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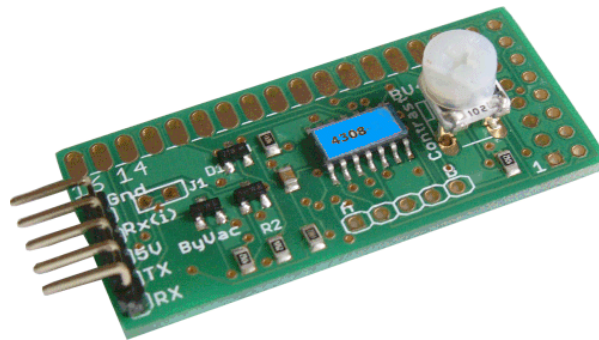
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# VT100 Display Controller

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# BV4308



## **BV4308**

### **VT100 display controller**

Product specification

June 2011 V1.0

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Rev	Change
June 2010	Preliminary
June 2010	V1.2 added macro command
July 2010	Added command to turn off scroll, fixed esc[x;1H did not ACK
Feb 2011	V1.5, factory reset added
July 2011	V2 – Updated some VT100 commands and this version can be set by the user for the display size

## 1. Introduction

This controller is designed for controlling LCD displays that use the standard HD44780 controller or one of its many equivalents. This is an updated version of the BV4308 display and can now handle any (within reason) display configurations; e.g. 16x2, 20x4.

**NOTE:** The newer (this) version has a blue label with BV4308. The older versions have a pink/orange label with either BV4308-2 or BV4308-4

There are two versions of this display controller. A Bluetooth version and a standard serial version. The standard serial version is BV4308 and the Bluetooth version is BV4338

## 2. Features

- Subset of the standard VT100 commands
- Automatic Baud rate detection up to 38.4K from a select set of Baud rates.
- Can connect directly to a PC COM Port
- Buffered input
- Contrast trimmer
- Back light fed by 20mA o/p port
- Fully scrolling
- Can connect directly to COM port
- Current: 6mA @ 5V
- Size: 48 x 22mm

## 3. Physical Specification



Figure 1

The device has three connection interfaces, one is for the serial interface and the other for the LCD. The LCD interface has two options one for connection to an LCD that has the connections down the side and the other for the type that has the connections along the top.

On the side connector pin 1 is the square pad.

### 3.1. Serial Interface (VT100-a)

This product is fitted with a VT100-a serial interface. See Appendix A for the different types of interface on offer.

There is a 5 way connector to the left hand side. Normally only three or four pins are connected at any one time and this will depend on whether a microcontroller or an RS232 interface is being used.

Pin	Serial interface
1	RX
2	TX
3	+5V
4	RX-RS232
5	Ground

#### 3.1.1.RX & RX-232

This is the input, use pin 4 if connecting to a PC COM port, a typical connection schematic is shown below. If using a microcontroller then connect its TX pin to the RX pin 1.

The main reason for having 2 receive connections apart from the higher voltages used on a COM port is that a PC COM port sends data inverted and so pin 4 will correct the signals before passing them to the controller.

Pin 1 is used to connect a microcontroller that should present 0 to 5V for the signal levels. The format is 1 start bit, 8 data bits, 1 or 2 stop bits and no parity.

#### 3.1.2.TX (pin 2)

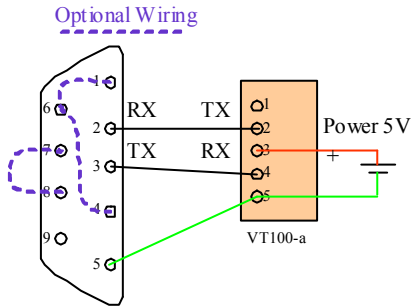
The device will output information and it is up to the user to use this line if required, it is entirely optional, the display can be made to function perfectly well without it. Its main purpose is for the ACK handshaking mechanism, see the section under ACK.

