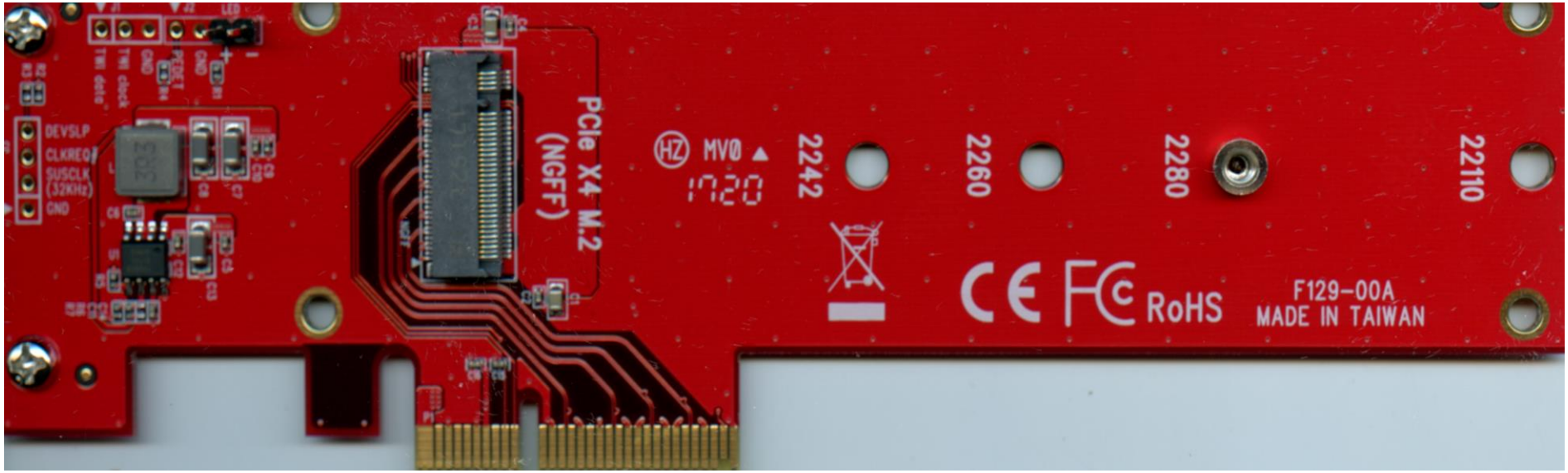
Figure 11. Removing the solid-state drive

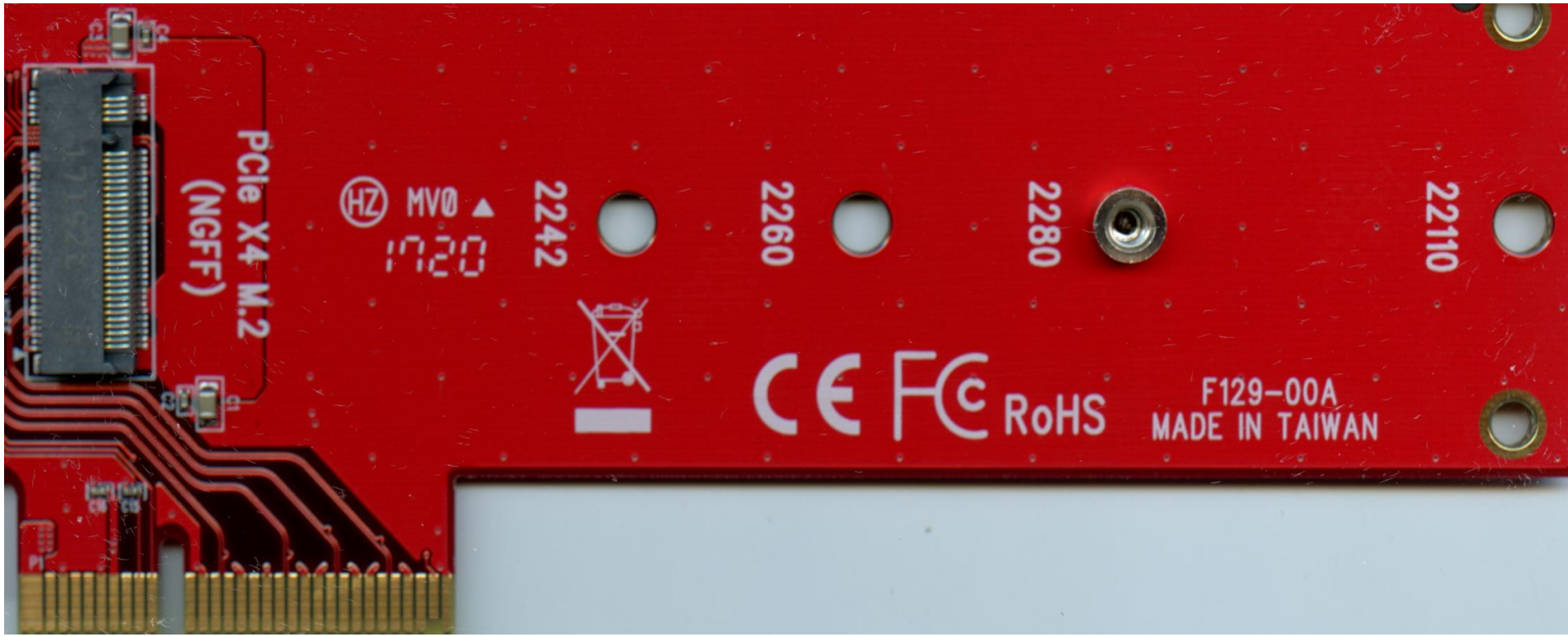
1	screw	2	thermal pad
3	solid-state drive slot	4	solid-state drive

"M.2 NVMe PCIe" SSD INSTALLATION

- PCIe-to-M.2 adapters let you install an "M.2 NVMe PCIe" into any desktop computer with a spare x4 or x16 PCIe slot.
  They do not work with x1 PCIe slots on the cheaper computer motherboards.


