MT–12232A

LCD display module
graphic 122x32 dots

General description

MT-12232A LCD display module is composed of LSI controller and LCD panel.
The display module appearance is shown in Fig. 1.
KB145VG4 controller manufactured by ANGSTREM OJSC (www.angstrem.ru) is an analogue of SEIKO EPSON SED1520DOA.
MT-12232A LCD display module allows displaying 122x32 dots graphic field.
Each glowing dot on LCD has its corresponding «1» in a RAM cell of the display module.
Dimensions of the display module are shown in Fig. 5.

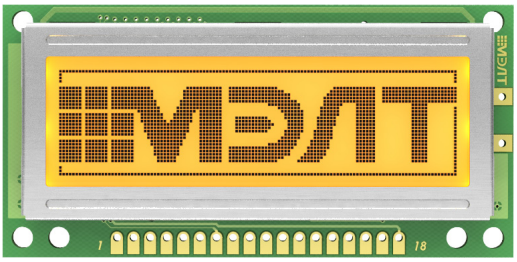

Fig. 1.

Caution! Exposure of the display module to the static electricity of over 30V must be avoided!

Display module features

- receives instructions from the data bus DB7-DB0 (instructions are listed in Table 3);
- read data from RAM to the bus DB7-DB0
- write data in RAM 8-bit data bus DB7-DB0;
- read the status of a condition on the bus DB7-DB0 (instructions are listed in Table 3);
- backlight and contrast adjustment.

Timing diagrams are shown in Fig.3.

Contrast adjustment

The display contrast depends on LCD panel supply voltage (U_{LCD}) and the temperature. Contrast adjustment is performed with the help of the external resistor (Fig. 2). When delivered, the display contrast is set to U_{CC}=5V, therefore at 5V supply voltage of the display module, 3(U_O) pin should be connected to 1 (GND) pin. Under the temperatures below 0°C contrast adjustment is required.

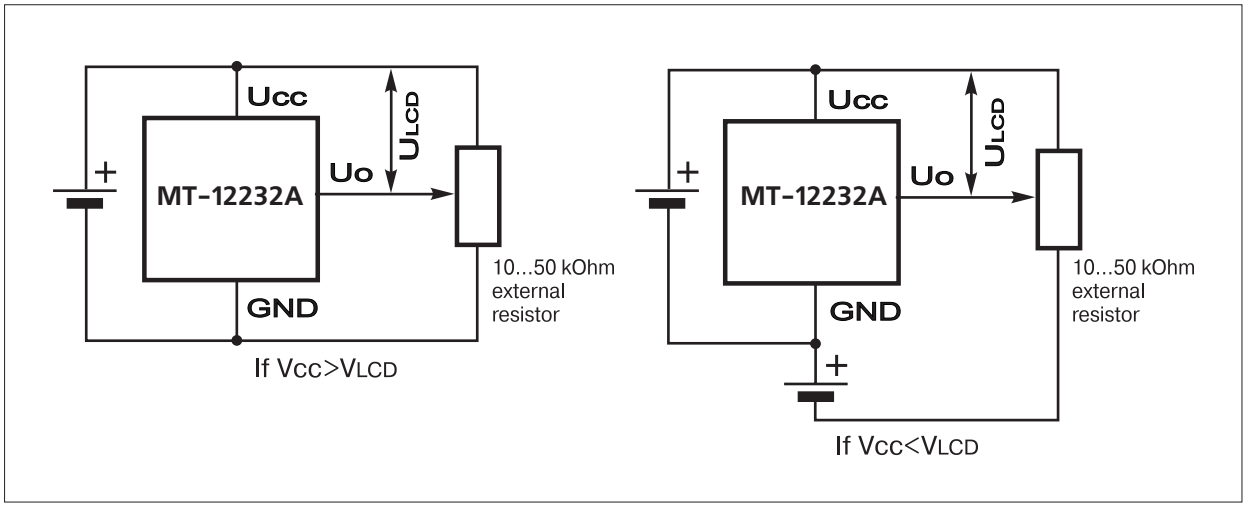

Fig. 2.

Table 1. Dynamic characteristics of the display module.

Item	Symbol	Min.	Max.	Units
Cycle time	t_{CYC}	2000	–	ns
Address set time	t_{AW}	100	–	ns
Address hold time	t_{AH}	20	–	ns
Data set time	t_{DS}	160	–	ns
Data hold time	t_{DH}	20	–	ns
Data delay time	t_{DOH}	20	120	ns
Access time	t_{ACC}	–	180	ns
Enable pulse duration (Read mode)	t_{EW}	300	–	ns
Enable pulse duration (Write mode)		250	–	ns

DC characteristics of the display module

Table 2. DC characteristics.

