

## Logomatic V1.0 Universal Data Logging Device 7/25/2006

Following the success of SFE's GPS Logger, customers began asking for a more generic form of data logging device that stores data to an SD card in a text file format. "Can it log other stuff?" "Will it run at 38400?" "What about a few ADC lines?" So in response, we give you the Logomatic V1.0.

### 1 Overview

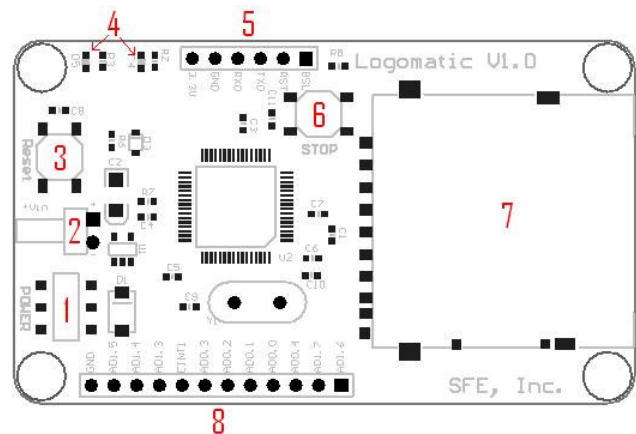
The Logomatic's list of features is lengthy:

- 3 modes of operation: Auto UART, Character-triggered UART, ADC
- Configurable baud rates in UART modes of 1200, 2400, 4800, 9600, 19200, 38400, 57600,

and 115200 baud

- Triggered UART mode has a configurable frame length of up to 510 characters (including trigger character)
- Triggered UART frames are delimited with carriage return and line feed characters for easy reading
- 10 ADC channels, all selectable as on or off
- ADC logging in ASCII or binary format
- ASCII logging delimited by tabs between measurements, delimited between frames by carriage return and line feed characters
- Variable frequency for ADC mode
- Frequency "safeties" to ensure that the file doesn't try to overwrite itself, maximum of 1500Hz for one channel and 150Hz for all ten channels (ASCII logging mode)
- For the brave of heart, you can turn the safety off!

The basic layout of the Logomatic V1.0 looks like this:



- 1) Power switch
- 2) Right-angle +Vin jack
- 3) Reset button
- 4) Status LEDs

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- 5) UART0 / programming port
- 6) Stop logging button
- 7) Push-push SD card socket
- 8) ADC ports

The Logomatic has an LDO 3.3V regulator and a reverse current protection Schottky diode. The maximum power dissipation of the voltage regulator is about 450mW, and the maximum current draw of the Logomatic is about 80mA (worst case). Neglecting the voltage drop on the Schottky diode, the maximum voltage the Logomatic could run with is  $(450\text{mW}) / (80\text{mA}) + 3.3\text{V} = 8.925\text{V}$ , but this will be very close to putting the voltage regulator into thermal shutdown. For best operation, the supply voltage should be kept between 3.6V and about 7.5V.

## 2 Theory of Operation

The Logomatic saves data to an SD card in a two-stage process. Data is first saved to one of two 512-byte data buffers. As each buffer is filled, it is logged to the SD card and logging continues on the other buffer.

The limiting factor on the speed of the Logomatic is the write process to the SD card. The longest write cycle is approximately 42.5mS, which means that the shortest time allowed to log data to one of the buffers is also 42.5mS. If logging occurs faster than this, the buffer that's currently being written to the SD card will be overwritten by new input during the write process to the SD.

In UART modes, this could possibly become an issue at a baud rate of 115200 (1 start bit, 1 stop bit, 8 data bits). If streaming at this rate without any breaks, 512 bytes are filled in 44.4mS. Lower data rates should not show any difficulty.