PCIe X4 M.2
(NGFF)
MV0
1020
2242
2260
2280
22110
RoHS
F129-00A
MADE IN TAIWAN


DEVSLP
CLKREQ
SUSCLK (32KHz)
GND
PCIe X4 M.2 (NGFF)
MV0
2242
2260
2280
22110
RoHS
F129-00A
MADE IN TAIWAN


PCIe X4 M.2
(NGFF)
MV0
2242
2260
2280
2110
RoHS
F129-00A
MADE IN TAIWAN

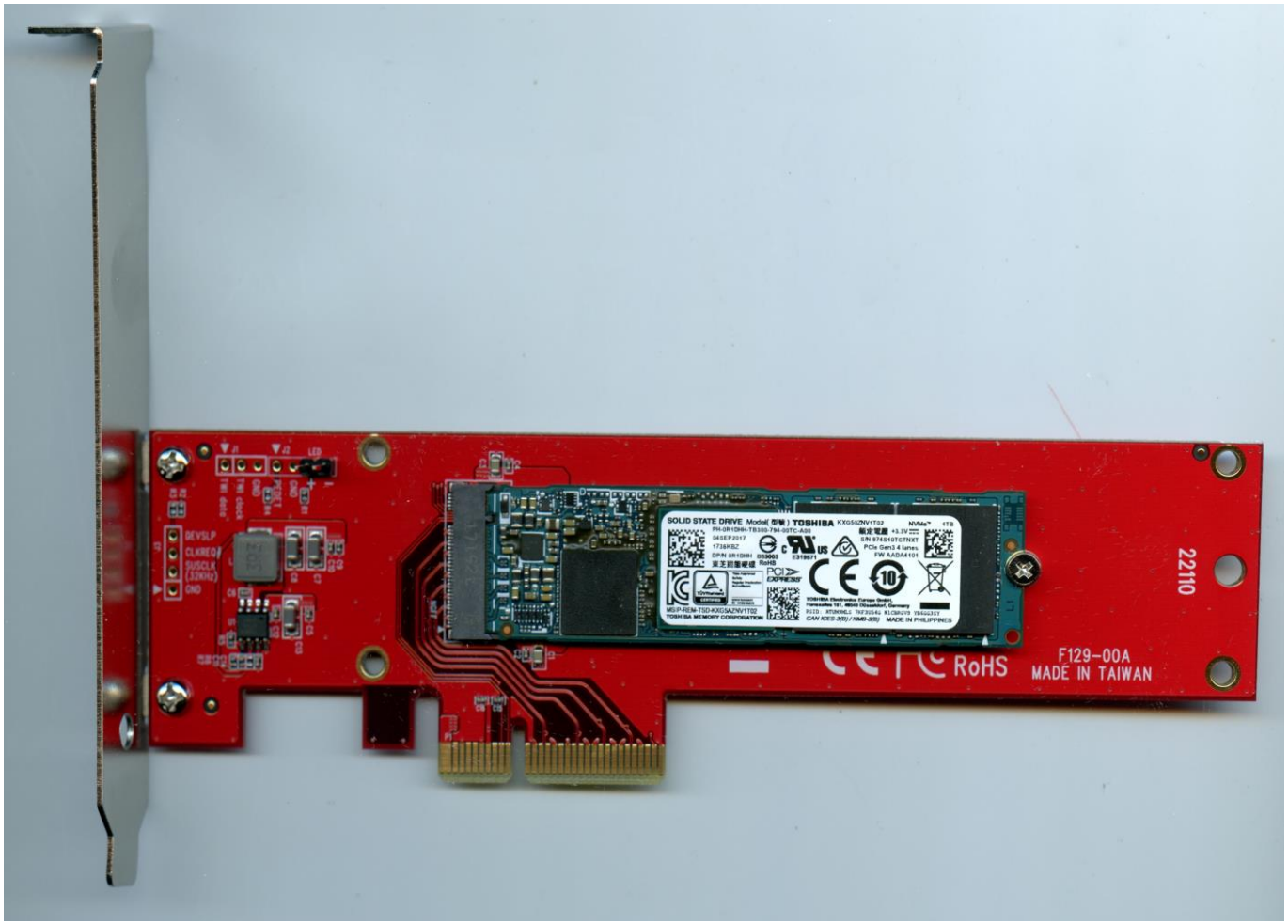
"M.2 NVMe PCIe" SSD INSTALLATION

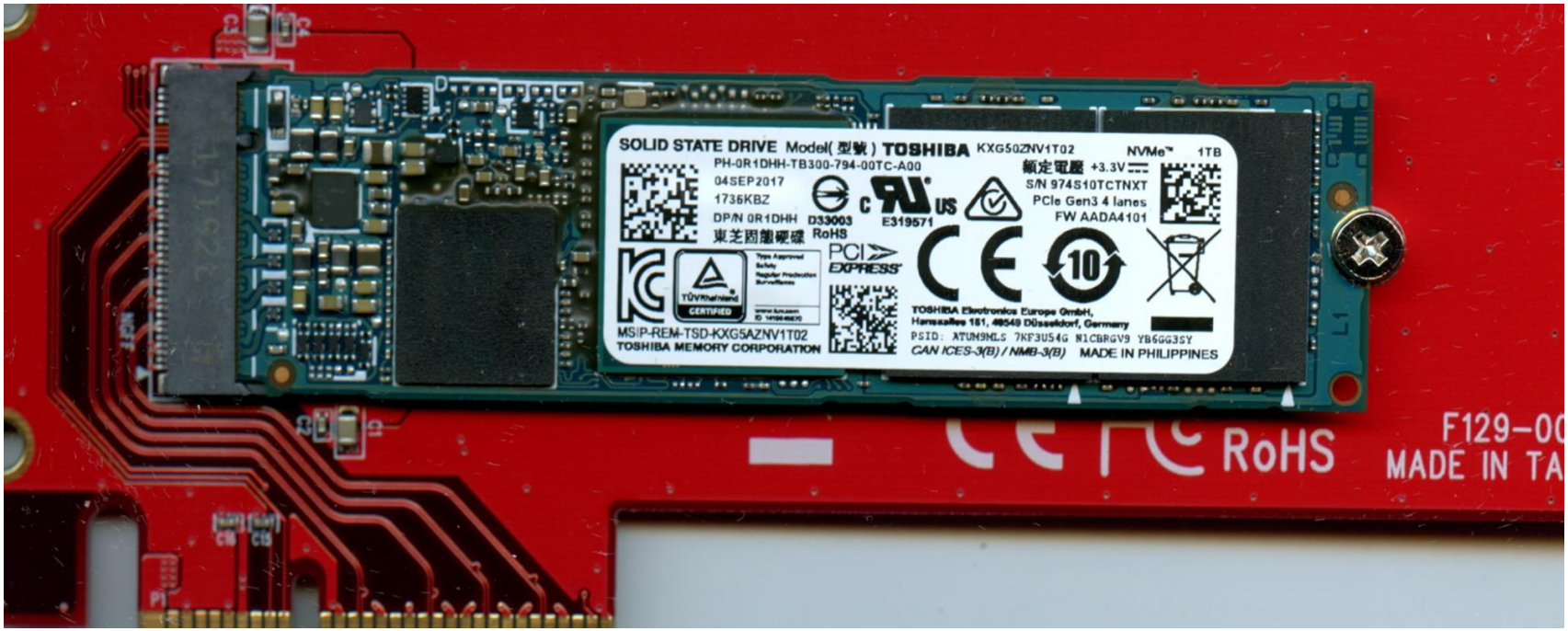
- Note that I am placing the board on an anti-static bag
- The M.2 form factor board is inserted into the M.2 connector with the M.2 form factor board at a 25 degree angle relative to the printed circuit board.

