

Serial LCD Controller

DIY Electronics K192

User Guide

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1 Introduction.

This serial display module provides easy operation of a standard character LCD display. The simple command structure allows text and bar graphs to be displayed on the LCD. Provision is made for up to 8 user-defined characters. The module also includes four digital outputs.

The LDC backlight and contrast may be adjusted under program control to compensate for differing lighting conditions and viewing angles.

The module supports 2 interfaces:

- Serial RS232 interface
- Serial TTL interface

The module has the following features:

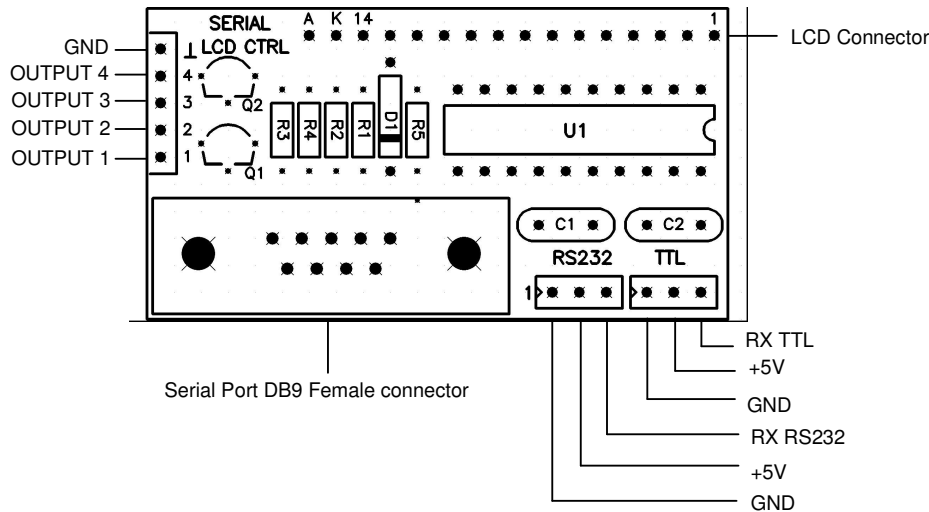
- Communicates over serial interface with software controlled speed
- 32 Byte buffer for messages received via communication interface
- Up to 8 custom characters can be defined
- Built in commands for drawing bar graphs
- LCD Backlighting controlled via software, has 254 brightness levels
- LCD Contrast controlled via software, has 254 contrast levels
- 4 digital outputs
- Save the basic settings in module internal EEPROM

NOTE:

The supplied LCD does not have backlighting. User must supply a backlit LCD if this feature is required.

2 Module connection.

The module has 5 connectors: LCD, Serial Port DB9 connector, Serial RS232 interface connector, Serial TTL interface connector and Digital output connector.



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2.1 Serial RS232 interface connector.

Table 2.1 shows the connector pin assignments.

Table 2.1

Pin No.	Pin Name	Description
1	GND	Ground connection
2	VDD	Supply voltage (+5V)
3	RX RS232	RX signal (RS232 level)

2.2 Serial TTL interface connector.

Table 2.2 shows the connector pin assignments.

Table 2.2

Pin No.	Pin Name	Description
1	GND	Ground connection
2	VDD	Supply voltage (+5V)
3	RX TTL	RX signal (TTL level)

2.3 Digital output connector.

Table 2.3 shows the connector pin assignments.

Table 2.3

Pin No.	Pin Name	Description
1	1	Digital output 1
2	2	Digital output 2
3	3	Digital output 3
4	4	Digital output 4
5	GND	Ground connection

2.4 Communication interface.

The device supports 2 interfaces:

- Serial RS232 interface
- Serial TTL interface

Serial Interface

Baud Rates 2400, 4800, 9600 and 19200 bits per second (default 9600).