In ADC mode, safety margins are imposed to alleviate buffer overwriting. Sample rates are capped depending on how many channels you have active, though this is only imposed when logging in ASCII format. The frequency caps are:

- 1 channel active, 1500Hz maximum
- 2 channels active, 750Hz maximum
- 3 channels active, 500Hz maximum
- 4 channels active, 375Hz maximum
- 5 channels active, 300Hz maximum
- 6 channels active, 250Hz maximum
- 7 channels active, 214Hz maximum
- 8 channels active, 187Hz maximum
- 9 channels active, 166Hz maximum
- 10 channels active, 150Hz maximum

It should be noted that these frequency caps are very close to the allowable margins. Buffer overwriting is unlikely to occur, but the text files produced may exhibit a rare stray character. The solution to this is to reduce the sample rate until no stray characters are seen.

The frequency caps are not imposed in binary ADC logging mode. Faster sample rates can be realized in binary mode, from a 43% increase for 10 channels to 57% increase for one channel, but you will be required to write your own application that can interpret the resulting file. To get the faster data rates, just change the "Safety On" option from "Y" to "N" and set the "Frequency" number to whatever you want. The parser that reads the configuration file reads up to 4 digits, so you can set it as high as 9999Hz (though it will likely stop running at that speed).

## 3 First Power-up and the Configuration File

Before you power up your Logomatic for the first time, put your SD card into your card reader and format it in FAT16. Then install the card into your Logomatic and turn it on. The LEDs will blink reassuringly and then go quiet. Turn off your Logomatic, pull out the SD card and

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put it back in your reader. You will now find 2 files on your card, LOGCON.TXT and LOG0.TXT. The first is the configuration file, the second is the first logged file (empty). Open up the configuration file and you will see this:

```
MODE = 0
ASCII = N
Baud = 4
Frequency = 100
Trigger Character = $
Text Frame = 100
AD1.5 = N
AD1.4 = N
AD1.3 = N
AD0.3 = N
AD0.2 = N
AD0.1 = N
AD1.2 = N
AD0.4 = N
AD1.7 = N
AD1.6 = N
Safety On = Y
```

## 3.1 Mode

There are 3 mode settings. “0” for automatic UART logging, “1” for triggered UART logging, and “2” for ADC logging.

Mode 0 logs everything that comes in on UART0, provided that it’s the right UART format (8 data bits, one stop bit, no parity, data rate of your choosing).

Mode 1 logs a specified number of characters (“Text Frame = 100” in this case will result in 99 characters logged after the trigger) after a specified character (“Trigger = \$” in this case).

Mode 2 logs ADC measurements according to which are selected as active at whatever frequency is specified (“Frequency = 100” in this case).

## 3.2 ASCII

The “ASCII” field only applies to ADC mode (mode 2). It specifies whether the unit will log in ASCII format (“ASCII = Y”) or binary format (“ASCII = N”).

## 3.3 Baud

The “Baud” field sets the baud rate for the UART logging modes. The available rates are as follows:

“1” = 1200

“2” = 2400

“3” = 4800

“4” = 9600

“5” = 19200

“6” = 38400

“7” = 57600

“8” = 115200

## 3.4 Frequency

The “Frequency” field only applies to ADC logging mode and is responsible for setting the sampling rate of the Logomatic. The number shown (100 in this case) is in hertz and can be set from 1 to 9999. However, if the frequency safeties are active, the maximum values will be imposed as indicated in an earlier section.

## 3.5 Trigger Character

The “Trigger Character” field only applies to to the triggered UART mode (mode 1). This is the character that the device waits for to begin logging a specified number of characters.

## 3.6 Text Frame

The “Text Frame” field specifies the number of characters to be logged with the trigger character when the Logomatic is running in mode 1. The reader should be aware that the first character in the logged text frame will be the trigger character, so if you wish to log 100 characters after the trigger you should set the text frame to 101.

**Note:** This mode of operation is slightly different than the other modes in that each text frame has it’s own dedicated 512 byte buffer. When the end of the text frame is reached, the buffer will be logged and any new data coming in will be routed to the other input buffer.

Each text frame is delimited with a carriage return and a line feed character, so the maximum text frame size is 510 bytes. If this number is exceeded, it will automatically be reset to 510.