#### 3.1.3.Wiring

Below are two examples of how the interface should be wired

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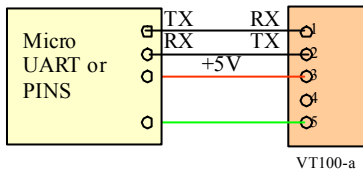
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**Figure 1 Example wiring for RS232**

The dashed wiring is optional and will be required if the software used by the PC, uses hardware handshaking, this will 'fool' the software that handshaking is happening.

A USB-RS232 converter can be used if required, e.g. 'Prolific'.



**Figure 3 Example wiring to Microcontroller**

Note how the microcontroller will send data to pin 1 whereas the RS232 will send data to pin4. A converter such as the BV101 can be used instead of the microcontroller.

### 3.1.4. Handshaking

This is a simple device and no hardware handshaking is provided in the form of RTS/CTS and so this should be switched off on the host. There is however the ACK method of handshaking that can be optionally used. See the section under ACK.

### 3.2. LCD Interface

The LCD connector has the following pin designations.

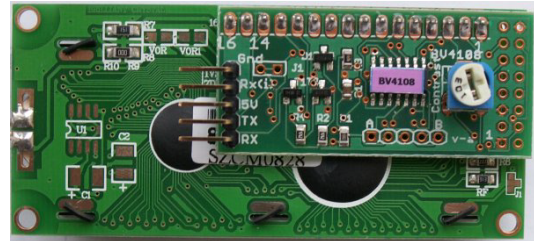
Pin	LCD Connection
1	Ground
2	LCD power
3	VL (contrast)
4	RS
5	RW (ground)
6	E
7	No connection
8	No connection
9	No connection

10	No connection
11	D4
12	D5
13	D6
14	D7

**Table 1 LCD Connector**

The table shows the 10 connections that should be made to the LCD, observe that pins 7 to 10 are not connected to anything, optionally these can be left unconnected.

Most LCD displays have the same connecting pins and the BV4308 is designed to be mounted on the underside of an LCD with the components upwards.



**Figure 2 Mounting the BV4308**

As can be seen from Figure 2 the board mounts directly on to this 16x2 LCD display.

13	24
11	12
9	10
7	8
5	6
3	4
1	2

Pin numbering for the side connector, pin 1 has a square PCB pad.

### 3.2.1. Display size

The factory settings for the controller are for a 16x2 display, this however can be changed by using the VT100 commands below.

### 3.2.2. Back Light

The back light is supplied by pins 15 and 16 of the LCD interface connector. Pin 16 is connected to ground and pin 15 can source or sink up to 20mA.

### 3.3. Serial Communication

This is a very simple device, any data sent to the device on pins 1 or 4 will appear on the display.

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### 3.4. Baud Rate

The Baud rate is established on the first CR (byte value 0x0d) sent to the device. The device will select the nearest Baud rate from this list:

2400, 9600, 14400, 19200, 38400

It follows therefore that the first thing that should be sent to the display is CR otherwise the Baud rate for subsequent data cannot be established properly.

There is a command to fix this baud rate if required and so relieving the necessity for this first CR which may be desirable in some systems.

### 3.5. Buffer

There is an 80 byte buffer that will accept commands and data whilst the display is working. There is no indication that the display is full so care must be taken when sending large quantities of data to the display. It is recommended that the ACK mechanism be used or a suitable delay introduced.

## 4. ACK & Output

Most of the time there will be no need to connect the output pin (2) to the host as this is a mainly read device. When using RS232 and a microcontroller the output requirements are slightly different.

The RS232 signal is inverted and so there is a command that can invert the output signal. The ACK has been chosen carefully at '\*' if this is inverted it shows up as '5' but with the high bits set which will be ignored by most terminals.

There is no hardware handshaking available, this makes interfacing very simple as the device will 'always' work, however commands given to the display vary in time they take to carry out. The buffer will help with this and more than one command can be sent at a time.