8 Bits per character

No Parity

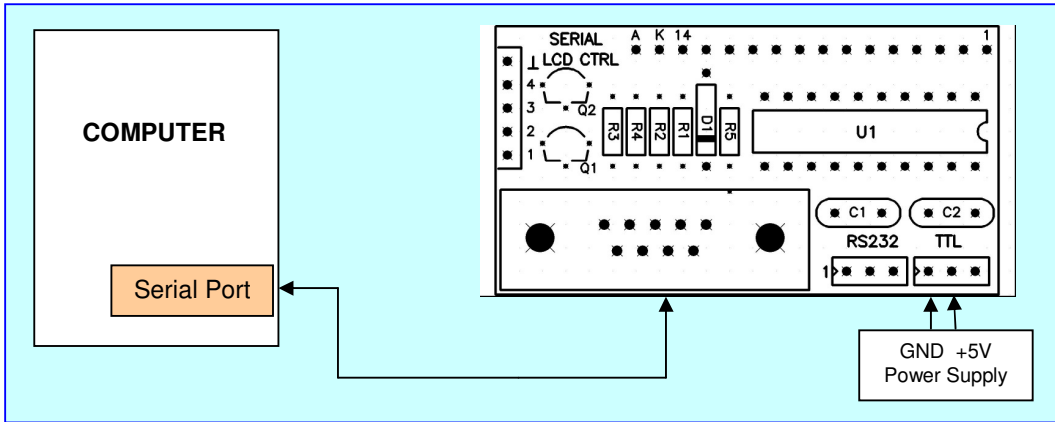
1 Stop Bit

No Flow Control (Handshaking)

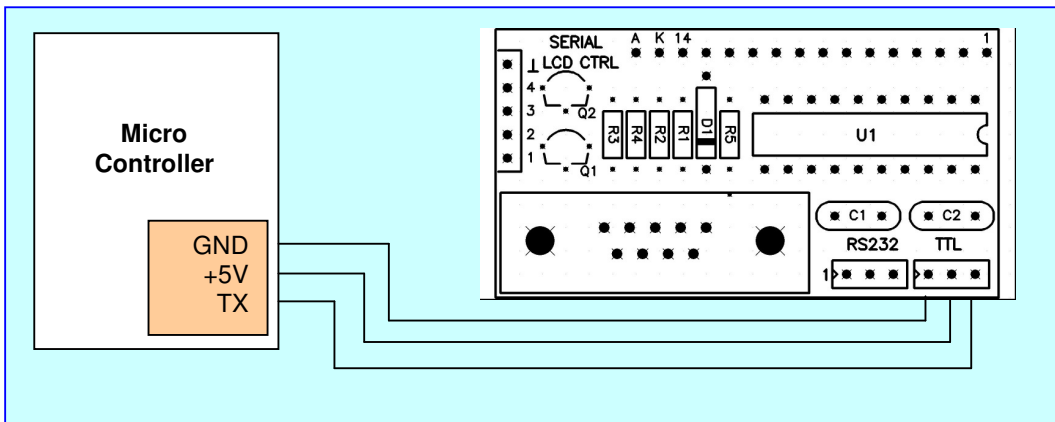
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2.5 Module connection example.

Module connecting to computer serial port.



Module connecting to Serial TTL interface.



3 Commands.

The module is controlled using ASCII characters. The character 254 (0xFE) is a command prefix. Any data sent to the LCD that is not prefixed by the command prefix (0xFE) will be displayed on the LCD.

LCD includes a built-in 5 x 7 dot matrix font with the full range of ASCII characters plus a variety of extended characters, as shown in Figure 3-1.

Lower 4 Bits \ Upper 4 Bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	@	P	`	P				-	夕	ミ	α	P	
xxxx0001	(2)		!	1	A	Q	a	q			。	ア	チ	△	△	q
xxxx0010	(3)		"	2	B	R	b	r			「	イ	ツ	×	β	θ
xxxx0011	(4)		#	3	C	S	c	s			」	ウ	テ	モ	ε	∞
xxxx0100	(5)		\$	4	D	T	d	t			、	エ	ト	ト	μ	Ω
xxxx0101	(6)		%	5	E	U	e	u			・	オ	ナ	1	ε	ü
xxxx0110	(7)		&	6	F	V	f	v			ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)		'	7	G	W	g	w			ア	キ	ヌ	ラ	g	π
xxxx1000	(1)		<	8	H	X	h	x			イ	ク	ネ	リ	√	∞
xxxx1001	(2)		>	9	I	Y	i	y			ウ	ケ	ル	ル	'	γ
xxxx1010	(3)		*	:	J	Z	j	z			エ	コ	ン	レ	j	≠
xxxx1011	(4)		+	;	K	[	k	[			オ	サ	ヒ	ロ	*	≠
xxxx1100	(5)		,	<	L	¥	l	l			カ	シ	フ	ワ	φ	∞
xxxx1101	(6)		-	=	M	]	m	]			ユ	ヌ	ハ	ン	も	÷
xxxx1110	(7)		.	>	N	^	n	^			ヨ	セ	ホ	ッ	ñ	
xxxx1111	(8)		/	?	O	_	o	_			ッ	ソ	マ	マ	ö	■

To display normal text, just enter its ASCII number.

