SD card usage

Abstract

The application note describes the use of SD cards in control systems, both for defined use from the DetStudio development environment and the AWDet design environment.

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Annex

Contents of the file: –

–	None

Content

Revision history

Version	Date	Author of the change	Changes
01	26. 04. 2022	Kupčík M.	New document.

Related documentation

1. Help for the PseDet section of the DetStudio development environment
   file: PseDet_cs.chm
2. Help for the EsiDet part of the DetStudio development environment
   file: EsiDet_cs.chm
3. Help for the AWDet design environment
   file: AwDethelp_cs.chm
4. Application Note AP0046 – Web Server Parameterization
   file: ap0046_cz_xx.pdf

   Other documentation available at the time of publication of this document:
5. Flash Memory Guide
   file: https://media.kingston.com/pdfs/MKF_283.1_Flash_Memory_Guide_EN.pdf
6. microSDHC/microSD230I
   file: https://cdn.transcend-info.com/products/images/modelpic/997/EN_USD230I_PS_2020.pdf
7. microSDHC/SDXC10I
   file: https://cdn.transcend-info.com/products/images/modelpic/574/Transcend-microSDHC_SDXC10I.pdf

1 Definition of used terms

SD card
These are flash memory cards in microSD or microSDHC format. The tested capacities are 1 GB and 2 GB for microSD and 4 GB, 8 GB, 16 GB and 32 GB for microSDHC. The brands tested were Kingston, Transcend, ADATA and SanDisk.

Allocation unit (cluster)
The smallest indivisible storage unit available for read-write operating systems.

Web server
The web server is part of the Generation 1 control systems with the letter W in the name. For Generation 2 control systems, the **Webserver** communication object must be inserted into the project to make the web server functional. The web server is used primarily for displaying web pages and for communication via FTP.

2 SD card characteristics

Each SD card has its own set of basic characteristics. These typically include:

- type of memory cell production, resulting number of write cycles,
- capacity,
- read and write speed,
- working temperature and humidity range,
- price.

Given the typical use of SD cards in recent times primarily in multimedia applications, huge increases in capacities and communication speeds can be observed. However, these increases are due to changes in the internal structures of the memory cells, which can withstand fewer and fewer write cycles.

2.1 Number of write cycles, capacity

In the context of flash data storage, there is often talk of so-called "SLC", "MLC" or "TLC" manufacturing technologies, often also associated with the adjective "3D". Simply put, it is a representation of the number of data bits that a single memory cell can store. In the case of "SLC" it is one bit, "MLC" two bits and "TLC" three bits.

Kingston's manufacturer lists write cycle counts of up to 30,000 for SLC, up to 3,000 for MLC and up to 500 for TLC. Transcend lists a maximum written capacity of 5,800 TB for a 64 GB card for "industrial" use with SLC. After recalculation, this corresponds to 90 000 write cycles. For another type of "industrial" card with MLC, up to 120 TB is claimed for a 64 GB card. After recalculation, this corresponds to 1 800 write cycles.

In the 7 "Appendix A" section, there is a Panasonic document from 2017 that shows that TLC technology was used for the cheapest "consumer" SD cards from that manufacturer.

From the above, it can be deduced that the cheaper the card, or series of cards, the fewer the number of writes to the memory cell the card can withstand.

In one of the internal tests of one of the cheapest 8 GB microSDHC cards, write issues were detected after writing less than 93 GB of data.

However, there is a debate to be had as to how many write cycles are actually required to work with SD cards when used with AMiT products:

Let's have an example where a 128 B long string containing variable values will be archived every minute to an archive on a 4 GB SD card. This corresponds to 525,600 records per year, or 64.16 MB of written data. The entire overwriting of the SD card in this way will occur in less than 64 years. However, it is necessary to take into account that the SD card is always written in allocation units (clusters), which is defined with a size of 32 kB for a 4 GB SD card. Furthermore, flash memories do not allow adding data to existing data in the cluster, but must always be read from existing data, deleted and written to the entire cluster. Therefore, when writing 128 B of data sequentially, it does not write only 1× to the currently written cells of the cluster, but it writes sequentially to all memory cells of the cluster as many times as the number of written strings the cluster can hold. In the above case, this is 256 writes (32 768 B / 128 B). Here it can be seen that the lifetime of an SD card is of greatest importance in that the less data to be written per write cycle to an SD card, the more overwrite cycles the SD card must have.

It is understandable that as the archiving period shortens, the SD card's endurance time decreases, but as the capacity increases, it increases again. However, if the cluster size increases with increasing capacity, a larger capacity with a small regular write to the SD card can have exactly the opposite effect on lifetime.