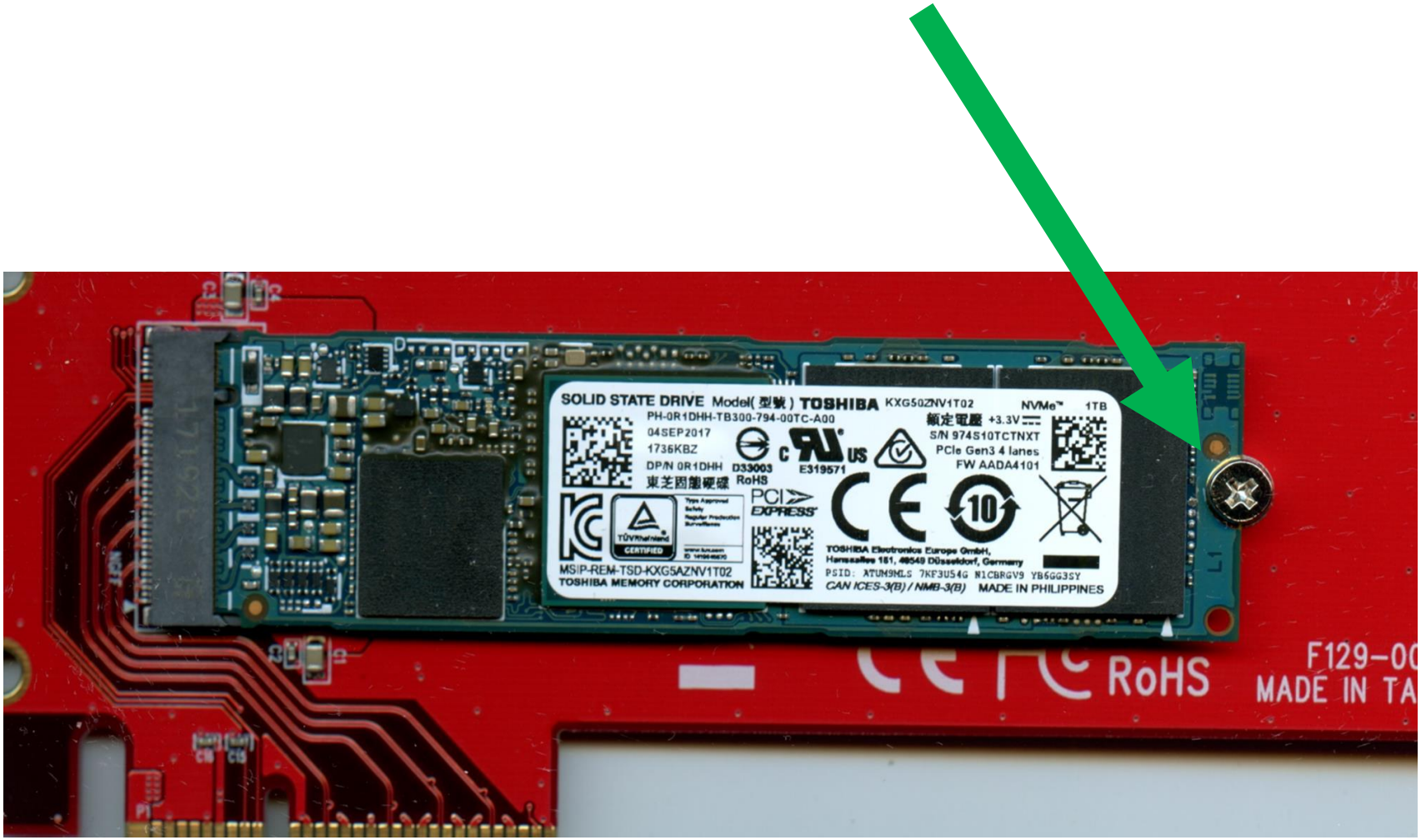
SOLID STATE DRIVE
TOSHIBA
2242
2260
2280
RoHS

"M.2 NVMe PCIe" SSD INSTALLATION

- The machine screw to hold down the M.2 SSD is absolutely necessary.
  Without it, the M.2 SSD will eventually wiggle free and fall off:


SOLID STATE DRIVE
TOSHIBA
22110
F129-00A
MADE IN TAIWAN
RoHS


SOLID STATE DRIVE Model(型號) TOSHIBA KXG50ZNV1T02 NVMe™ 1TB
PH-0R1DHH-TB300-794-00TC-A00
04SEP2017
1736KBZ
DP/N 0R1DHH D33003
東芝固態硬碟 RoHS
E319571
額定電壓 +3.3V
S/N 974S10TCTNXT
PCIe Gen3 4 lanes
FW AADA4101
MSIP-REM-TSD-KXG5AZNV1T02
TOSHIBA MEMORY CORPORATION
TOSHIBA Electronics Europe GmbH,
Hansaallee 181, 40549 Düsseldorf, Germany
PSID: ATUM9MLS 7KF3U54G N1CBRGV9 YB6GG3SY
CAN ICES-3(B) / NMB-3(B) MADE IN PHILIPPINES
RoHS
F129-0
MADE IN TA