A number from 0x00 to 0x07 displays the user defined custom character, 0x20 to 0x7F displays the standard set of ASCII characters. Numbers from 0xA0 to 0xFD display the characters and symbols that are factory-masked on the LCD controller and 0xFE is reserved for function command.

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Command Summary

Prefix	Command	Parameter	Description
0xFE	0x02	1 byte	Changing BAUD Rate
0xFE	0x03	1 byte	Set Backlight Brightness
0xFE	0x04	1 byte	Set Contrast
0xFE	0x06	None	Display Firmware Version Number
0xFE	0x07	None	Display Serial Baud Rate
0xFE	0x0A	None	Turn On Display
0xFE	0x0B	None	Turn Off Display
0xFE	0x0C	2 bytes	Set Cursor Position
0xFE	0x0D	None	Home Cursor
0xFE	0x0E	None	Turn On Underline Cursor
0xFE	0x0F	None	Turn Off Underline Cursor
0xFE	0x10	None	Move Cursor Left One Space
0xFE	0x11	None	Move Cursor Right One Space
0xFE	0x12	None	Turn On Blinking Cursor
0xFE	0x13	None	Turn Off Blinking Cursor
0xFE	0x14	None	Clear Screen
0xFE	0x15	Variable	Print String
0xFE	0x16	1 byte	Init Horizontal Bar Graph
0xFE	0x17	4 bytes	Draw Horizontal Bar Graph
0xFE	0x18	None	Init Vertical Bar Graph
0xFE	0x19	4 bytes	Draw Vertical Bar Graph
0xFE	0x1A	9 bytes	Load Custom Characters
0xFE	0x1E	1 byte	Write to Digital Outputs

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3.1 Configuration Commands.

All settings are stored in internal module EEPROM and loaded during power up.

Changing BAUD Rate

Syntax hexadecimal 0xFE 0x02 [baud]

Parameter	Length	Description
[baud]	1 byte	New Serial communication rate (1 – 4)

Description: This command sets the serial communication rate, the single byte parameter select the desired BAUD rate as in the table below.

Default: 9600

The rate change requires 50 ms to take effect; therefore subsequent input must have an appropriate delay.

Parameter	BAUD
1	2400
2	4800
3	9600
4	19200

Set Backlight Brightness

Syntax hexadecimal 0xFE 0x03 [brightness]

Parameter	Length	Description
[brightness]	1 byte	Set backlight brightness (0 – 250)

Description: This command sets the backlight value, the single byte parameter select the desired brightness. The module modulates the backlight via a transistor. This allows to set different brightness settings.

Default: 60

The command requires 50 ms to take effect; therefore subsequent input must have an appropriate delay.

NOTE: Supplied LCD does not have backlighting.

Set Contrast

Syntax hexadecimal 0xFE 0x04 [contrast]

Parameter	Length	Description
[contrast]	1 byte	Set LCD contrast (0 – 100)

Description: This command sets the LCD contrast value, the single byte parameter select the desired contrast. The module set the contrast voltage.

Default: 20

The command requires 50 ms to take effect; therefore subsequent input must have an appropriate delay.

Display Firmware Version Number

Syntax hexadecimal 0xFE 0x06

Parameter	Length	Description
None	None	Display the firmware version number

Description: This command displays the firmware version number.

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Display Serial Baud Rate

Syntax hexadecimal 0xFE 0x07

Parameter	Length	Description
None	None	Display the baud rate

Description: This command displays the current baud rate.

Default: None.

3.2 LCD Display Commands.

Turn On Display

Syntax hexadecimal 0xFE 0x0A

Parameter	Length	Description
None	None	Turn on LCD screen

Description: This command turns on the LCD display screen.