Referring to the command table the ACK column will indicate when commands will return an ACK. The ACK is simply a character that is sent to the TX pin when a command has completed. The host software can wait for this character before sending the next command. In this way the buffer will never become full and will ensure reliable operation.

## 5. Commands

Sending data to the display will result in that data being displayed on the screen. There are times however when the display needs to behave in a certain way, for example clearing the screen or moving the cursor to a specified position. This is what the commands are for.

A command always starts with an escape character (byte value 27 or 0x1b). The

command will be acted upon as soon as the last byte of the command has been received. As an example, to clear the screen is esc[2J. In byte form this is:

0x1b 0x5b 0x32 0x4a

This can of course be types in at a terminal or sent as part of a program. It is based on the DEC VT100 commands that were used in the old terminals but lends itself very well here.

## 6. Factory Reset

Added to version 1.5 and above. It is possible to remove the macro and reset the device back to automatic baud rate by carrying out the following procedure.

- 1) Remove the power
- 2) Using a short bit of wire connect pads 1 and 5 together on the row of 5 holes. Pins 1 and 5 are marked with A and B
- 3) Connect the power
- 4) Remove the power
- 5) Remove the shorting link.

After the 'Press CR' message the screen will go blank ready for your own macro.

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## 7. Appendix A Interface Differences

The following highlights the differences between the various interface options for ByVac Products. The 'interface' describes both the physical and logical aspects. The physical is what it can be connected to and the logical is how it works when connected.

All serial interfaces with the exception of I2C use 1 start bit, 8 data bits and 1 or 2 stop bits.

Feature	Interface Name				
	ASI-V2	VT100-a	VT100	DUAL	I2C
Connect to RS232[2]	Y	Y			
Connect to Microcontroller	Y	Y	Y	Y	Y
I2C				Y	Y
VT100		Y	Y	Y	
ASI Commands	Y				
Multiple devices on same bus[1]	Y		Y	Y	Y
Device addressing	Y				Y
Device select by line			Y	Y	
Auto Baud detect	Y	Y	Y	Y	
Device discovery[1]	Y				

### NOTES

[1] See the section under ASI-V2

[2] These can be connected to + and -12V signals

### 7.1. ASI-V2

This interface is addressable and so many devices can be connected to the same serial bus without any additional wires. All data sent to the device is in the form of a command. To turn on the back light of a display for example would require 'ab1<CR>' where 'a' is the device address, 'b' is the command for back light and '1' is for on. If two or more devices were on the same bus then the second device could be addressed by 'b'. In addition to this there are commands that reveal what addressed devices are connected to the bus.

#### Advantages

The main advantage for this interface is that more than one device can be used on the same bus.

#### Disadvantages

More complex to use and the commands are limited to the basics required for the device, no built in scrolling.

### 7.2. VT100-a

This has the same electrical interface as the ASI-V2 devices, however the command set is based on VT100. This makes the device much easier to use, on a display any data sent to the interface will be reflected on the display.

#### Advantages

Much easier to use, if the device is a display it will wrap at the end of a line and scroll when reaching the bottom of the display.

#### Disadvantages

Only one device can be on the bus at a time.

### 7.3. VT100

This interface is normally part of a dual interface but not always. It will not accept RS232 voltage levels but multiple devices can exist on the same bus by the use of a device deselect line. This line when active will disable the device allowing two or more devices to be used on the same bus.

#### Advantages

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Comprehensive VT100 command set which is generally easy to use, all data sent goes to the device and commands are initiated by escape codes.

**Disadvantages**

If using multiple devices then each device requires a deselect input

**7.4. Dual**

Dual is simply a combination of VT100 and I2C on the same device. The user chooses which interface at start up. I2C is chosen by holding the SDA line high at reset. This of course is done automatically if an I2C bus is connected because of the pull up resistors required on the I2C bus. VT100 is selected by not connected the I2C bus.

