LAVA 10

SVGA Graphics Controller for embedded systems

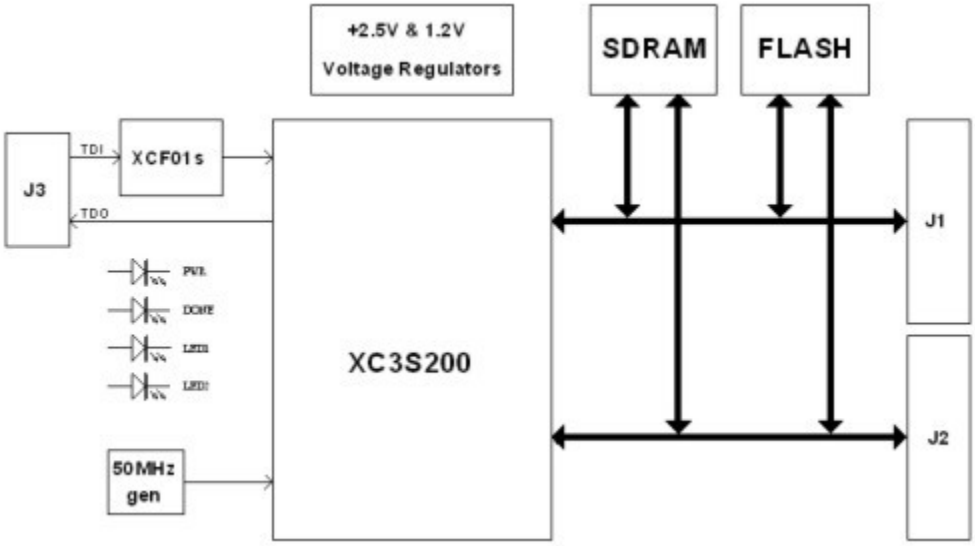
MYLIUM

1 Introduction

LAVA 10 is a SVGA Graphics Controller based on FPGA module (made by PROPOX Sp. z o.o. www.propox.com) designed for use in embedded systems. Main task of this device is taking over most of complex operations related with displaying graphics from main processor.

Features:

- 3-in-1 Integrated SVGA Display Controller, SDRAM Controller, Flash Memory Controller
- displaying 65536 colors (RGB565) in SVGA (800x600) resolution (60Hz) – perfect for use with LCD Monitors
- Xilinx Spartan 3 (XC3S200)
- 32 MB SDRAM memory for storing frames (2 buffers) and for general purposes (not necessary related with graphics)
- 8 MB Flash memory for storing non-volatile data (fonts, icons, pictures etc.)
- ready to use with the Evaluation Board
- embedded character generator (Code page 437[1] based characters)
- outputs for Video DAC
- fast 8-bit interface for bidirectional communication (can be connected to any host controller)
- reprogrammable via JTAG interface (adding new hardware functions, using module for other FPGA based projects etc.)
- single low power design: 3.0-3.6V supply @100mA
- prepared for use directly in the application or with the evaluation board
- simple instruction set (library written in C is available)



[1] http://en.wikipedia.org/wiki/Code_page_437

2 Pin out description

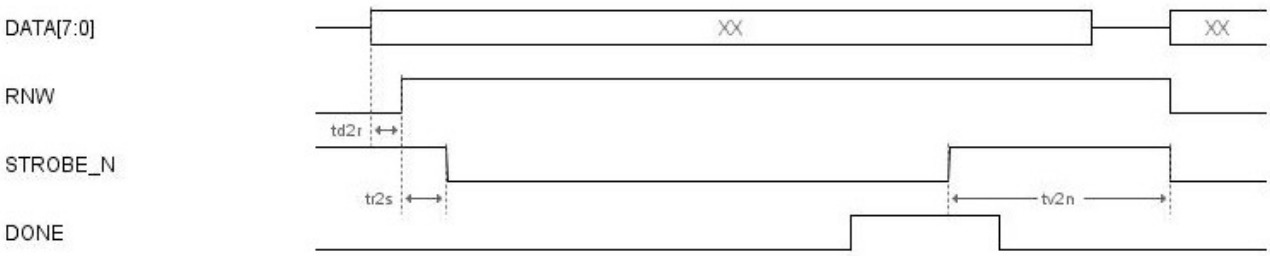
Pin No.	Name	Type	Description
J2-5	VSYNC	O	Vertical sync
J2-6	HSYNC	O	Horizontal sync
J1-21	BLANK	O	Blank (signal used by Video DACs)
J2-7	B[4]	O	Blue Video
J2-8	B[3]	O	Blue Video
J2-9	B[2]	O	Blue Video
J2-20	B[1]	O	Blue Video
J2-19	B[0]	O	Blue Video
J2-10	G[5]	O	Green Video
J2-11	G[4]	O	Green Video
J2-12	G[3]	O	Green Video
J1-23	G[2]	O	Green Video
J1-24	G[1]	O	Green Video
J2-16	G[0]	O	Green Video
J2-13	R[4]	O	Red Video
J2-14	R[3]	O	Red Video
J2-15	R[2]	O	Red Video
J2-18	R[1]	O	Red Video
J2-17	R[0]	O	Red Video
J2-37	RESET_N	I	Module reset signal (active low)
J1-12	HOST_DATA[7]	I/O	Host bidirectional port
J1-11	HOST_DATA[6]	I/O	Host bidirectional port
J1-10	HOST_DATA[5]	I/O	Host bidirectional port
J1-9	HOST_DATA[4]	I/O	Host bidirectional port
J1-8	HOST_DATA[3]	I/O	Host bidirectional port
J1-7	HOST_DATA[2]	I/O	Host bidirectional port
J1-6	HOST_DATA[1]	I/O	Host bidirectional port
J1-5	HOST_DATA[0]	I/O	Host bidirectional port
J1-13	STROBE_N	I	Strobe signal (start read/write operation – active low)
J1-14	DONE	O	Operation done (confirmation signal)
J1-15	RNW	I	Read not Write signal ('1' for Read op, '0' for Write op)
J2-1,J2-3	VCC		Power supply (3.3V)
J2-2,J2-4	GND		Ground