Default: LCD screen is on

Turn Off Display

Syntax hexadecimal 0xFE 0x0B

Parameter	Length	Description
None	None	Turn off LCD screen

Description: This command turns off the LCD display screen.

Default: LCD screen is on

Set Cursor Position

Syntax hexadecimal 0xFE 0x0C [cool] [row]

Parameter	Length	Description
[row] [cool]	2 bytes	Put cursor at location specified row and cool

Description: This command moves the cursor to the specified location where the next character will be displayed. Row value = 0 to 3, column value = 0 to 19.

The command requires 2 ms to take effect; therefore subsequent input must have an appropriate delay.

Home Cursor

Syntax hexadecimal 0xFE 0x0D

Parameter	Length	Description
None	None	Position cursor at line 0 column 0

Description: This command moves the cursor move the cursor to line 0, column 0 of the LCD screen.

The command requires 2 ms to take effect; therefore subsequent input must have an appropriate delay.

Turn On Underline Cursor

Syntax hexadecimal 0xFE 0x0E

Parameter	Length	Description
None	None	Turn on underline cursor

Description: This command turns on the underline cursor, the cursor position is where the next character will appear.

Default: Underline cursor is off.

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Turn Off Underline Cursor

Syntax hexadecimal 0xFE 0x0F

Parameter	Length	Description
None	None	Turn off underline cursor

Description: This command turns off the underline cursor.

Default: Underline cursor is off.

Move Cursor Left One Space

Syntax hexadecimal 0xFE 0x10

Parameter	Length	Description
None	None	Move cursor left one space

Description: This command moves the cursor position left 1 space.

Default: None.

Move Cursor Right One Space

Syntax hexadecimal 0xFE 0x11

Parameter	Length	Description
None	None	Move cursor right one space

Description: This command moves the cursor position right 1 space.

Default: None.

Turn On Blinking Cursor

Syntax hexadecimal 0xFE 0x12

Parameter	Length	Description
None	None	Turn on the blinking cursor

Description: This command turns on the blinking cursor; both the cursor and the character on the cursor will blink.

Default: Blinking cursor is off.

Turn Off Blinking Cursor

Syntax hexadecimal 0xFE 0x13

Parameter	Length	Description
None	None	Turn off the blinking cursor

Description: This command turns off the blinking cursor.

Default: Blinking cursor is off.

Clear Screen

Syntax hexadecimal 0xFE 0x14

Parameter	Length	Description
None	None	Clear LCD and move cursor to line 1 column 1

Description: This command clears the display and place the cursor at line 1 column 1.

Default: None.

The command requires 2 ms to take effect; therefore subsequent input must have an appropriate delay.

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Print String

Syntax hexadecimal 0xFE 0x15 [count][string]

Parameter	Length	Description
[count][string]	variable	Print string

Description: This command prints the string with length [count] to the LCD at the present cursor position.

3.3 Bar Graphs and Custom Characters.

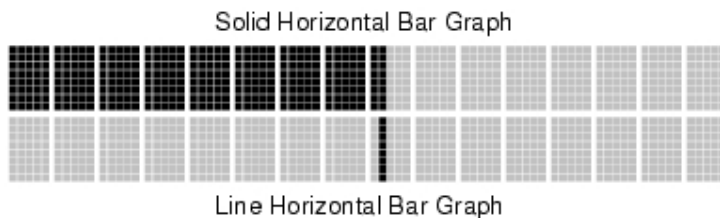
The module supports horizontal and vertical bar graph functions.

Each display character consists of five horizontal pixels x eight vertical pixels.

Horizontal bar graphs display a set of vertical lines that are each composed of one horizontal pixel by eight vertical pixels, within a single character - a pixel column. Each character can display one to five vertical pixel columns, where five pixel columns display the entire character.

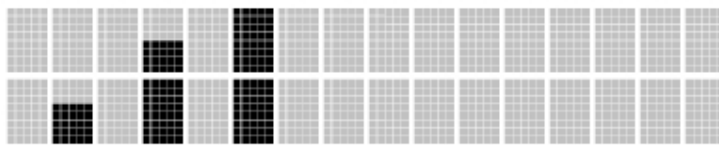
Starting on the left side of the display, the first pixel column is numbered 1 and the last pixel column is numbered $N * 5$, where N is the number of characters. A 16-character display has 80 possible pixel columns numbered 1 to 80.