Due to internal SD card access algorithms, it is not recommended to archive more frequently than 5 s (Generation 2 control systems) or 15 s (Generation 1 control systems), otherwise some time samples may not be archived.

The maximum supported SD card capacity is 32 GB. Based on experience, for only 1 GB microSD cards the cluster size is 16 kB, for 2 GB microSD and 4 GB to 32 GB microSDHC cards the cluster size is 32 kB.

2.2 Write speed, operating temperature range

With AMiT products, access to the SD card is relatively slow – in the tens, maximum hundreds of kB/s. For this reason, the maximum advertised read or write speed is not at all decisive; even the slowest SD cards with a "Class 4" designation are more than sufficient.

The typical temperature range of SD cards is similar to that of standard AMiT products. Only if the "industry" temperature range is used, i.e. temperatures below 0 °C or -25 °C, the corresponding "industry" SD card must also be selected.

3 Filesystem

The term "filesystem" refers to the organization of data on a data storage device. Typically, microSD cards use the FAT system and microSDHC cards use the FAT32 system.

When using archiving to the FAT/FAT32 file system, the archived files on the SD card will be directly visible by any file manager. So no accompanying software is needed.

3.1 Power failure behaviour.

Writing to the SD card takes some time. In the event of a power failure during this write, the write is not completed correctly. Depending on the data currently being written to the SD card, this can have various consequences, from archiving a blank or false value, to the complete impossibility of further work with the SD card – either no further writing or the impossibility of reading already stored archives.

Warning:
For the above reason, it is not recommended to archive data on the SD card, the loss of which may cause problems for downstream operations. Typically, e.g. the dates according to which invoices are invoiced, etc.

Warning:
The same problems can occur when you overwrite an application with a newer one or when you unexpectedly remove the card.

Note:
The battery used to back up data in the system memory is not used to back up the completion of the write to the SD card.

For the reasons described above, it is therefore not advisable to use SD card archiving in an environment where power failures may occur and which is not backed up by a UPS. Ideally, it is advantageous to feed information from the UPS about a power failure to the control system. The control system can then suspend archiving to the SD card based on the power failure information.

In the case of overwriting an application with a newer one, it is clearly necessary to ensure no archivation on the SD card, then wait and only after a certain time, typically 5 seconds, start uploading the new version of the application.

In case of physical removal of the SD card, it is necessary to provide typically on the terminal or I/O a signalling of the appropriate moment to remove the SD card, or to have the possibility to set by the operator that it should stop archiving on the SD card and that the SD card will be removed after a certain period of time.

4 Archiving of values

Archiving of values is understood as periodic or event-based storage of a selected list of values. Typically, even the smallest 1 GB SD card has enough capacity for years of archived values, but if the capacity is exhausted, the oldest files with archived values will be deleted from the card.

4.1 Generation 1 control systems

For Generation 1 control systems, it is not possible to archive to the SD card directly from the control part of the application. For archiving to the SD card, the possibilities of integrated web servers or the **VarLog** module defined from the **AWDet** design environment are used.

For the functionality of the **VarLog** component, it is necessary to have a so-called control variable in the control system, which determines whether or not it should be archived. It is the value of this variable that must be available for editing for the purposes of the previously mentioned SD card removal or application playback event.

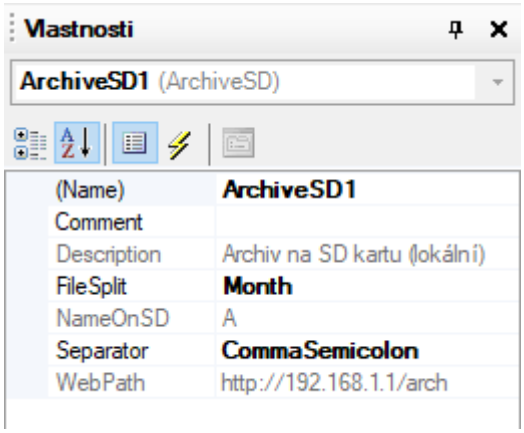
Communication with the SD card is handled by the communication CPU, so it takes place outside the user processes and cannot delay them in any way, nor can their execution affect the archiving period.

For more information about logging with **VarLog** , see the **AWDet**Help.

4.2 Generation 2 control systems

The **ArchiveSD** object is uniformly used for archiving to the SD card. The definition of items for archiving and archiving time points is identical to that of the **Archive** object. The main difference is the absence of archive depth.

In the case of the **ArchiveSD** object, its setting in the Properties window is important.



