Build Your Own Data Logger
Module 3: Proof of Concept
Submodule 5 – Reading and Writing to the SD Card

Terminology Starter Guide

Video	Intro
Flash Memory Card	A storage device that contains flash memory on a removable device (eg. a card) instead of on a computer chip
Flash Memory	A type of non-volatile computer memory that can be erased electronically and rewritten, and keeps its data, even when the system is turned off.
NAND Flash	A type of flash memory where the memory cells are on a single level, and are organised in a series. Based on the NAND logic gate. Reads more slowly, writes more quickly, cheaper and more common than NOR. 3D NAND is NAND flash memory that vertically stacks single levels of memory cells (and therefore increases capacity).
NOR Flash	A type of flash memory where the memory cells are on a single level and organised in parallel. Based on NOR logic gates. Read more quickly, writes more slowly, longer life-span, more expensive, less common.

	3D NOR is NOR flash memory that vertically stacks single levels of flash memory cells.
Read Speed	The amount of time it takes to retrieve and display a piece of data or file from the memory card.
Write Speed	The amount of time it takes to save data to the memory card.
Erase Speed	The amount of time it takes to delete data from the memory card. In most situations, when data is deleted or erased from the memory card (or hard drive), it's ***marked as deleted*** yet remains on the hard drive until it's overwritten by something else. Sometimes, deleted files can be recovered from the memory card or hard drive because they are only marked as deleted (and not permanently deleted yet).
Bus Speed / Serial Bus Speed	How quickly data can be communicated / transferred via a serial bus. In this case, how quickly data can be transferred to and from the SD card.
Endurance	How long, how much data, or how many program / erase cycles the memory card can handle before it physically degrades, and the memory card can no longer be used. Usually measured in program / erase cycles (see below).
Program / Erase cycle (P/E Cycle)	The cycle of erasing data from a block in the memory cell so new data can be written to the block.

	P/E cycles are finite because blocks physically degrade a little each time data is programmed / erased to them.
Blocks or Sector (in the context of memory cards)	A group of memory cells to which data is written or erased. For SD cards, data can only be written to one block at a time, even if only one byte in that block needs to be changed. Likewise for reads where you have to read a complete block even if you only want one byte in it.
Flash Memory Cell	The physical component in the flash storage device that holds electrical charge, and to which data can be written / erased.
Wear Levelling	Hardware and software that manages the program / erase cycles so that the memory cells within the memory card physically degrade evenly and consistently.
File System	A piece of software that organises how and where data is stored on a memory storage device.
File Allocation Table (FAT)	A type of file system created by Microsoft. The clusters of storage data are stored by a table which acts as a map to navigate the storage media and data. When a file is created, clusters are allocated in the File Allocation Table which is where the name comes from.
Addressing	The amount of bits (binary digits or 0s and 1s) used for addressing the cluster the file is saved in.
Maximum File Size	The largest file size for a single file that can be saved on the memory card.

Sector	A unit of storage that the file system breaks the storage device into.
File Allocation Unit / Cluster	A group of sectors and the smallest storage unit that a file can be saved into.
Serial Peripheral Interface (SPI) Bus	A type of connection between a peripheral and the MCU to communicate data.
File Pointer	A file pointer is like a 'cursor' to tell where in the file to read/write to. When a file is first opened in default mode, the file pointer points to the beginning of the file and all reads and writes start from here. If a file is opened in APPEND mode, the file pointer starts at the end of the file so all reads and writes start from there.
Hot Swap	Plugging something into or out (eg. a sensor or SD card) of the board whilst its powered. Not recommended!

Tutorials / Useful Links

SD Card Symbols Meanings	https://www.yugatech.com/guides/6-markings-on-sd-cards-and-their-meanings/ https://www.askdavetaylor.com/how-do-i-interpret-all-the-symbols-and-codes-on-a-microsd-card/
Choose the Right SD card	https://www.element14.com/community/groups/embedded/blog/2018/03/26/why-not-all-sd-cards-are-created-equal-storage-insights-1

	https://www.element14.com/community/groups/embedded/blog/2018/03/26/why-not-all-sd-cards-are-created-equal-storage-insights-1
Explanation of Different Kinds of Flash Memory	https://flashdba.com/2014/07/03/understanding-flash-slc-mlc-and-tlc/
Flash Memory Guide (from Kingston Manufacturer – PDF)	https://media.kingston.com/pdfs/MKF_283.1_Flash_Memory_Guide_EN.pdf
Physical Structure of Flash	https://flashdba.com/2014/06/20/understanding-flash-blocks-pages-and-program-erases/
How It works – NAND Flash Technology Basics	https://www.silicon-power.com/blog/index.php/guides/nand-flash-memory-technology-basics/
microSD Card Power Consumption Comparison	https://gaidi.ca/weblog/low-power-showdown-usd-card-sleep-and-write-current-draw
Tech Republic – FAT File System	https://www.techrepublic.com/article/file-systems-101-fat/
FAT explained	https://www.minitool.com/lib/file-allocation-table.html
FAT File Systems - Clusters	https://www.slideshare.net/harleen-johal/file-system-12292068
Formatting a microSD card to FAT32 - Windows	https://support.amcrest.com/hc/en-us/articles/360037523632-How-to-Format-a-MicroSD-Card-to-FAT32
Formatting a microSD card to FAT32 - Mac	https://support.amcrest.com/hc/en-us/articles/360039631652-How-to-Format-a-MicroSD-Card-Using-Mac
Unsigned Integers	https://www.arduino.cc/reference/en/language/variables/data-types/unsignedint/