Solid bar graphs display 1 to N pixel columns, within a set of specified continuous characters. Line bar graphs display only the specified pixel column. Below is an example of both types of horizontal bar graphs.



Vertical bar graphs display a set of horizontal lines that are each composed of one vertical pixel by five horizontal pixels, within a single character - a pixel row. Each character can display one to eight horizontal pixel rows, where eight pixel rows display the entire character.

Starting on the bottom of a character, the first pixel row is numbered 1 and the last pixel row is numbered 8. Combining two rows can generate a vertical bar graph of 16 pixel rows.



Only one type of bar graph (horizontal or vertical) may be used for current screen at a time since they each require their own set of characters and load those characters to LCD custom character RAM.

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Init Horizontal Bar Graph

Syntax hexadecimal 0xFE 0x16 [type]

Parameter	Length	Description
[type]	1 byte	Init horizontal bar graph 0 = solid graph, 1 = line graph

Description: Initializes the LCD to display the specified type of horizontal bar graph. This function should be called prior to calling Draw Horizontal Bar Graph. The type of bar graph must be specified. This function does not draw a bar graph, but loads the custom character RAM with the data required to display the specified type of bar graph. This routine must be called to change between horizontal bar-graph types.

The command requires 2 ms to take effect; therefore, the subsequent input must have an appropriate delay.

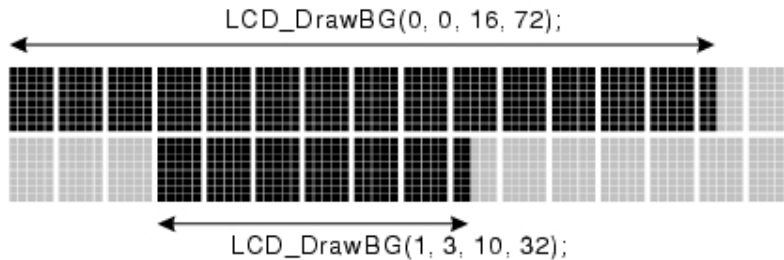
Draw Horizontal Bar Graph

Syntax hexadecimal 0xFE 0x17 [Row][Col][Len][PixelColEnd]

Parameter	Length	Description
[Row][Col][Len][PixelColEnd]	4 bytes	Draws the horizontal bar graph

Description: Draws the horizontal bar graph starting at character location (Row, Col) with a character length of "Len" to column position of "PixelColEnd".

Examples of Horizontal Bar Graphs



Note Solid bar graphs draw all the pixel columns from the first pixel column of the character defined by bRow and bCol to the pixel column specified by bPixelColEnd. Line bar graphs draw the specific pixel column specified in the define character.

For line bar graphs bLen=1 and bPixelColEnd is in the range of 1 to 5.

Init Vertical Bar Graph

Syntax hexadecimal 0xFE 0x18

Parameter	Length	Description
None	None	Init vertical bar graph

Description: Initializes the LCD to display vertical bar graphs. This should be called prior to calling Draw Vertical Bar Graph. This function initializes the custom character RAM with the data required to draw vertical bar graphs.

The command requires 2 ms to take effect; therefore, the subsequent input must have an appropriate delay.

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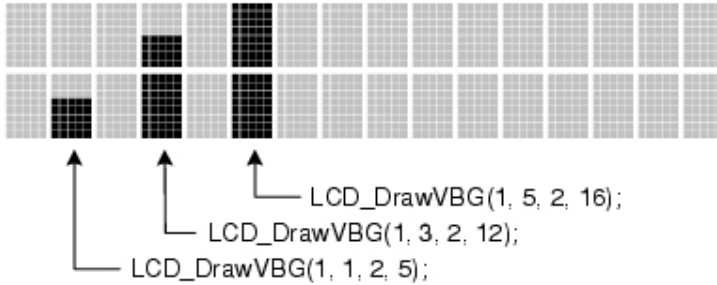
Draw Vertical Bar Graph

Syntax hexadecimal 0xFE 0x19 [Row][Height][Len][PixelRowEnd]

Parameter	Length	Description
[Row][Col][Height][PixelRowEnd]	4 bytes	Draws the horizontal bar graph

Description: Draws a vertical bar graph starting from the first pixel row at character location (Row, Col), with a character height of Height, up to the specified vertical pixel row PixelRowEnd.