SOLID STATE DRIVE Model(型號) TOSHIBA KXG50ZNV1T02 NVMe™ 1TB
PH-0R1DHH-TB300-794-00TC-A00
04SEP2017
1736KBZ
DP/N 0R1DHH D33003
東芝固態硬碟 RoHS
E319571
額定電壓 +3.3V
S/N 974S10TCTNXT
PCIe Gen3 4 lanes
FW AADA4101
MSIP-REM-TSD-KXG5AZNV1T02
TOSHIBA MEMORY CORPORATION
TOSHIBA Electronics Europe GmbH,
Hansaallee 181, 40549 Düsseldorf, Germany
PSID: ATUM9MLS 7KF3U54G N1CBRGV9 YB6GG3SY
CAN ICES-3(B) / NMB-3(B) MADE IN PHILIPPINES
RoHS
F129-0
MADE IN TA

U.2 FORM FACTOR HAS MORE CAPABILITIES

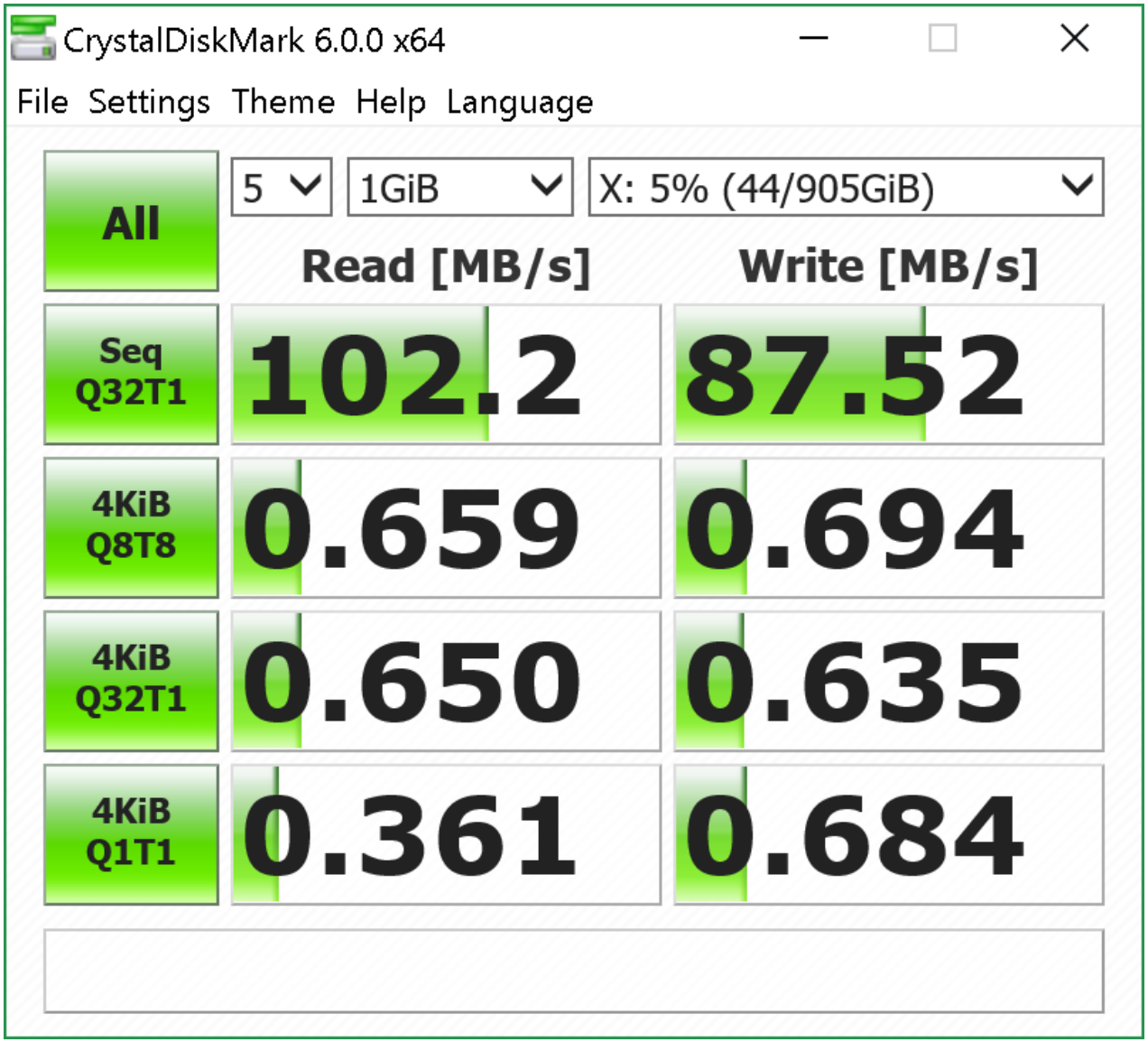
- https://www.gamersnexus.net/guides/2405-u2-vs-m2-vs-sata-express-best-for-ssds

SPEED COMPARISONS FROM 5400 HDs TO M.2 NVMe PCIe SSDs:

"5400 RPM SEAGATE 750GB HARD DRIVE:

- 102 MB per second sequential read

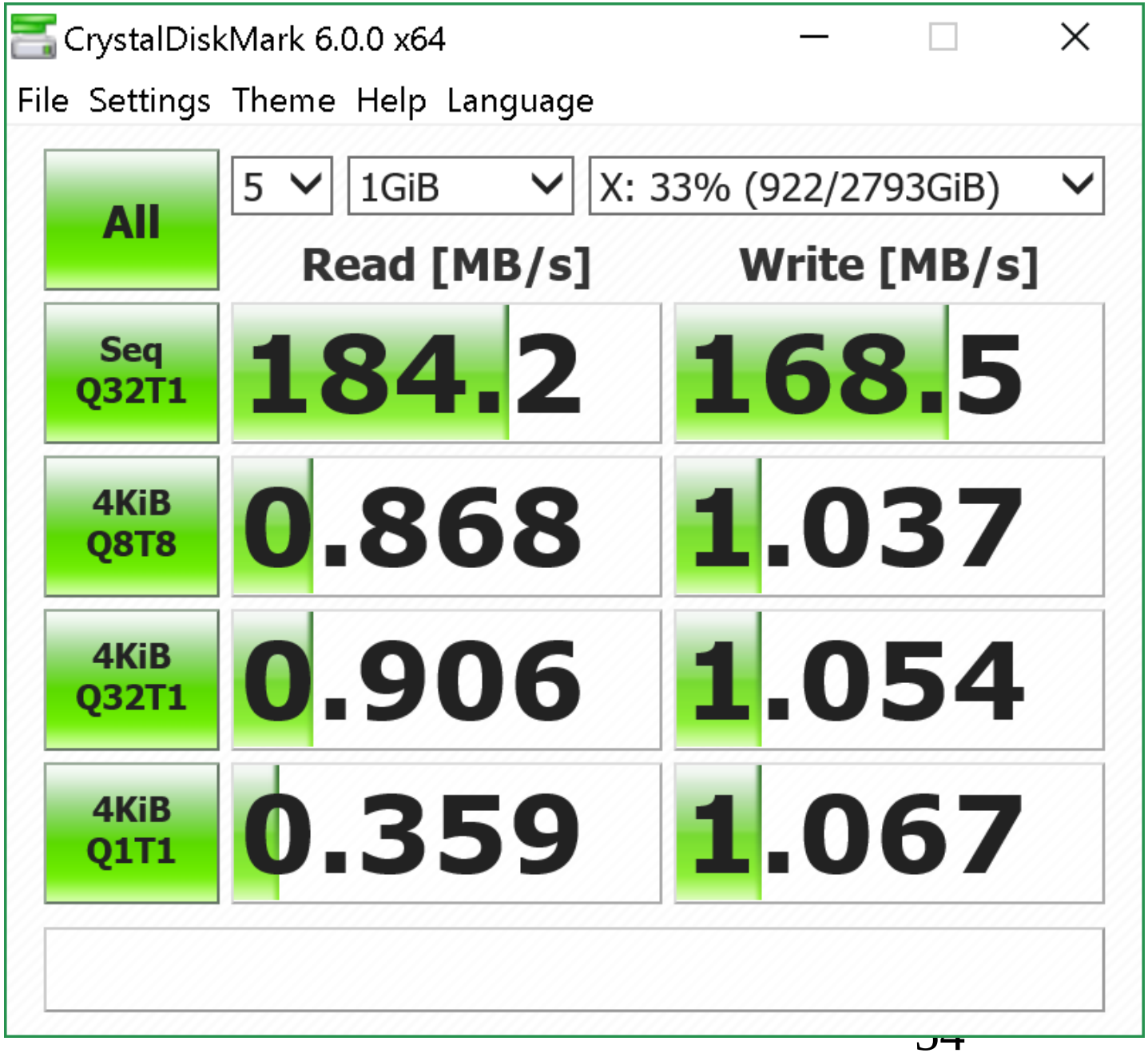
http://www.seagate.com
S/N:S31LJ9JFB05268
Model : ST1000LM024
HDD P/N : HN-M101MBB/M2
LBA 1,953,525,168 1000.0GB
RSNE
P/N : 665259-003
European Regulatory Address:
Seagate Technology Int'l
Koolhovenlaan 1,
1119 NB Schiphol-Rijk,
The Netherlands
REV. C
F/W : 2BA30001
WARRANTY VOID IF REMOVED
SAMSUNG
SPINPOINT
ADVANCED AF FORMAT
Momentus®
HARD DISK DRIVE RATED: DC+5V 0.85A
Seagate Technology LLC
WARNING : SENSITIVE PARTS INSIDE. FAILURE MAY OCCUR IF SUBJECTED TO EXCESSIVE SHOCK. TOUCHING THE CIRCUITRY MAY CAUSE DAMAGE. REMOVING THIS COVER WILL VOID ANY AND ALL WARRANTIES.
E190397
N176
D33027
DO NOT DROP!
DO NOT PRESS!
Product of CHINA
HDD Mfg by Seagate Technology LLC
DOM: 11/2014
Site: DGT
KCC-REM-STX-Momentus-C
DO NOT COVER THIS HOLE
2015-3-26 HP17J-173L
CT : 2DQQR011Y7QG51
P/N : E7083-G94A-DKY7P


CrystalDiskMark 6.0.0 x64
File Settings Theme Help Language
All
5
1GiB
X: 5% (44/905GiB)
Read [MB/s]
Write [MB/s]
Seq Q32T1
102.2
87.52
4KiB Q8T8
0.659
0.694
4KiB Q32T1
0.650
0.635
4KiB Q1T1
0.361
0.684

"7200 RPM SEAGATE 1TB HARD DRIVE:

- A bit faster:
  184 MB per second sequential read

Seagate
Barracuda™
57174
3000GB
RoHS
SERIAL ATA
SN: Z1F11KMW
MODEL: ST3000DM001
PN: 9YN166-500
VDC AMPS
+5V 0.75 A
+12V 0.75 A
Product of Thailand
FW: CC4B
WWN: 5000C5004E2489A4
Caution. Product warranty is void if any seal or label is removed, or if the drive experiences shock in excess of 350 Gs.
Date: 13076 Site: TK
IMPORTANT!
Visit www.seagate.com/beyond-2TB for complete installation instructions. This high capacity drive may require a special device driver. Always backup critical data before making changes.
Made in TH
DP/N 03GPRT
SATA
Capacity: 3000GB
7200 RPM
Firmware: CC4B
TH-03GPRT-21233-28G-01N3-A00
Canada Class B digital apparatus ICES-003/
Classe B appareil numérique NMB-003
KCC-REM-STX-Barracuda
E106814
N176
D33027
HDD Mfg by Seagate Technology LLC
DOM: 08/2012
www.seagate.com


CrystalDiskMark 6.0.0 x64
File Settings Theme Help Language
All
5
1GiB
X: 33% (922/2793GiB)
Read [MB/s]
Write [MB/s]
Seq Q32T1
184.2
168.5
4KiB Q8T8
0.868
1.037
4KiB Q32T1
0.906
1.054
4KiB Q1T1
0.359
1.067