Item	Symbol	Min.	Typ.	Max.	Units
Supply voltage	U_{CC}	3,1/4,5	3,3/5,0	3,5/5,5	V
Consumption current	I_{CC}	–	1,5	–	μA
Input "High" Voltage	U_{IH}	0,8∗ U_{CC}	–	U_{CC}	V
Input "Low" Voltage	U_{IL}	0	–	0,2∗ U_{CC}	V
Supply voltage backlight at a current of 70 mA		–	4,0	4,2	V

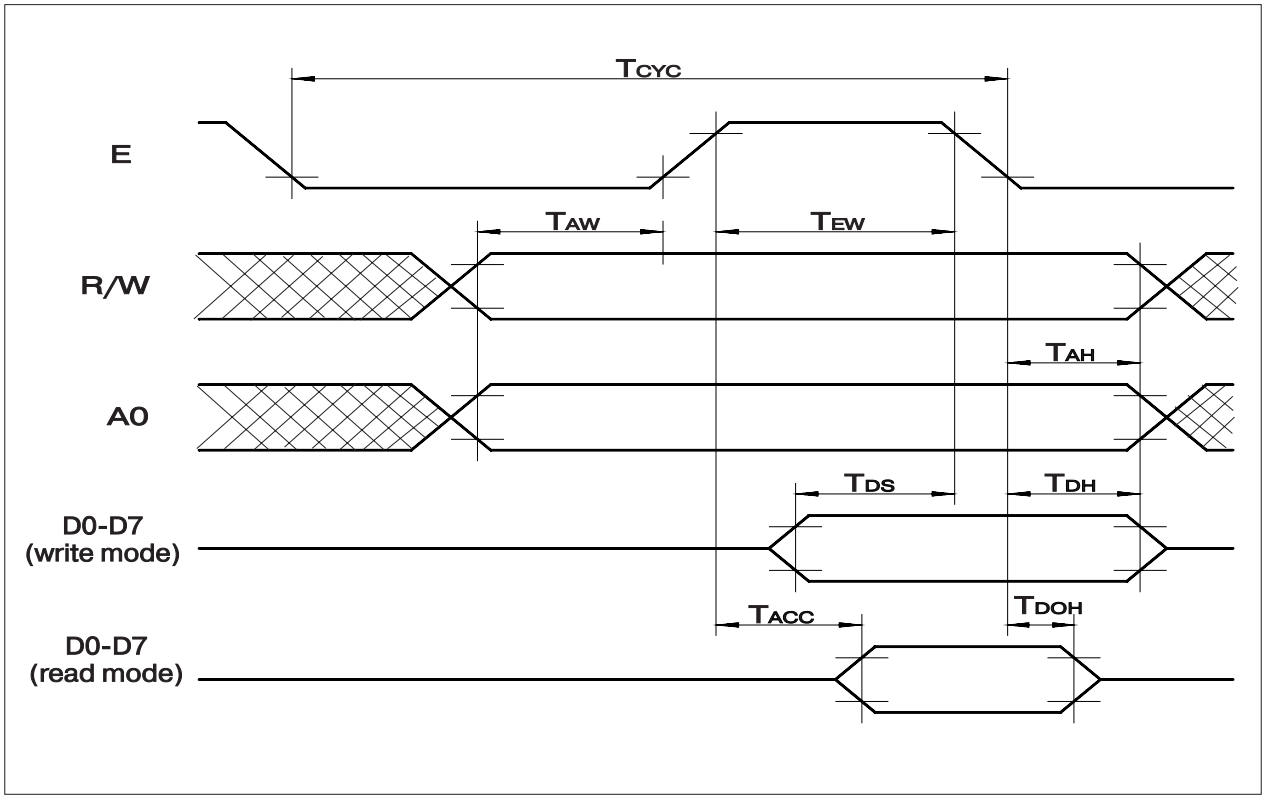

Fig. 3. Time diagrams exchange Protocol

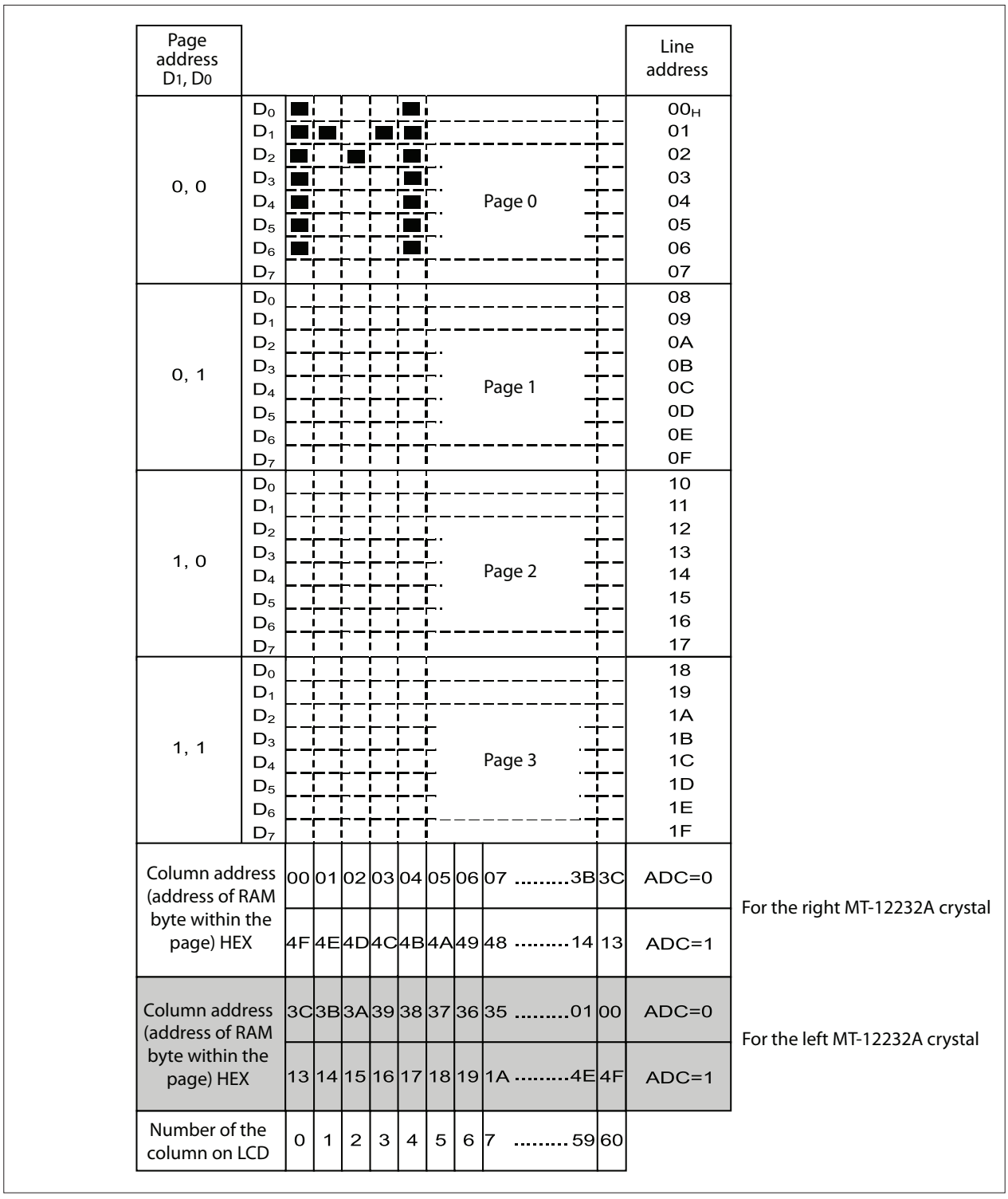

Fig. 4. Correlation between the module RAM addresses and the displayed dots on LCD

Description of instructions

Table 3.

