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Epson microSD TSE Technical Specification

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Epson microSD TSE (BSI-TR-03153, UHS-I, MLC)

1. Product Summary

- Fully compliant with SD Memory Card Specification 2.0 and 3.0 and microSD Memory Card Addendum 4.00
  - SDHC default/high speed mode and UHS supported
  - Speed class 10 and U1 according SD3.0 specification (please refer to section 4.1)
  - SD2.0 backward compliant
  - FAT32 preformatted
- High performance 3.0 specification
  - UHS-I speed 0…100MHz (SDR50), 0…50MHz (DDR50)
  - SD High speed 0…50MHz
  - SD Default speed 0…25MHz
  - Up to 33Byte/s sequential data rate (please refer to section 4.1)
  - firmware optimized for random write performance
  - up to 640 write IOPs (4kB) (please refer to section 4.1)
- Power Supply: (Low-power CMOS technology)
  - 2.7…3.6V normal operating voltage
- Standard microSD Memory card form factor
  - 15.0mm x 11.0mm x 0.7mm (1.0mm)
- Extended Temperature Range: -25° up to 85°C [1]
- Additional security features (please refer to section 2.2)

2. Product Features

2.1 Flash Card Features

- Optimized FW algorithms especially for high read access and long data retention applications
  - Patented power-off reliability technology
  - Wear Leveling technology
  - Write Endurance technology
  - Read Disturb Management
  - Data Care Management
  - Near Miss ECC technology

- High reliability
  - Designed for industrial market - especially read intensive application like navigation, infotainment, POS/POI, medical and general boot medium use case
  - The product is optimized for a long life cycle that requires good data retention because of high temperature mission profile
  - Number of card insertions/removals up to 20,000
  - SIP (System In Package) process for extreme dust, water and ESD resistance
  - Selected AEC-Q100 qualification
- Manufactured in a TS 16949 certified factory

[1] Adequate airflow is required to ensure the drive temperature does not exceed the specified maximum operating temperature

2.2 Fiscal Solution Features

- BSI-TR-03153 compliance coming with EDS-SW ("Einheitliche Digitale Schnittstelle" or compatible)
- Inalterability of data inside TSE Tar Storage
- Data retention 10 years (please refer to section 4.4)
- In-field firmware update in compliance with TR-03153 requirements

2.3 Supported TSE Profiles

The Epson TSE conforms with the following parts of BSI TR-03153 test specification[2]:

Supported Profile ID	**Comment**
STORAGE_BASIC	Has local storage (6.5 GB)
SM_BASIC	Has a local Secure Element (384 bit ECDSA, signature time <250ms)
SM_NOAGG	Supports signed transaction updates (saves 1 signature per receipt)
SM_MULTI	Supports managing multiple transactions in parallel (up to 512)
CUSTOM_INTEGRATION_INTERFACE	Manufacturer specific interface (Android, Linux, Windows, Java, embedded)
SDI_DELETE	Supports method deleteStoredData
NO_TIME_SYNC	Time is set by host
MULTI_CLIENT	Supports multiple clients (up to 100)

[2] Cf. BSI: "Technische Richtlinie BSI TR-03153 - Technische Sicherheitseinrichtung für elektronische Aufzeichnungssysteme. Testspezifikation (TS)"

3. Ordering Information

Table 1: Available SKUs

Capacity	Validity	Epson SKU
8 GBytes	3 Years	7112110
8 GBytes	5 Years	7112345

Configuration

The production configuration is specified as follows:

Table 2: TSE configuration

Item	Value	Remark
CSP (Smart Card)	Yes	BSI-DSZ-CC-1118, TCOS CSP 2.0 Release1/P60D145/P6022y
Overall size of all TSE_TAR files	6.5 GB	Value in GB
Key length / algorithm for digital signature	brainpoolP384r1, ecdsa-plain-384	384 bit ECC Key of the curve brainpoolP384r1 with SHA384 as hash algorithm
TSE Description	BSI-K-TR-0373 BSI-K-TR-0414	128 Byte NULL terminated ASCII string containing the certificate ID issued by BSI to prove TR-03153 compliance.
Storage Type	microSD	Which form factor (USB / microSD / SD)
Memory Size	8GB	Memory size
Fiscal Data protection	Yes	All Fiscal Data are access protected according TR-03153
Subdirectory Support	Yes	Defines if the TSE Files shall be made available in sub directories (e.g. on Android hosts)
Certificate Validity (certificate for signing transactions)	Up to 5 years	At the time of production, the expiration date is set to additional 6 months. These additional 6 months are intended as a time buffer for logistics & stocking.

4. Product Description

The microSD Memory Card is a small form factor non-volatile memory card which provides high capacity data storage. Its aim is to capture, retain and transport data, audio and images, facilitating the transfer of all types of digital information between a large variety of digital systems. The card operates in two basic modes:

- SD/SDHC and UHS-I card modes
- SPI mode

The microSD Memory Card also supports SD Default and High Speed mode with up to 50MHz clock frequency as well as UHS-I modes DDR50, SDR12/25/50 with up to 100MHz clock frequency.

The cards are compliant with

- SD Memory card Specification Part 1, Physical layer Specification V3.01
- SD Memory card Specification Part 2, File System Specification V3.00
- SD Memory card Specification Part 3, Security Specification V3.00
- MICRO SD Memory Card Addendum V4.00

Simplified specifications are available at https://www.sdcard.org/

The Card has an internal intelligent controller, which manages interface protocols, data storage and retrieval as well as hardware BCH Error Correction Code (ECC), defect handling, diagnostics and clock control. The advanced wear leveling mechanism assures an equal usage of the Flash memory cells to extend the life time.

The hardware BCH-code ECC allows to detect and correct up to 40 defect bits per 1kByte.

The controller performs control read operations and checks the consistence of the data. If an error of some bits is detected, the card refreshes all data in the flash cells to prevent data retention problems.

The card has a power-loss management feature to prevent data corruption after power-down. The cards are RoHS compliant and lead-free.

4.1 Performance Specifications

The Read/Write performance cannot be fully tested due to policy restrictions that protect some areas of the freely addressable memory space.

4.2 Environmental Specifications

4.2.1 Recommended operating conditions

The recommended operating conditions for the TSE microSD Memory Card are provided in Table 3 below.

Table 3: microSD Memory Card recommended operating conditions

Parameter	Min	Typ	Max[3]	Unit
Extended Operating Temperature	-25	25	85	°C

4.2.2 Recommended storage conditions

The recommended storage conditions are listed below in Table 4.

Table 4: microSD Memory Card recommended storage conditions

Parameter	Min	Typ	Max[3]	Unit
Extended Storage Temperature	-25	25	100	°C

[3] High Temperature storage without operation reduces the data retention, in operation the data will be refreshed, if data error issues were detected

4.2.3 Humidity and EMC

The humidity and EMC conditions are listed below in Table 5.

Table 5: Humidity & EMC

Parameter	Condition
Humidity (non-condensing)	85% RH @85°C 1000h
ESD	up to ±4 kV (contact discharge), according to IEC61000-4-2 and SDA, Human Body Model 150pF/ 330Ohm, on each contact pad, non-operating up to ±15 kV, (air discharge), according to IEC61000-4-2 and SDA, Human Body Model 150pF/ 330Ohm, isolated contact pad area, non-operating

4.2.4 Environmental conditions

The Environmental conditions are listed below in Table 6.

Table 6: Environmental conditions

Parameter	Condition
UV light exposure	UV: 254nm, 15Ws/cm2 according to ISO7816-1
X-Ray	0.1 Gy 70keV to 140KeV (ISO7816-1) according SDA
Durability	20,000 mating cycles
Drop Test	1.5m free fall
Bending / Torque	10N / 0.15Nm ±2.5° max
Mechanical Shock	1500G, 0.5ms, half sine wave ±xyz-axis, 4 pulses each non-operating, JESD22B110 Condition B
Vibration	50G, p-p, 20..2000Hz, sweep xyz-axis, 4 pulses each, non-operating, MIL-STD-883 M2007.3 Condition B

4.3 Physical dimensions

The physical dimensions of the Epson microSD TSE are listed in the following table.