"M.2 SATA III" SSD EXAMPLE

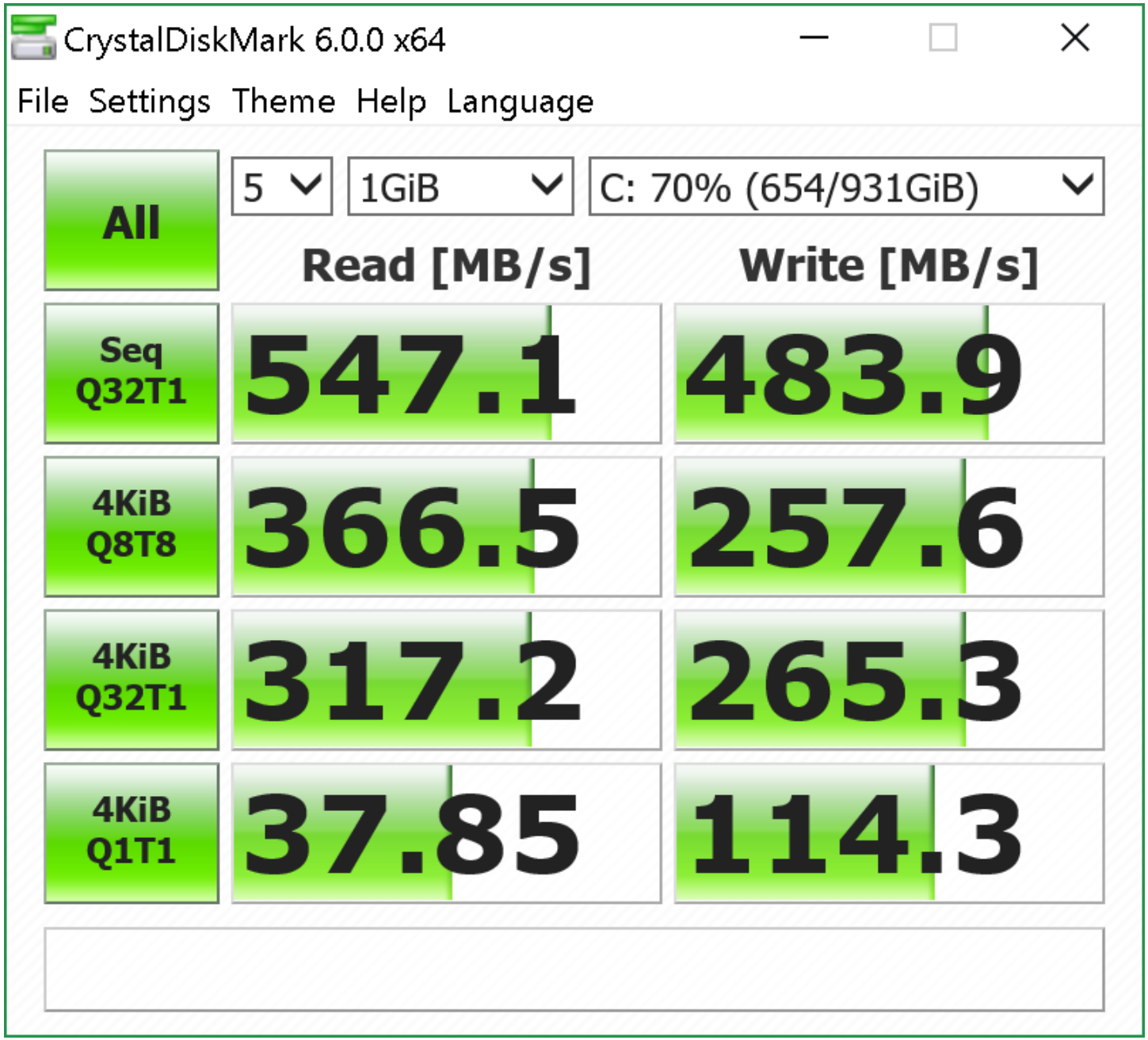
- http://www.dignited.com/26742/m2-ssd-sata-vs-pcie-ssd-nvme/
- Has both B and M keys:

"WESTERN DIGITAL" 1TB SATA SSD:

- A bit faster still:
  547 MB per second sequential read

WD
WD BLUE™
9-6-2017 =2
1TB SATA
PC SSD
Solid State Drive

WD Blue PC SSD
1TB
SATA 2.5"
WDS100T1B0A
MDL: WDS100T1B0A-00H9H0
S/N: 170507801471
WWN: 5001B448B41DD11A
DOM: 31 JAN 2017
5VDC 1.6A
E319334
MSIP-REM-TAD-SD8SB8U
D33724
R/N: BL1T00A
Made in Malaysia
台北市敦化北路205號14樓1402室
WARRANTY VOID IF REMOVED
WD NL B.V. Taurusavenue 5, 2132 LS Hoofddorp NL
CAN ICES-3(B)/NMB-3(B)
WARNING: Product can be damaged by Electrostatic Discharge (ESD)
SERIAL ATA
6Gb/s


CrystalDiskMark 6.0.0 x64
File Settings Theme Help Language
All
5
1GiB
C: 70% (654/931GiB)
Read [MB/s]
Write [MB/s]
Seq Q32T1
547.1
483.9
4KiB Q8T8
366.5
257.6
4KiB Q32T1
317.2
265.3
4KiB Q1T1
37.85
114.3

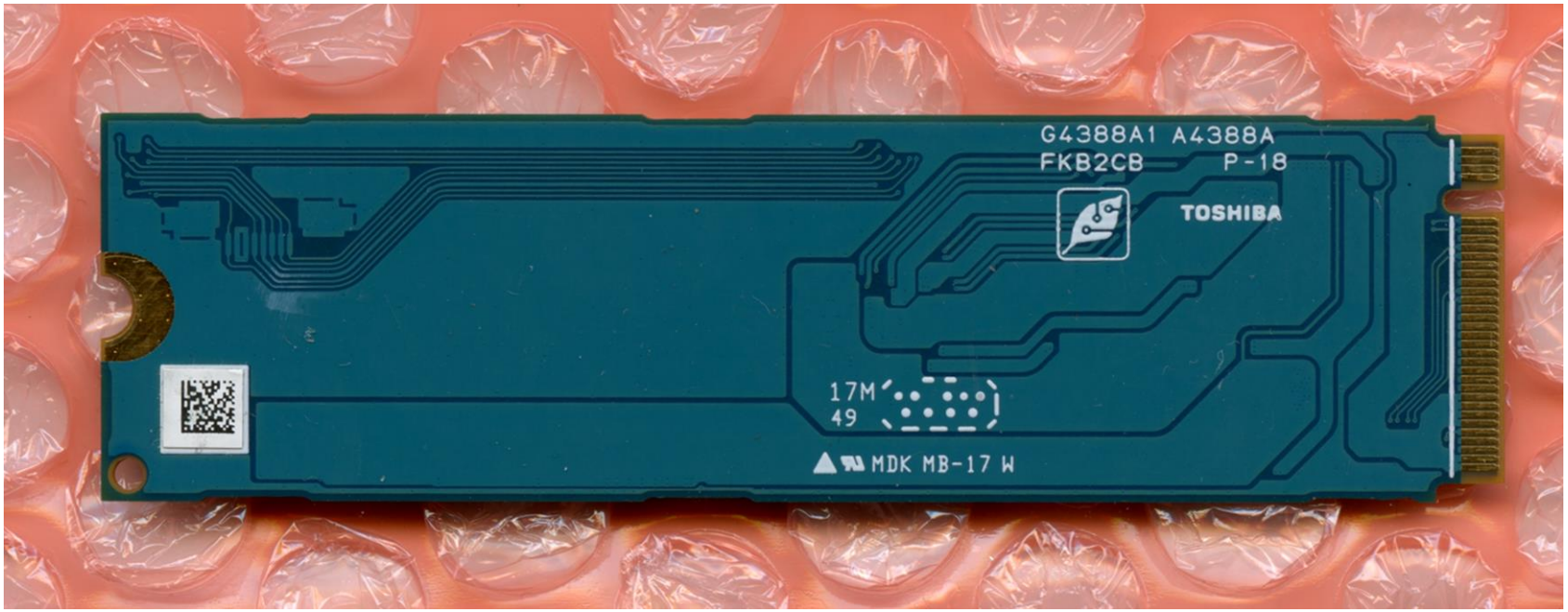
1TB "M.2 SATA PCIe" SSD:

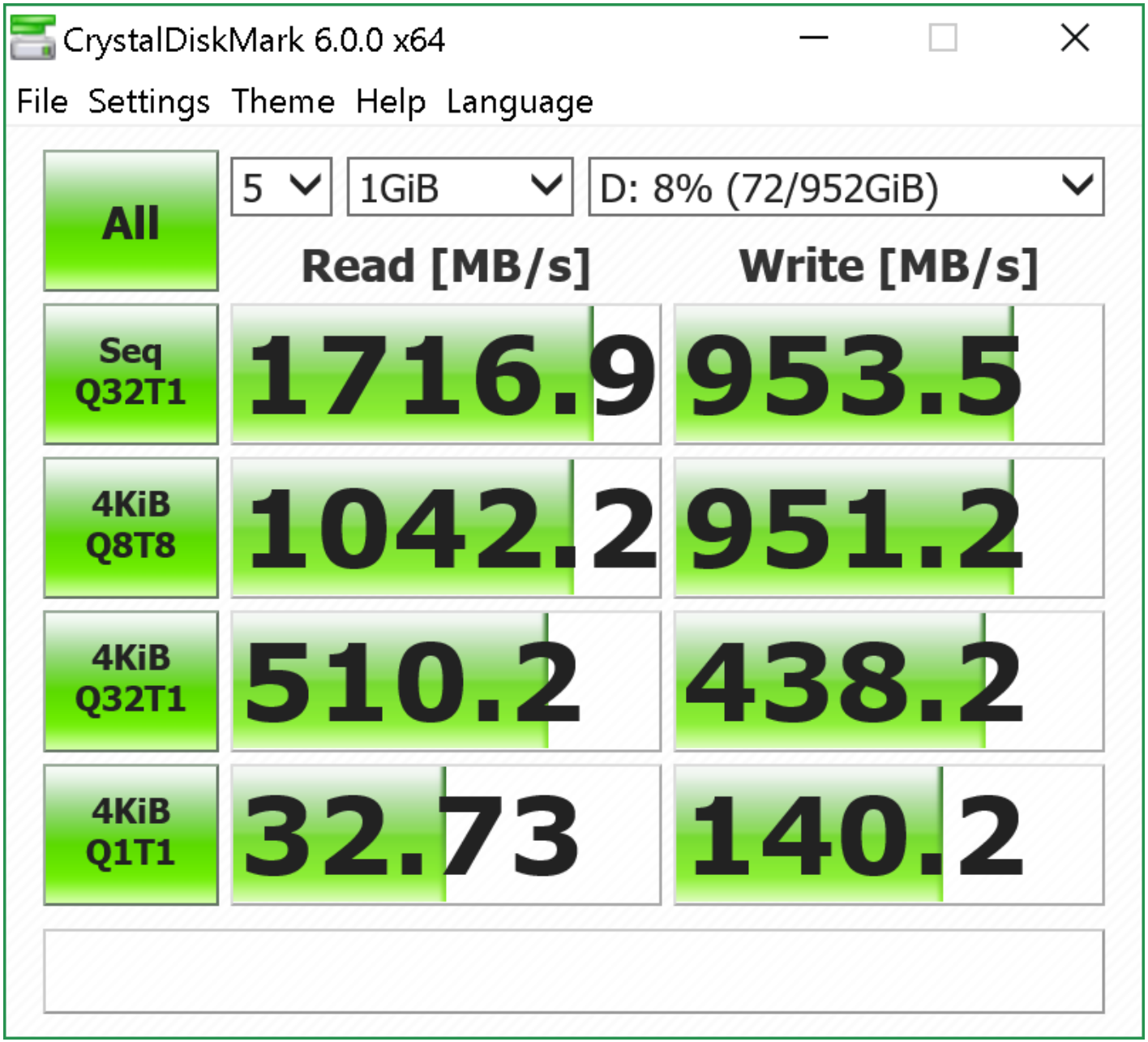
- Not available to us for testing but it would be the same speed as a 2.5-inch SATA SSD

"TOSHIBA" 1TB "M.2 NVME PCIe" SSD:

- A lot faster:
  1716 MB per second sequential read

TOSHIBA MEMORY CORPORATION Model KXG50ZNV1T02 XG5 NVMe™ CAN ICES-3(B) / NMB-3(B)
HP P/N: 934102-001
DC+3.3V 1.8A
E319571
D3B817
RoHS
HW: 01
FW AAHA4102
CT: UGPUK01P5A40EH
14NOV2017
1746KBZ
MSIP-REM-TSD-KXG5AZNV1T02
EUI64 00080D0200366068
S/N Y7ES10EHTP8T
PSID: Q29LNGOF MFWEP23R QKXMGN35 9F39V5A0
MADE IN PHILIPPINES


G4388A1 A4388A
FKB2CB P-18
TOSHIBA
17M
49
MDK MB-17 W


CrystalDiskMark 6.0.0 x64
File Settings Theme Help Language
All
5
1GiB
D: 8% (72/952GiB)
Read [MB/s]
Write [MB/s]
Seq Q32T1
1716.9
953.5
4KiB Q8T8
1042.2
951.2
4KiB Q32T1
510.2
438.2
4KiB Q1T1
32.73
140.2

THUNDERBOLT PORTS WILL REPLACE SOME USB 3 PORTS BUT..