Instruction	Command code										Function		
	A0	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0			
Display ON/OFF	0	0	1	0	1	0	1	1	1	0/1	Sets LCD on or off, irrespective of the data in display RAM or internal status		
											1	display on	
											0	display off	
Display START Line	0	0	1	1	0	Display START Line(0...31)					Specifies RAM line to be displayed in the top line of LCD (LCD start line)		
Set Page	0	0	1	0	1	1	1	0	Page (0...3)		Sets RAM page in the page address mode (page 0...3)		
Set Address	0	0	0	Column address (0...79)							Sets RAM column in the column address mode		
Status Read	1	0	BUSY	ADC	ON/OFF	RESET	0	0	0	0	Reads the display status byte		
											BUSY	1	The display module is busy with internal processing
												0	The display module is ready to work with external MP
											ADC	1	Direct data output
												0	Inverse data output
											ON/OFF	1	LCD if off
												0	LCD is on
											RESET	1	Reset status
												0	Normal status
Write Display Data	0	1	Write Data								Write data to the display module RAM		These instructions select RAM at the preset address, whereupon the column address is incremented
Read Display Data	1	0	Read Data								Read data from the display module RAM		
ADC Select	0	0	1	0	1	0	0	0	0	0/1	Used to inverse the correlation between the column address and the position on the display module		
											0	Direct correlation	
											1	Inverse correlation	
Static Drive ON/OFF	0	0	1	0	1	0	0	1	0	0/1	Static/normal control mode select		
											1	Static control (low consumption)	
											0	Normal control	
Duty Select	0	0	1	0	1	0	1	0	0	0/1	Multiplex select		
											1	For MT-12232A LCD display module	
Read Modify Write	0	0	1	1	1	0	0	0	0	0	On this instruction, RMW flag is set. Then the column count address is incremented during data write to RAM (not incriminated during data read)		
END	0	0	1	1	1	0	1	1	1	0	RMW flag removal		
RESET	0	0	1	1	1	0	0	0	1	0	Display Start Line is reset to 0, page address is set to =0, RAM contents remain unchanged.		

Initial setup

Below are the steps to be taken to perform initial setup of the display module:

1. after voltage supply hold RES pin in logic '0' status for at least next 10 μs;
2. supply differential from logic '0' to logic '1' onto RES pin, front duration – 10μs max;
3. wait for 'RESET' bit reset in the status byte or wait for at least 2 ms;
4. issue the 'RMW (END)' instruction (flag removal instruction);
5. issue normal operation mode enable instruction (Static Drive ON/OFF);
6. issue multiplex select instruction (Duty Select);
7. issue display on instruction (Display ON/OFF).

RAM allocation

The display module includes RAM for storing the data displayed on LCD (80x32 bit). RAM is divided into 4 pages, 80x8 bits each. Each RAM page is arranged in 80x8 bit structure. Each glowing dot on LCD has its corresponding logic '1' in a RAM cell of the display module. The correlation between the display module RAM cells and the dots displayed on LCD is shown in Fig. 4. Only 61 of 80 bytes from each page are displayed on LCD. Two pages are displayed simultaneously: top 8 dots arranged vertically correspond to the 0 page, while bottom 8 dots – to the 1st page (where 0 start line was selected at the initial setup). This can be changed using the 'Display START Line' instruction.

Display modes

The display module offers two modes of displaying the information from internal RAM: direct and inverse. The difference lies in the location of the first displayed byte on LCD and in the address increment direction in internal RAM during the shift of the displayed position on LCD. In the direct display mode, the address in the internal RAM is incremented during the move of the displayed position to the right on LCD. In the inverse mode the address is decremented. The operation mode is selected using the 'ADC Select' instruction.

Data reading and writing

Reading (writing) of information from (to) the display module is performed on a per-page basis (80x8 bits or 80x1 byte). Each page represents 80 bytes. Pages do not intersect. 80 to 127 addresses are not used, data cannot be written in there, and during reading any information can appear on the data bus at those addresses.

To read or write a data byte at an arbitrary address, RAM page needs to be preset and a column inside the RAM page needs to be selected. This is done using the 'Set Page' and 'Set Address' instructions correspondingly. After that a data byte can be read or written. The 'Set Page' instruction alone is not enough, since it doesn't change the column address. To simplify programs, the display module also supports a continuous sequence of read or write operations (as well as a combination thereof, see below): after reading (writing) of the byte the column count increments automatically by 1, and the display module is ready to the new read (write) operation at the next address without the need for presetting the RAM page and column address. The column count counts only within one page! Upon achieving address 79, the next count value will be 80 and so on, i.e. neither switch to the next page, nor count reset to 0 takes place.

Accordingly, after read (write) of the last data byte at address 79 the display will stop receiving (sending) information.

In the data read mode, after the 'Set Page' and 'Set Address' instructions, a single 'no-op' read operation should be executed. The result of that operation cannot be used.

The display module supports a special mode that involves the column address count increment only during data writing. This mode is convenient to use when information in the display module RAM needs to be modified: you can read the data first, modify it, and write to the display at the same address (without the need to reset the column address for the write operation). After the write operation, switchover to the next data byte will be executed. The 'Read Modify Write' instruction is used to turn this mode on, while the 'END' instruction is used to turn it off.