**7.5. I2C**

I2C is a short range bus with a special protocol allowing transmit and receive using a master / slave protocol. All devices will be slave and the address can be changed by the user.

**Advantages**

Well known interface allowing multiple devices on the same bus. No need for a UART in the master.

**Disadvantages**

The host needs to have a master I2C interface that may not always be available.

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**8. Appendix B Trouble Shooting**

The following is the most common cause of problems:

1. Assuming that the connections have been checked make sure that the host is set to one of the following Baud rates: 2400, 9600, 14400, 19200, 38400
2. After switch on the first byte to send is Carriage Return (13 or 0xd), in C this is usually puts("\r") or putc(13)
3. Put is delays after each command especially the clear screen command and then remove one by one checking the results each time. Most of the time delays will not be needed. After this consider using the ACK mechanism instead of delays.
4. The commands work as soon as the last letter of the command is received so do not follow them with CR otherwise the display will also CR, for example to place Fred on line 1 column 3 the following will do <esc>[1;3HFred.



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## 8.1. Command Table

In the table columns indicate:

**S** is the VT100 standard, **Y** is standard, **P** is partially standard, **N** is non-standard

**Code** is the escape sequence to invoke the command

**DEF** column shows the default values from the factory

**ACK** column indicates that this command is capable of sending an ACK character when it has finished.

S	Code	DEF	ACK	Name	Description
<b>Cursor Movement</b>					
N	0x02		Y	Alive	This is mainly for the Bluetooth device; when sending a byte of value 2 (control B if using a terminal) the device will simply respond with ACK, the display and its contents will not be effected. This is useful for seeing if the display and the connections are still there and responding.
Y	0x0a			Line Feed	When this is sent to the display the cursor will move down one line, if the cursor was at the bottom of the screen, the text above will scroll to accommodate the new line.
Y	0x0d			Carriage Return	Moves the cursor to the beginning of the line, see system commands as line feed may also be automatically added
Y	0x08			Back space	Deletes the previous character and positions the cursor for a new character.
P	esc[A		Y	Move up	Moves the cursor up one line, if the cursor is already at the top line then the command is ignored.
P	esc[B		Y	Move down	Moves the cursor down, if the cursor is already at the bottom line it will move down further and the text above will scroll.
P	esc[C		Y	Move right	Moves the cursor to the right, if the cursor is at the end of the line it will move to the start of the next line, if the cursor is at the end of the last line the display will scroll.
p	esc[D		Y	Move left	Moves the cursor to the left, if the cursor is already at the beginning of the line the command will be ignored.
Y	escH		Y	Home	Send cursor to home position
Y	esc[<row>;<col>H		Y	Move to position	Moves the cursor to a specified position given by <row> (line number) and <col> (character position). The rows and columns start at 1 and so: esc[1;1H Will set the cursor to the home position. If the numbers used exceed the display size then scrolling