- https://www.bhphotovideo.com/c/product/1381233-REG/dynapower_usa_netstor_na611tb3_thunderbolt_3.html

Dynapower USA Netstor NA611TB3 Thunderbolt 3 NVMe SSD Storage Enclosure

B&H # DYNA611TB3 • MFR # NA611TB3

Special Order

Expected availability: 2-4 weeks

Free Standard Shipping on Orders Over $49

Product Highlights

- Thunderbolt 3 Host Interface
- 2 x M.2 Slots
- 40 Gb/s Data Transfer Rate
- RAID 0 or 1 Available via OS

Show more

★★★★★ Review 1 | 3 Questions, 3 Answers

$0.00 Tax Collected Outside NY and NJ

You Pay: $359.00

1 QTY

Add to Cart

Add to Wish List

netstor
SSD2
SSD1

Free Standard Shipping on Orders Over $49

Product Highlights

- Thunderbolt 3 Host Interface
- 2 x M.2 Slots
- 40 Gb/s Data Transfer Rate
- RAID 0 or 1 Available via OS

You Pay: **$359.00**

1 QTY

Add to Cart

THUNDERBOLT PORTS WILL REPLACE SOME USB 3 PORTS BUT..

- https://rog.asus.com/articles/hands-on/easy-guide-to-ssds-sata-msata-m-2-and-u-2/

crucial
intel
intel

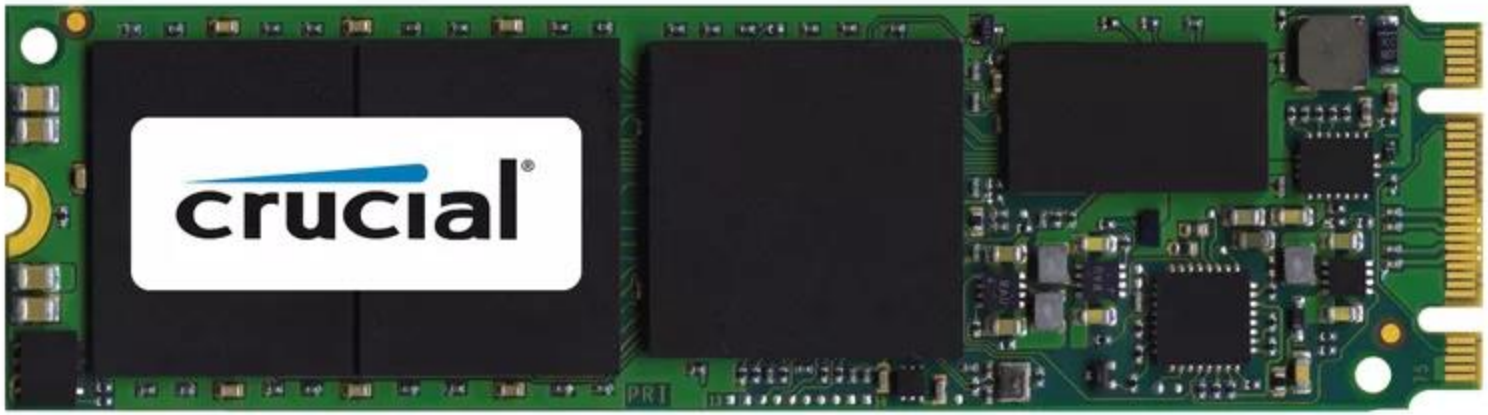
crucial
2.5-inch SOLID STATE DRIVE

PLEXTOR
S/N: P02344106230
Model: PX-128M6M
Power: DC ⎓ 3.3V 0.95A
Warranty Void If Label Removed
KCC-REM-LIT-LMT-256M6M
US E205203
P/N: 3C03110034
F/W: 1.04
10/28/2013
WWN: 50023031000AF323
N1580
MADE IN TAIWAN
MR-ML-04
R37
MSATA
M6M-TT REV:01
J1
P1
C91
F1
P51

SM951
2015.06

M.2 VARIATIONS CONSTRICT WHICH MODELS WILL WORK FOR WHICH MODELS OF COMPUTERS

- https://www.lifewire.com/what-is-m2-833453
- Start off with the computer's motherboard specifications for it's M.2 port
- Double-sided versus single-sided


crucial

"A" KEY SLOT USUALLY MEANS "Wi-Fi ADAPTER"

- https://arstechnica.com/gadgets/2015/02/understanding-m-2-the-interface-that-will-speed-up-your-next-ssd/

4-DIGIT SIZE CODE

- http://www.dignited.com/26742/m2-ssd-sata-vs-pcie-ssd-nvme/
- Check the 4-digit size code to make sure that that M.2 module will fit on the motherboard or add-on card

4-DIGIT SIZE CODE (continued)

- <Start of quote:>
  It's important to note that the M.2 slots on the motherboard are all 22mm in width. In that regard, even the cards which exceed this width are designed to fit within the 22mm limit. M.2 card sizes vary in length from as short as 30mm to as long as 110mm.

4-DIGIT SIZE CODE (continued)

- <Continuation of quote:>
  When buying an M.2 card, be it an SSD, WiFi module, name it, you will encounter a bunch of digits i.e. M.2 2230, 2260, 2280, 22110 e.t.c. The first digits indicate a width of 22mm to a length of 80mm.
  <End of quote>

MOST ADD-ON "M.2 TO PCIe" ADAPTERS ARE NOT BOOTABLE

- Assume that an add-on "M.2 to PCIe" adapter is not bootable unless you find specifications that state that they are bootable
- Some "ASUS" "M.2 to PCIe" adapters are bootable when inserted into a compatible "ASUS" motherboard

"M.2 SLOTS" TAKE UP A LOT OF "LANES" INTO THE PROCESSOR

- If your laptop comes with a "M.2 NVMe PCIe" slot on its motherboard, your laptop usually will not also have spare SATA ports or spare PCIe ports on its motherboard.