## 3.7 Operational ADC Lines

The next ten lines in the configuration file indicate which ADC lines are to be read by the Logomatic. They can each be turned on by changing the “N” to a “Y”. These values have no affect when in one of the two UART modes. For ease of use, they are listed in the configuration file in the same sequence that they’re seen on the Logomatic PCB.

## 3.8 Safety On

The last field in the configuration file is the “Safety On” field. This sets the frequency caps for ADC mode on with a “Y” or off with an “N”. The values for those caps are mentioned in an earlier section.

There is also a hardware test function that can be accessed through this parameter. Instead of a “Y” or an “N”, setting it to “T” will put the unit in hardware test mode. In this mode, you can watch the ADC lines slowly polled over the serial UART lines at 9600 baud. **Note:** this mode is not intended for normal operation. It is only intended for determining hardware failures.

## 4 Output Formats

The formats of the text files produced by the Logomatic will be a little different in each mode.

For mode 0 (automatic UART), any ascii characters that come in on the UART will be sent to the SD card. Nothing is omitted and nothing is added.

For mode 1 (triggered UART), anything after and including the trigger character will be logged, including white space characters, up to the end of the specified data frame. Each data frame is delimited with a carriage return and a line feed character to make it easier to distinguish between the frames.

In ASCII ADC mode (mode 2, ASCII = Y), each single measurement is between 1 and 4 characters in length depending on how many digits are required, followed by a tab (ASCII 9) for delimiting. At the end of each measurement frame, that is, one time through the list of selected active ADC lines, carriage return and a line feed characters are placed for further delimiting. The sequence of measurements displayed in the file from left to right are exactly the sequence of channels selected in the configuration file from top to bottom.

In binary ADC mode (mode 2, ASCII = N), each measurement is two bytes in length (MSB, LSB), and they will occur in the same sequence as the ASCII logs with respect to the configuration file. There are no delimiters between measurements, but measurement frames are delimited by the characters “\$\$”.

## 5 Operation

Before we illustrate general operation, turn on your Logomatic *without the SD card in place*. You'll see the status LED's blink rather quickly during the initialization, then they will go into a slow and steady sort of blinking. Familiarize yourself with that particular blinking. It's what the Logomatic will do whenever it is stopped. In this case it's stopped because it doesn't see the SD card. It will also do this if the card has been formatted in FAT32 instead of FAT16, or if the STOP button has been pushed.

Now that you know how the Logomatic works and what all of the settings do, it's time to power it up. Set your configuration however you like, plug your SD card into the Logomatic and turn it on. The two status LED's will blink at you rather quickly during the initialization, then the unit will go to work with the settings you chose. The only further indication of operation that you will see is when one of the two data buffers logs to the SD card, STAT0 for buffer #1 and STAT1 for buffer #2. These will be very quick "blips" because the LED's are only on during the write process, between 20 and 40mS.

When you are done logging, press the STOP button before shutting off the unit. Why a stop button? The Logomatic is interrupt driven. Pressing the STOP button disables the interrupts, logs the remainder of whichever buffer hasn't been written yet and updates the FAT. This ensures that you get ALL of your data and prevents leaving the file in an unfinished and corrupt state. Not pressing the STOP button prior to shutting down can leave you with a corrupted text file.

The Logomatic will create up to 256 log files in text format, numbering from LOG0.txt to LOG255.txt. The most recent log file will be the one with the highest number.

## 6 Options and Firmware

You may optionally attach the LPC programming adapter (SKU# LPC-ICP) to the Logo-

matic to log true RS232 data and to load new firmware updates. The source code is also freely available for user tweaks, and we use Rowley Crossworks to compile. A 30 trial version of Crossworks for ARM is available for download from <http://www.rowley.co.uk/>. New code can be loaded with the Philips LPC2000 Flash Utility, which is available for free download from the [http://www.semiconductors.philips.com/products/microcontrollers/support/software\\_download/lpc2000/index.html](http://www.semiconductors.philips.com/products/microcontrollers/support/software_download/lpc2000/index.html).

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