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## LED array controller

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There are two modes in which the LED-Array can be accessed, namely line-based and pixel based. Each of the below section will describe these access modi. Note that:

- On the GECKO5Education there is an RGB-array that uses a scanning frequency of 1kHz.
- On the GECKO4Education there is only a single color array, writing to any of the red, green or blue bits will light up the led.
- The intensity of the LED's cannot be controlled (they are either on or off).
- This module supports burst mode, or single word mode. Short or byte access will result in a bus-error.

## 1 Line-based control

The base address of the line-based control of the LED-array is 0x50000800. The offset inside this control mode is 10-bit (byte based) or 8-bit (word based). The functionality of these offset bits is shown below:

Byte-based offset:									
9	8	7	6	5	4	3	2	1	0
access mode		line index				color mode		0	0

Word-based offset:							
7	6	5	4	3	2	1	0
access mode		line index				color mode	

The different items are:

- **Color mode:** The color mode defines which of the LED's are activated in the selected line of LED's. Their definition is:

Value:	Mode:
0	Write to the blue LED's of the line.
1	Write to the green LED's of the line.
2	Write to the red LED's of the line.
3	Write to the red,green, and blue LED's of the line (white color).

- **Line index:** This selects the line of the LED array, where line 0 is the top-most line of the array and line 8/9 the bottom line of the array. Note that when line-index is bigger than 9 this will not do anything.

- **Access mode:** To set or clear a LED, a word is written. In this word the LSB (bit 0) references the right-most LED in the line, and bit 10 the left-most LED in the line. The bits 31..11 of this word are don't care. How the LED's react on a 1 or 0 is determined by the access mode:

Value:	Access mode:
0	The bit will be directly written hence a 1 lights up the LED, a 0 will turn it off.
1	The bit will be or-masked written hence a 1 lights up the LED, a 0 will leave it as is.
2	The bit will be and-masked written hence a 0 turns off the LED, a 1 will leave it as is.
3	The bit will be xor-masked written hence a 1 inverts the LED, a 0 will leave it as is.

Reading from any of the locations inside this address space will show the current state of the LED's, where the access-mode is ignored.

## 2 Pixel-based control

The RGB-array can also be addressed pixel by pixel. The base-address for this mode is `0x50000C00`. The offset inside this control mode is 9-bit (byte based) or 7-bit (word based), where the offset indicated the pixel inside the array. Offset 0 is the pixel on the left-top and offset 107/119 (short based) is the pixel on the right-bottom.

To each pixel the RGB-value can be written where the red-value is bit 2 of the data-word. The green value is bit 1 of the data-word, and bit 0 is the blue value. Reading from a location will return the current RGB-value of the pixel (LED).

## 3 Writing the base address

**Important:** Do not use this function if you do not know what you are doing, as it could result in funny results.

By default the led controller is at the memory address `0x50000800`, however, it can be moved in the memory space by writing a complete 32-bit memory

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address. Please note that the bits 9..0 of this address must be 0. The base-address register can be accessed by a word offset of **0x1FF** from the current base address. Hence in the start-up mode on address **0x50000FFC**.