Table 7: Physical dimensions

Outer physical dimensions	Value	Unit
Length	15.0±0.1	mm
Width	11.0±0.1	mm
Thickness	0.7 (1.0)±0.1	mm
Weight (typ.)	0.4	g

4.4 Regulatory Compliance

The Epson USB TSE complies with the standards listed in the following table.

Table 8: Regulatory Compliance

Compliance	Country	Type	Standard(s)/Directive
CE	European Union	Compliance	Directive 2014/30/EU: • EN 55032 (2012) + AC (2013), Class A • EN 55024 (2010) + A1 (2015) Directive 2011/65/EU : • EN 50581 (2012)

4.5 Reliability

Table 9: Reliability

Parameter	Value[4]
MTBF (at 25°C)	> 6,000,000 hours
Supported number of cryptographic signatures (reliable key usages)	20 million
Data Retention at beginning (<300 PE cycles) @ 40°C	10 years
Data Retention at life end (2k-3k PE cycles) @ 40°C	1 year

Data Retention correlates negatively with the amount of data written to the device over its lifetime. The specified endurance of this device is max. 3'000 program/erase (PE) cycles on flash cell level (MLC). After consuming the max. available PE cycles, the data retention @40°C is 1 year (i.e. data is readable after 1 year of unpowered storage at max. 40°C).
In order to attain a data retention of 10 years @40°C (i.e. data is readable after 10 years of unpowered storage at max. 40°C), the amount of data written to the card must be max. 300 PE cycles (on flash cell level).

A product feature named global wear leveling makes sure that write/erase operations to both (1) the memory area reserved for fiscal transactions and (2) the freely available memory area will be distributed evenly over the full memory capacity.

4.6 Geometry Specification

Table 10: microSD Memory Card capacity specification

Capacity	Sector	Total Addressable Bytes
8GB	15,663,104	8,019,509,248

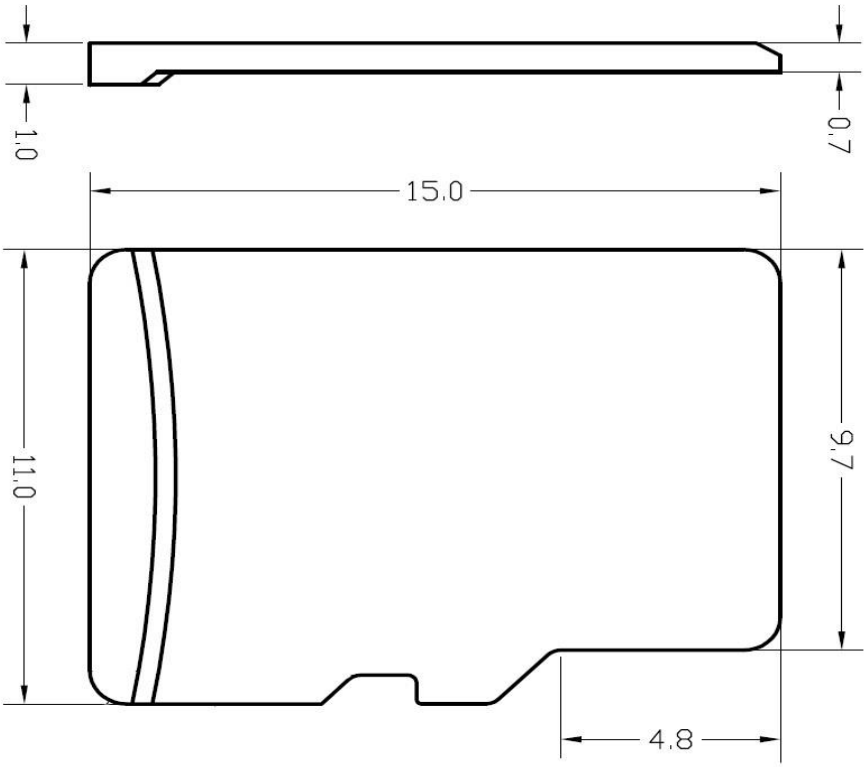
[4] After every power on the card reads the whole flash and performs a data refresh if necessary, to optimize data retention.