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					will take place.
<b>Screen Clearing</b>					
Y	esc[K		Y	Erase to end of line	Erases from current cursor position to the end of the current line, the cursor stays where it is.
Y	esc[1K		Y	Erase to beginning of line	Erases from current cursor position to the beginning of the line, the cursor stays where it is.
Y	esc[2K		Y	Erase line	The current line is erase and the cursor is positioned at the beginning of the line
Y	esc[2J		Y	Clear and home	Clears screen and homes cursor
<b>Display Attributes</b>					
N	esc[0m		Y	Back light off	Turns the back light off
N	esc[1m	Y	Y	Back Light on	Turns the back light on
N	esc[2m		Y	Cursor off	
N	esc[3m	Y	Y	Cursor on	Normal steady cursor displayed as a short line under the text
N	esc[4m		Y	Cursor on blink	Turns on the full character blinking cursor
N	esc[5m	Y	Y	Vertical scroll on	When the cursor reaches the end of the display, the text moves up and a new line is started at the bottom of the display
N	esc[6m		Y	Vertical scroll off	When the cursor reaches the bottom of the display, it is returned to the top of the display, no scrolling takes place.
N	esc[<n>L		Y	Sets number of lines	The display factory defaults to a 2 line display, use this command to change the number of lines. The change is temporary until reset but can be made more permanent by writing the values to EEPROM using the esc[4c command. The minimum and maximum number of lines is 1,4 respectively. There are no checks so a stupid value will get stupid results. The normal setting for this value would be either 2 or 4
N	esc[<n>C		Y	Sets number of characters per line	Sets the number of characters per line, this is set at the factory to be 16 but can be any number, normally 16 or 20, the minimum value is 1 and the maximum is 80. There are no checks so it is up to you to put a correct value in. The change is only temporary but can be written to the EEPROM using the esc[4c command.
<b>System Commands</b>					
Y	<esc>c			Reset	This command will reset the device, a delay is required following this command to give the device

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					time to establish.
N	esc[0c			Turns ACK off	Turns off the ACK output
N	esc[1c	Y		Turns on ACK	Turns on the ACK output
N	esc<num>a	Y	Y	Sets ACK	Sets the ACK character, the default is 0x2a but this can be set to any value between 0 and 255 using this command. The returned ack value is immediate
N	esc[2c	Y		Add line feed	When this is activated and when a CR (0x0d) is received a line feed (LF) is added to the output.
N	esc[3c			Don't add LF	Turns off the addition of LF when a CR is received.
N	esc[4c	Y	Y	Fixes Baud rate ** Writes to EEPROM	This command will write three values to the EEPROM:  <ol style="list-style-type: none"> <li>1) The Baud rate will be fixed when next the device is reset. It is fixed to the current Baud rate and so will not require a CR on start up to establish the baud Rate.</li> <li>2) The number of lines for the display set by command esc[&lt;n&gt;L will be written and thus will be the same after reset.</li> <li>3) The number of characters for the display as set by command esc[&lt;n&gt;C.</li> </ol>
N	esc[5c	Y	Y	Auto Baud	The device will require a CR to establish the Baud rate each time it is reset.
N	esc[6c			Invert o/p	The output from pin 2 of the VT100-a interface is inverted, this will match an RS232 com port.
N	esc[7c	Y		Normal o/p	The output from pin 2 of the VT100-a interface is not inverted, this has the same polarity as pin 1 and should be used when a microcontroller is connected.
N	esc[8c		Y	Record macro	The default sign on screen is a macro with the following data: esc[1;2HBV4308-n Vn.n  Where 'n' varies depending on the display. This is stored in EEPROM and can be up to MAX characters in length, where MAX is the number of characters in the display, for example 80 on a 4x20 display.  A macro can contain commands and text and will be displayed at start up. As an example the following macro data will clear the screen and display hello on line 2: <esc>[2J<esc>[2;1HHello  To record it start with esc[8c and terminate with <esc><esc> as follows <esc>[8c<esc>[2J<esc>[2;1HHello<esc><esc>

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					<p>NOTES:</p> <ol style="list-style-type: none"> <li>1. If autobaud is on then this will effect the outcome.</li> <li>2. All keystrokes are recorded so mistakes will also be recorded, you cant use back space.</li> <li>3. The result can be tested with &lt;esc&gt;c</li> <li>4. Once used the message cannot be returned to the original unless this command is used to do it.</li> </ol>
N	esc[9c		Y	Version	Returns the firmware version, output to the serial port
M	esc[10c		Y	Version	Returns version output to the display at the current cursor position
N	esc[11c	*	Y	Echo on	Echoes everything that is sent to the display, this can be used for verification on remote displays. The default for this is ON for the Bluetooth device and OFF for the serial device.
N	esc[12c		Y	Echo off	Turns the echo off

**Notes**