Vertical displacement of displayed information

The display module supports the 'Display START Line' instruction that sets the number of the topmost displayed line. This enables smooth vertical information shift on LCD through modifying the number of the first displayed line. The number can be within the range of 0 to 31, which corresponds to the interval from the first line of RAM 0 page to the last line of RAM 3rd page. After display of the last line (31), the 0 line will be displayed once again.

Table 4. Pinout.

Pin	Symbol	Pin assignment
1	DB4	Data bus
2	DB5	Data bus
3	DB6	Data bus
4	DB7	Data bus
5	A0	Choice of register data / commands
6	RD/RW	Read / Write
7	E	Strobe read / write permissions
8	DB3	Data bus
9	DB2	Data bus
10	DB1	Data bus
11	DB0	Data bus
12	GND	Common pin (CP)
13	NC	not used
14	Ucc	Power controller
15	+LED	+ of the backlight power supply
16	–LED	– of the backlight power supply
17	RES	Initialization
18	CS	Crystal select

LCD display module dimensions

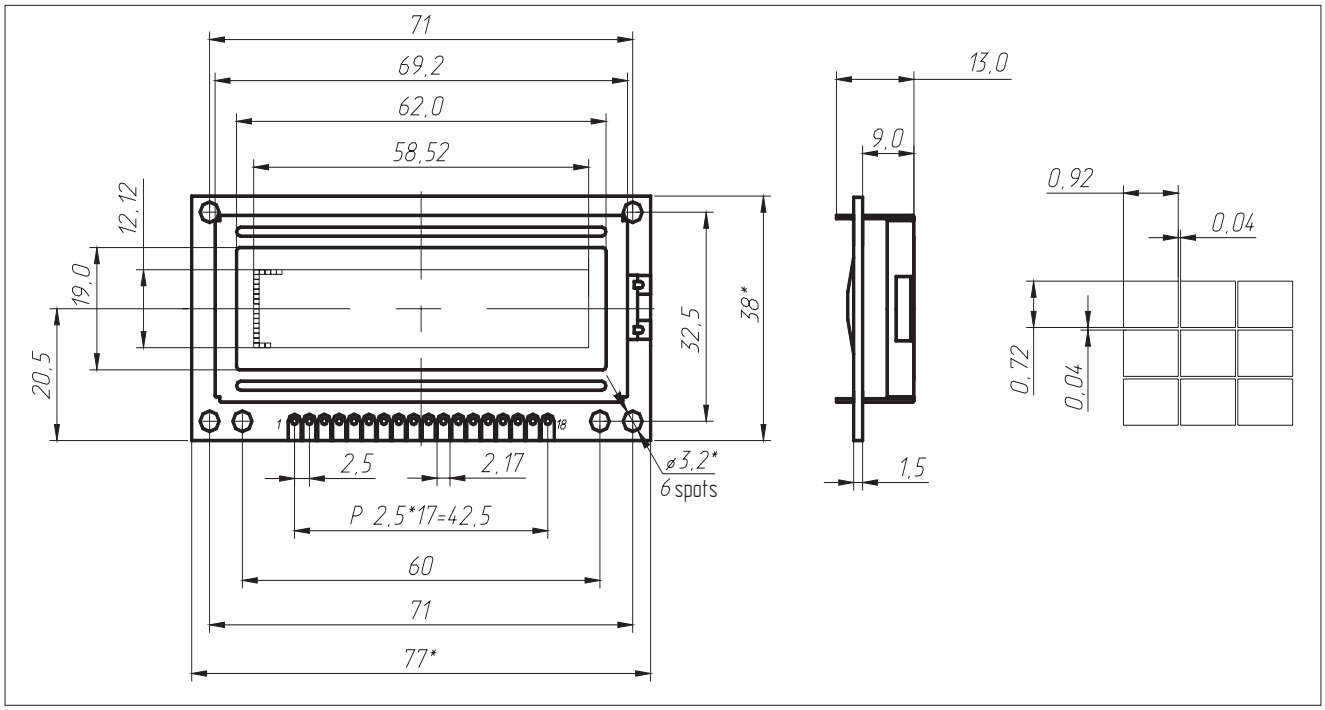

Fig. 5.

Revision history

Document version	Date	Alterations	Page
1.0	09/07/2013	Revision 1	

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Passed for printing on July 09, 2013. A4 format.
Printed in Russia.