5. Card physical

5.1 Physical description

The Epson microSD TSE contains a single chip controller and Flash memory module(s). The controller interfaces with a host system allowing data to be written to and read from the Flash memory module(s).

Figure 1: Simplified mechanical dimensions of the Epson microSD TSE



The dimensions and tolerances are according to the microSD specification.

6. Electrical Interface

6.1 Electrical description

Figure 2: Epson microSD TSE shape and Interface (Bottom view)

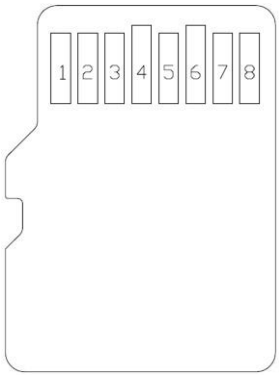


Table 11: Pad Assignment – SD Mode

Pin	SD Mode		
	Name	**Type[5]**	**Description**
1	DAT2[6]	I/O/PP	Data Line [Bit 2]
2	CD/DAT3[7]	I/O/PP[8]	Card Detect/ Data Line [Bit 3]
3	CMD	PP	Command/Response
4	VDD	S	Supply voltage
5	CLK	I	Clock
6	VSS	S	Supply voltage ground
7	DAT0	I/O/PP	Data Line [Bit 0]
8	DAT1[9]	I/O/PP	Data Line [Bit 1]

Table 12: Pad Assignment – SPI Mode

Pin	SPI Mode		
	Name	**Type[5]**	**Description**
1	RSV		
2	CS	I8	Chip Select (neg true)
3	DI	I	Data In
4	VDD	S	Supply voltage
5	SCLK	I	Clock
6	VSS	S	Supply voltage ground
7	DO	O/PP	Data Out
8	RSV		

[5] S: power supply; I: input; O: output using push-pull drivers; PP: I/O using push-pull drivers

[6] DAT2 line may be used as Read Wait signal in SDIO mode (refer to "SDIO Card Specification" for further details).

[7] The extended DAT lines (DAT1-DAT3) are input on power up. They start to operate as DAT lines after SET_BUS_WIDTH command. The Host shall keep its own DAT1-DAT3 lines in input mode, as well, while they are not used.

[8] At power up this line has a 50kOhm pull up enabled in the card. This resistor serves two functions Card detection and Mode Selection. For Mode Selection, the host can drive the line high or let it be pulled high to select SD mode.
If the host wants to select SPI mode it should drive the line low. For Card detection, the host detects that the line is pulled high. This pull-up should be disconnected by the user, during regular data transfer, with SET_CLR_CARD_DETECT (ACMD42) command.

[9] DAT1 line may be used as Interrupt Output (from the Card) in SDIO mode during all the times that it is not in use for data transfer operations (refer to "SDIO Card Specification" for further details).

6.2 Power up / Power down behavior and reset

6.2.1 Power up

When the voltage is ramped up the controller is ready (internal reset pin released) if the voltage reaches 1.65V. The host can start with communication 1ms after 2.7V is reached according the SDA specification. That should perform 74 clock cycles and start with the sequence CMD0, CMD8, ACMD41 until card is ready as described in the SD specification 3.01.

6.2.2 Power down

When the power falls below 2.6V the controller stops the communication to the flash but enables the flash to finish a started flash program operation.

After next initialization the controller checks the last written data for consistency and refreshes the data. Either the new or the old data (if the write operation could not be finished) are available.