Obr. 1 – ArchiveSD object properties

In addition to basic properties such as name, user comment and description, the following items are available:

- **`FileSplit`** – split files by days/weeks/months/years,
- **`NameOnSD`** – there can be multiple **ArchiveSD** objects in a project; to make the individual archives on the SD card uniquely distinguishable, each archive on the SD card is automatically assigned a non-editable unique name after project generation,
- **`Separator`** – definition of separator of decimal places and archived items between each other,
- **`WebPath`** – web address for accessing archived files via a web browser – requires the presence of the **Webserver** communication object in the application project.

A maximum of 256 characters can be inserted into a single line in an archived file. The header line with descriptions of the names of archived variables typically takes the most characters.

In general, it is recommended to archive a maximum of 10 values in one **ArchiveSD** object.

The **ArchiveSD** object also offers the **`Status`** property, which indicates the status of the SD card. Typically, this is a signalling of presence (or lack thereof) of the SD card and the impossibility of further archiving to the SD card.

For actions of planned SD card removal or application playback, it is clearly necessary to work with the **`Enabled`** property of the **ArchiveSD** object.

Communication with the SD card is asynchronous, i.e. it takes place outside the user processes and cannot delay them in any way. On the contrary, if the archiving period is low and the total execution time of all processes is high (greater than the archiving period), writes to the SD card may be delayed and possibly lead to failures in the archived data.

More information about the **ArchiveSD** object can be found in the **DetStudio** Help, EsiDet section.

5 Reading the archives

First of all, it should be noted that in **DetStudio** version 2.2 and older there is no way to read the values in the archives stored on the SD card from the control systems and display the values on the terminal. Archiving to SD card is therefore used for processing on PC.

Files with archived values can typically be retrieved from the control system in two ways:

- by physically removing the SD card from the station and loading it in the PC,
- downloading archived values via FTP access (for Generation 2 control systems, this is conditional on the presence of the **Webserver** communication object in the DetStudio project):
  - using an FTP client, e.g. integrated in **AWDet**,
  - by using a web browser and typing in the address bar:
    - Generation 2 control systems: the address specified in the **`WebPath`** property of the **ArchiveSD** object, typically <IP address of the control system>/arch.</IP>
    - Generation 1 control systems: <IP address of the control system>/varlog.

The archived values are stored in *.csv files. Subsequent opening and processing of the values can be done by any program supporting this file type.

The organization of files in archive folders depends on the type of archiving and is described in the **DetStudio** help, EsiDet section, or in the **AWDet** help.

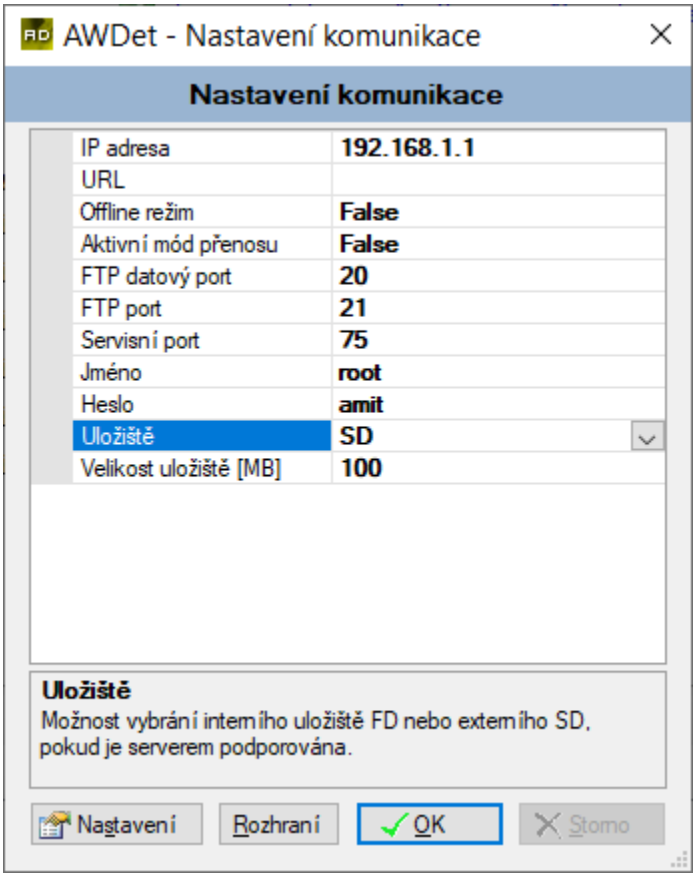
6 Background files for the website

In addition to the archived values, all the underlying files for the web pages can be stored on the SD card.

Web pages for web servers are created in the **AWDet** design environment. This environment defines whether the source files for the web servers are to be stored in the internal storage, called "FD", or on the SD card.