3 Host interface

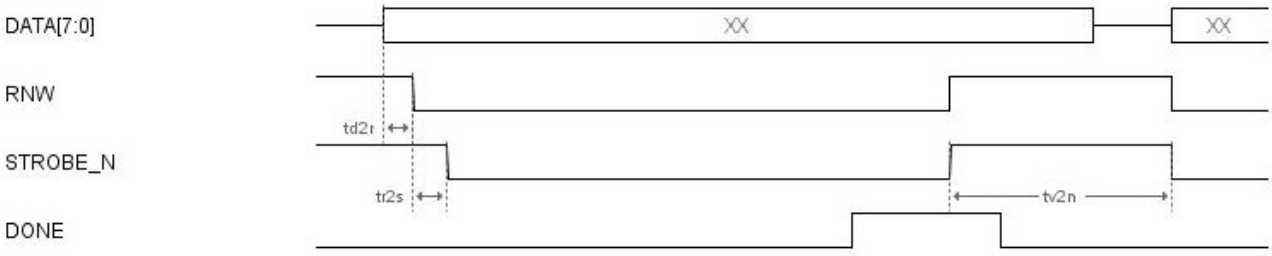
Communication between host controller and **LAVA 10** is made via 8-bit parallel port. There are 2 types of operation available – READ, WRITE.

In general, DATA and RNW signals must be set before STROBE_N goes low. STROBE_N should be kept low until DONE signal will be set high (confirmation of the operation). Next operation can be executed after min. 50 ns (tv2n on diagrams).

3.1. READ



3.2. WRITE



4 Commands

There are 4 basic commands that control the device:

- COPY MEMORY
- WRITE MEMORY
- READ MEMORY
- DRAW TEXT

Each data stored in the module has size of 16 bits, therefore even number of writes/reads has to be made.

Information about the type of the operation is contained in 1st byte.

Bits:

- [7:4] – command
  - COPY MEMORY – 0x1
  - WRITE MEMORY – 0x2
  - READ MEMORY – 0x3
  - DRAW TEXT - 0x4
- [3:0] – memory type
  - SDRAM 0x0
  - FLASH 0x1
  - READ CSR 0x6
  - WRITE CSR 0x2

4.1. READ MEMORY

Read memory command is used for reading from any register from the module.

To execute this command, 4 bytes of data has to be written to module, then 2 bytes of data has to be read.

Command format

W	READ MEMORY | MEMORY TYPE
W	ADDRESS [23:16]
W	ADDRESS [15:8]
W	ADDRESS [7:0]
R	DATA [15:8]
R	DATA [7:0]

Note:

Reading data from FLASH memory requires 2 commands (WRITE MEMORY – to set read mode; READ MEMORY – to read actual data[2] : Table 4. Commands – M28W640FC datasheet).

4.2. WRITE MEMORY

Write memory command is used for writing to any register from the module.

[2] http://www.numonyx.com/Documents/Datasheets/M28W640FC.pdf

To execute this command, 6 bytes of data has to be written to module.