6.2.3 Power drop

If the voltage drops below 2.6V and rises again, the card performs a reset. The card must be initialized like after a power on.

6.2.4 Operation below minimum voltage

If the card initialization is performed below the specified voltage of 2.7V, the card may be detected as 1MB card with no useful data. In this case the host should power off and on the card, and start initialization above 2.7V.

6.3 DC characteristics

Table 13: DC characteristics

Symbol	Parameter	Min	Typ	Max	Unit	Notes
I_{DD}	Operating Current Read		50	90[5]	mA	@ 25°C
I_{DD}	Operating Current Write		60	90[5]	mA	@ 25°C
I_{DD}	Background read and refresh[6]		55	120[5]	mA	@ 25°C
I_{DD}	Pre-initialization Standby Current		5	15	mA	@ 25°C
I_{DD}	Post-initialization Standby Current[7]		32	45	mA	@ 25°C
I_{DD}	Post-initialization Standby Current[7]		37	45	mA	@ 85°C
I_{LI}	Input Leakage Current	-2		2	µA	without pull up R
I_{LO}	Output Leakage Current	-2		2	µA	without pull up R

Table 14: microSD Memory Card recommended operation conditions

Symbol	Parameter		Min	Typ	Max	Unit
V_{DD}	Supply voltage	Normal operating status	2.7	3.3	3.6	V
-	Power Up Time (from 0V to V_{DD} min)				250	ms

[5] This value includes 10.5 mA (max) for the smart card.

[6] The card can perform auto data read of the whole card to check for ECC errors and performs data refresh

[7] Standby current will be significantly lower (typ. <5mA) if the TSE in not processing commands and the time is not synchronized (i.e. before execution of updateTime and after MAX_TIME_SYNCHRONIZATION)

6.4 Signal loading

According to SD specification

6.5 AC characteristics

6.5.1 Default speed mode (0-25MHz)

According to SD specification

6.5.2 High speed mode (0-50MHz)

According to SD specification

6.5.3 UHS modes

UHS modes were driven with a signal level of 1.8V.
The cards support following UHS-I modes:

Table 15: Supported UHS-I modes

Mode	Max. Burst MB/s	Max. Clock frequency MHz
SDR12	12.5	25
SDR25	25	50
SDR50	50	100
DDR50	50	50 (rising and falling edge)

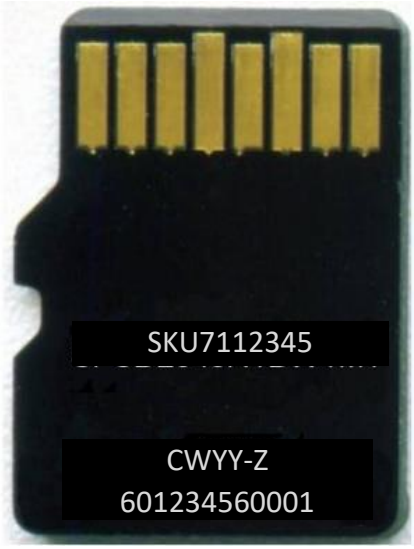
7. Marking specification

7.1 Front side marking

Epson logo
TSE TR-03153

Density, micro SDHC Memory Card logo

7.2 Back side marking



Epson SKU: 7112110 (3 years) or 7112345 (5 years)

Production date (calendar week and year) – Certificate Validity (in years)
Unique ID (8 digit Lot code & 4 digit counter)

8. Export Control

The Epson microSD TSE contains a smart card that provides exclusively digital signature functionality to recorded user data. Therefore, the Export Control Customs EU Tariff Number is 85235110.

9. Software Licensing and Disclaimers

Epson is using the following Open Source Software internally in the TSE either unchanged or in modified form.

libecc - Library for elliptic curves cryptography; provided under BSD License.

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Revision History

Table16: Document Revision History

Date	Revision	Description	Revision Details
January 19, 2021	1.10	Added new BSI certification ID BSI-K-TR-0414	
December 06, 2019	1.00	Initial release	