The "Communication Settings" dialogue box and the "Storage" item in it are used for the settings, which are displayed from the main menu "Transfer / Communication Settings" or also by the **F4** keyboard shortcut.

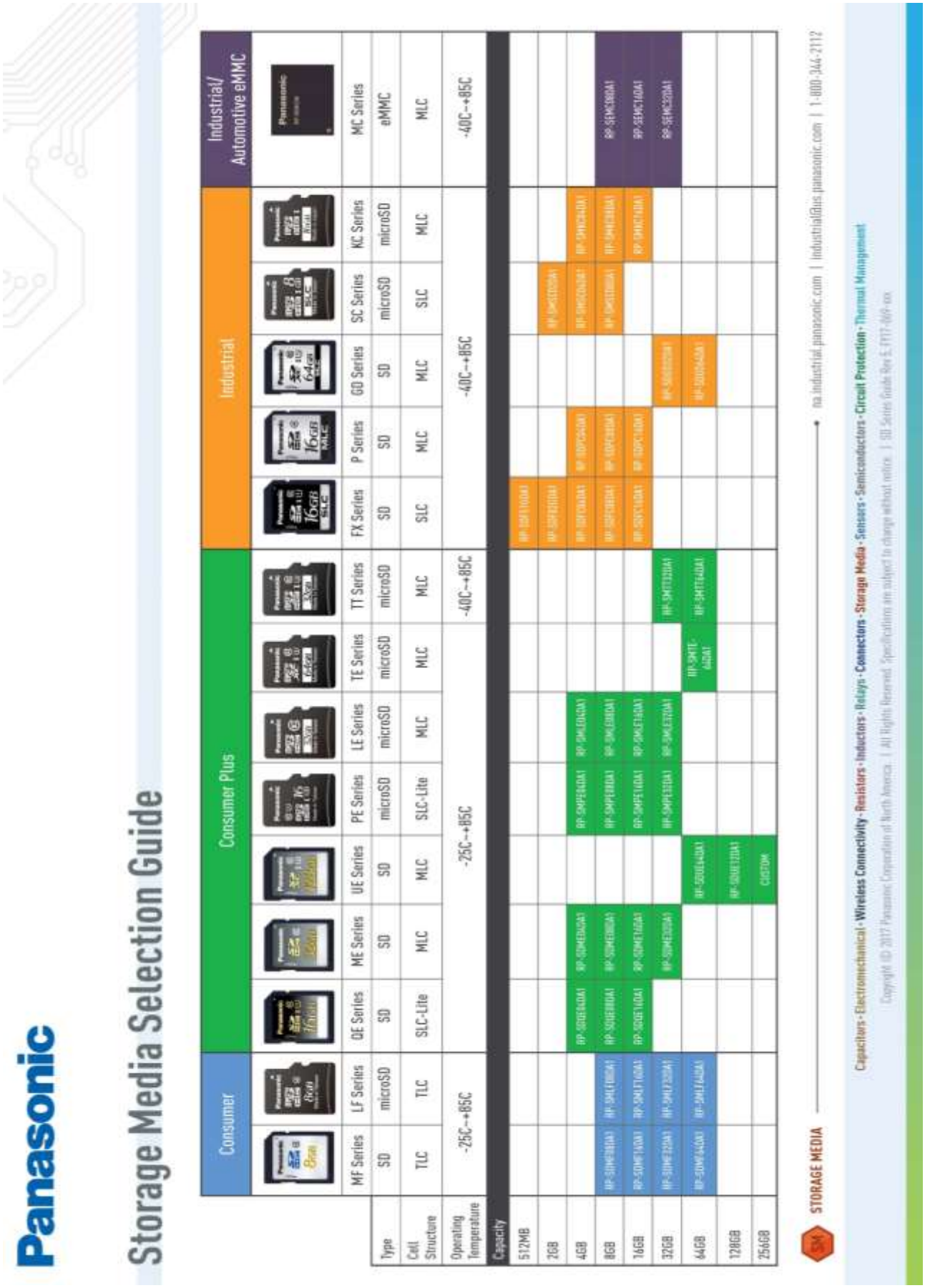
When you change the "Storage" item to "SD", the "Storage size [MB]" item appears, where you need to enter a value that is smaller than the SD card capacity, which is used to calculate the target storage capacity.



Obr. 2 – Communication and storage settings for website files

More information about communication settings and storage definition can be found in the **AWDet** Help.

7 Appendix A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8 Technical support

For all information regarding the use of the SD card in AMiT control systems, please contact AMiT Technical Support. Technical support can be contacted preferably by email at **support@amit.cz**

9 Notice

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