

# How to operate the EA DOGM128-6

## Programming and Hardware - Controller ST7565

### Consideration

The display EA DOGM128-6 from ELECTRONIC ASSEMBLY GmbH is equipped with an onboard controller ST7565. Same as the EA DOGM132-5 and the EA DOGL128-6.

The supply voltage is 3,3V, data transfer is serial through a 4 wire SPI interface. We recommend to use the CS-pin before any writing to the display; it is responsible for the synchronisation of the internal data register. This avoids problems caused by external spikes or EMI or when loosing a clock cycle.

Data must be sent to the display with the most significant bit (MSB) first. With a microcontroller which has an integrated SPI interface the right mode has to be chosen. The data transfer will be done at the rising edge of the pin SCL.

The pin A0 is to separate control data and display data.

- when A0 pin is low: transferred data are control data as initializing, page- and column change.
- when A0 pin is high: transferred data are display data to become shown on the screen.

Note: The display data remain stored in the internal display memory as long as they are overwritten or the supply voltage is switched off.

In the following table the whole structure and relation between display data RAM and display pixels is shown. The display has 128 vertical columns (0 – 127) and 8 horizontal pages. Each page has 8 lines with D0 to D7. This means that always 8 pixels in vertical orientation are represented by 1 byte. So the size of the display data memory is  $128 \times 8 = 1024$  bytes.

Relationship display Memory <> Display:

	Column0	Column1	Column2	Column3	.....	.....	.....	Column126	Column127
Page0	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7
Page1	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7
Page2	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7
Page3	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7
Page4	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7
Page5	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7
Page6	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7
Page7	D0   D7	D0   D7	D0   D7	D0   D7	D0   D7		D0   D7	D0   D7	D0   D7

### Initialization

This is an initialization example for single supply +3V / +3.3V supply with internal booster on.

1. RESET-pin must be set to high (as long as the pin RESET is low, nothing works).
2. CS-pin must be set to low (It can be written to the display, display input buffer is cleared).
3. A0-pin must be set to low (The display is prepared to receive command data).
4. Display software initialization. Note that initialization commands depending on circuit diagram, please refer to page 6 in the displays data sheet for single supply or dual supply. Following initialization is made for single supply operation with +3,3V:
  - 4.1 Send hex 40 to the display: Display start line = 0
  - 4.2 Send hex A1 to the display: ADC reverse, 6 o'clock viewing direction
  - 4.3 Send hex C0 to the display: COM0 – COM63 in normal scan mode
  - 4.4 Send hex A6 to the display: Display normal, not mirrored
  - 4.5 Send hex A2 to the display: Set bias 1/9 (Duty 1/65)
  - 4.6 Send hex 2F to the display: Booster, regulator and follower on
  - 4.7 Send hex F8 to the display: Set internal booster to 4x
  - 4.8 Send hex 00 to the display: Set internal booster to 4x
  - 4.9 Send hex 27 to the display: Contrast set
  - 4.10 Send hex 81 to the display: Contrast set
  - 4.11 Send hex 16 to the display: Contrast set
  - 4.12 Send hex AC to the display: No indicator
  - 4.13 Send hex 00 to the display: No indicator
  - 4.14 Send hex AF to the display: No indicator
5. End of Initialization set the CS-pin to high again.

Note: After this initialization a kind of invisible cursor / pointer is set to the first byte in display RAM (column 0 and page 0).

**After successful initialization the following pins should have roughly following voltage levels:**

EA DOGM128-6		
Pin Number	Pin Description	Voltage against VSS
Pin 21	V0	9,7V
Pin 22	V1	8,6V
Pin 23	V2	7,5V
Pin 24	V3	2,2V
Pin 25	V4	1,1V
Pin 26	VSS	0V
Pin 27	CAP2N	1,7V
Pin 28	CAP2P	7,9V
Pin 29	CAP1P	4,8V
Pin 30	CAP1N	1,7V
Pin 31	CAP3P	4,8V
Pin 32	Vout	12,3V
Pin 33	VSS	0V
Pin 34	VDD2	3,4V
Pin 35	VDD	3,4V
Pin 36	SI	Data In
Pin 37	SCL	Serial Clock
Pin 38	A0	3,3V
Pin 39	RST	3,3V
Pin 40	CS1B	3,3V

Note: Those measurement relates to 3.3V power supply only. A different supply voltage does lead to different measurement. Different displays (EA DOGM132-5 and EA DOGL128-6) do also lead to different voltages.

### Writing visible data to the display:

Example: Writing display data hex 12 or hex AA or hex F3 to the display RAM.

1. Initialize the display as described before
2. set CS-pin to low (ready to write to the display)
3. set A0-pin to high (for write display data)
4. write e.g. hex 12 and hex AA and hex F3 (after data is written, column cursor will be incremented automatically by 1)
5. set CS-pin to high (display is no longer selected)

hex 12 shows:

hex AA shows:

hex F3 shows:

	Hex 01																	
	Hex 02																	
	Hex 04																	
Page x	Hex 08																	
	Hex 10																	
	Hex 20																	
	Hex 40																	
	Hex 80																	

Example: Writing the letter "R" in the format 5x8.

To show the letter "R" on the display, following hex values have to be sent one by one: \$00, \$7F, \$09, \$09, \$76.

		00	7F	09	09	76
	Hex 01					
	Hex 02					
	Hex 04					
Page x	Hex 08					
	Hex 10					
	Hex 20					
	Hex 40					
	Hex 80					

### **Changing to another position in display RAM; new page**

1. set CS-pin to low (ready to write to the display)
  2. set A0-pin to low (for sending command data)
  3. write e.g. hex B1 to the display (page 1)
  4. set A0 to high (ready to receive display data)
- set CS-pin to high (display is no longer selected)

### **Changing to another position in display RAM; new column**

1. CS-pin set to low (select the display and synchronize the internal bit counter)
2. A0-pin set to low (for writing command data)
3. The next is a 2 byte command (column address set)
  - 3.1 Write e.g. hex 14 to the display (most significant 4bit)
  - 3.2 Write e.g. hex 00 to the display (least significant 4bit)Next display data will be written at column 64.
4. set A0 to high (ready to receive display data)
5. set CS-pin to high (display is no longer selected)

## **General Remarks**

- After the display is switched on and the initialization went true, any pixel may be on due to the status of the display memory. Normally content is random for each bit. To clear the display every byte in display RAM need to be cleared (set to hex 00).
- Data lines do not accept 5V,  $V_{in} = V_{DD} = 3.3V$  (typ.)
- The controller ST7565 has no internal character set. Every letter has to be made through single pixels. ELECTRONIC ASSEMBLY offers an EA USBSTICK-FONT with 10 different character sets and also a tool called "FontEditor.exe". With that Windows software all fonts can be changed individually. Even there's an import option to convert Windows fonts.
- The display content can not be read out.
- An easy way to handle the display content is to keep the complete display data as a copy in the uC memory and write from time to time the complete image (1kB) to the display. This can be made automatically by timer interrupt or after the end of a write function. Scroll function and change of pixels can be made easily. For this a memory of 1kB is necessary.

Issue 12.2009

ELECTRONIC ASSEMBLY reserves the right to change specifications without prior notice. Printing and typographical errors reserved.