Command format

W	WRITE MEMORY | MEMORY TYPE
W	ADDRESS [23:16]
W	ADDRESS [15:8]
W	ADDRESS [7:0]
W	DATA [15:8]
W	DATA [7:0]

Note:

Writing data to FLASH memory requires 2 commands (WRITE MEMORY – to set read mode; WRITE MEMORY – to write actual data: Table 4. Commands – M28W640FC datasheet).

4.3. COPY MEMORY

Copy memory command is used for copying data from SDRAM/FLASH memory to SDRAM memory. The maximum data size to be copied at once is 1024x16 bits. Following data is needed to execute this command:

- Source memory type – SDRAM/FLASH
- Source memory address
- Data size (max.1024 - 0x400)
- Destination memory address

To execute this command, 10 bytes of data has to be written to module.

Command format

W	COPY MEMORY | SRC MEMORY
W	SRC_ADDRESS [23:16]
W	SRC_ADDRESS [15:8]
W	SRC_ADDRESS [7:0]
W	DATA_SIZE [15:8]
W	DATA_SIZE [7:0]
W	**0x00**
W	SRC_ADDRESS [23:16]
W	SRC_ADDRESS [15:8]
W	SRC_ADDRESS [7:0]

Note:

7th byte is just to align data to 16 bits. The value written there “don't care”.

4.4. DRAW TEXT

Lava 10 has got the embedded character generator which contains ASCII chars 0-127. To execute this command, at least 4 bytes of data has to be written to module. 2nd byte contains the number of characters to be displayed (max. 10). In case of odd number of characters, data has to be aligned by writing one more byte (“don't care” value).

Each character has size 8x16 pixels. First letter will be drawn at the position indicated by configuration registers CSR_FONT_X and CSR_FONT_Y (position of top left corner of the first character). The color of characters is set in configuration register CSR_COLOR.

Command format

W	DRAW TEXT
W	TEXT LENGTH
W	CHAR 1 ASCII CODE
W	CHAR 2 ASCII CODE
W	CHAR 3 ASCII CODE
W	CHAR 4 ASCII CODE
W	CHAR 5 ASCII CODE
W	CHAR 6 ASCII CODE
W	CHAR 7 ASCII CODE
W	CHAR 8 ASCII CODE
W	CHAR 9 ASCII CODE
W	CHAR 10 ASCII CODE

5 Memory Map

5.1. Configuration registers

Name	Type	Address	Description
CSR_COLOR	R/W	0x000000	Character color (RGB565 value)
CSR_FONT_X	R/W	0x000001	X Position of the character (0-599)
CSR_FONT_Y	R/W	0x000002	Y Position of the character (0-799)
N/A	R/W	0x000003	Debug register (used by the producer)
BUFFER_REG	R/W	0x000004	Draw Buffer | Display Buffer
BUILD_VERSION	R	0x000005	Build version number
CONFIG_REG	W	0x000006	General purposes register

LAVA 10 is using 2 buffers to draw and display graphics. It can be used to avoid flickering, to keep two independent frames etc. Therefore there is a special register BUFFER_REG which points out which buffer should be currently displayed (bit 0)and which buffer should be used to draw (bit 8). The same buffer can be used to draw and display.

5.2. Buffer memory

LAVA 10 has got 32 MB of SDRAM on board; 2 buffers are using 1.920.000 bytes. To make drawing very simple, each pixel has the address based on the position on the screen and the buffer it belongs to. Bit 20 shows to which buffer pixel belongs; bits 19:10 contain position Y; bits 9:0 contain position X. So ie. writing value 0xFFFF to the address 0x000000 will draw white point in position Y=0,X=0 of buffer 0 and writing to 0x1000F0 will draw white point in position Y=0,X=240 of buffer 1.

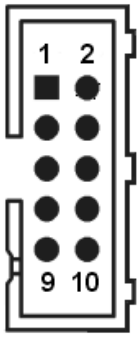
6 JTAG interface

LAVA 10 has got JTAG port on board which can be used to reprogram the module.

Note:

Please keep in mind that reprogramming PROM of the module will erase LAVA 10 functionality!

Pin	JTAG
1	Vcc
2	Gnd
3	TCK
4	TDO
5	TDI
6	TMS
7	-
8	-
9	-
10	-



7 Evaluation Board

To start designs with LAVA 10 we recommend the evaluation board (made by PROPOX Sp. z o.o. www.propox.com) which is specially prepared to work with LAVA 10 module. Features:

- socket for LAVA 10 module
- connector with all terminals of the module
- +5V i +3.3V voltage regulators
- power switch
- two RS232 ports with LED diodes
- socket for USB245 module
- socket for LAN module
- connector for 2x16 LCD display
- 6-digit LED display
- 8 LED diodes
- 8 push buttons
- DIP switch
- buzzer
- SD/MMC card connector
- two PS/2 connectors
- VGA output (9-bit output)