Examples of Vertical Bar Graphs



Load Custom Characters

Syntax hexadecimal 0xFE 0x1A [addr][d0 ... d7]

Parameter	Length	Description
[addr][d0 ... d7]	9 bytes	Load custom characters, [addr] 1 byte – custom character address from 0 to 7, [d0 ... d7] 8 bytes – custom character pattern bit map

Description: LCD module has space for 8 custom characters. Each custom character is 5 pixels wide by 8 pixels high.

The [addr] parameter indicates which custom character is defining, and must have a value from 0 to 7. Following the [addr] parameter are 8 bytes that define the custom character. Bits 0 to 4 each byte will each define a pixel character.

The command requires 2 ms to take effect; therefore, the subsequent input must have an appropriate delay.

Example: The bit map for character 'X'.

Bit	7	6	5	4	3	2	1	0	Hex
Byte 1	0	0	0	1	0	0	0	1	0x11
Byte 2	0	0	0	0	1	0	1	0	0x0A
Byte 3	0	0	0	0	0	1	0	0	0x04
Byte 4	0	0	0	0	1	0	1	0	0x0A
Byte 5	0	0	0	1	0	0	0	1	0x11
Byte 6	0	0	0	0	0	0	0	0	0x00
Byte 7	0	0	0	0	0	0	0	0	0x00
Byte 8	0	0	0	0	0	0	0	0	0x00

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Write to Digital Outputs

Syntax hexadecimal 0xFE 0x1E [Data]

Parameter	Length	Description
[Data]	1 byte	Write to digital outputs

Description: This command writes 1 data byte to 4 digital outputs.

3.4 Module control from Microsoft Visual Basic.

Visual Basic is one of the easiest languages to use for serial port communications. The mscomm32.ocx driver controls all the serial port communications and it's included with Visual Basic. The example shows how you can control the module using this serial port com driver.

```
Option Explicit

Private Sub Port_Init()
    With MSComm1
        .CommPort = 2           'set the active serial port
        .Settings = "9600,N,8,1" 'set the baud rate, parity, data bits, stop bits
        .PortOpen = True       'open the serial port
    End With 'MSComm1
End Sub

Private Sub Module_Control()
    With MSComm1
        If .PortOpen = False Then
            .PortOpen = True
        End If

        'Set the cursor position (row = 1, column = 5)
        .Output = Chr$(&HFE) + Chr$(&H0C) + Chr$(&H01) + Chr$(&H05)
        DoEvents ' process this command
        'Print the string "Hello"
        .Output = Chr$(&HFE) + Chr$(&H15) + Chr$(&H05) + "Hello"
    End With 'MSComm1
End Sub
```

3.5 Windows Software

A simple Windows control program is provided to enable manual setting of each of the features of the module. It allows the user to quickly test the module and get an idea of how each feature looks and works.

The Windows software can be downloaded from "www.kitsrus.com/zip/k192.zip"

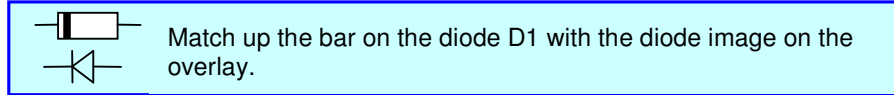
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Kit Assembly.

Before starting, check the components supplied in the kit against the parts list.

It is recommended that components be soldered in following order:

1. Resistors R1 ... R5.
2. Diode D1.



3. Capacitors C1, C2 (polarity is not important).
4. U1 socket.
5. Transistors Q1 and Q2.
6. Headers J1 ... J5.
7. DB9 connector.

Pre-test. Do not insert the microcontroller chip into socket yet and do not connect the LCD module to serial controller. Connect a 5VDC supply to J4 header and measure the voltage across pin 10 (ground) and pin 20 (+5V) of the socket U1. If this voltage is approximately 5 volts, **remove power**, insert the microcontroller chip U1 and connect the serial controller to LCD module.

Technical Support. Contact the kit developer by email to 'polar@BasicISP.net'

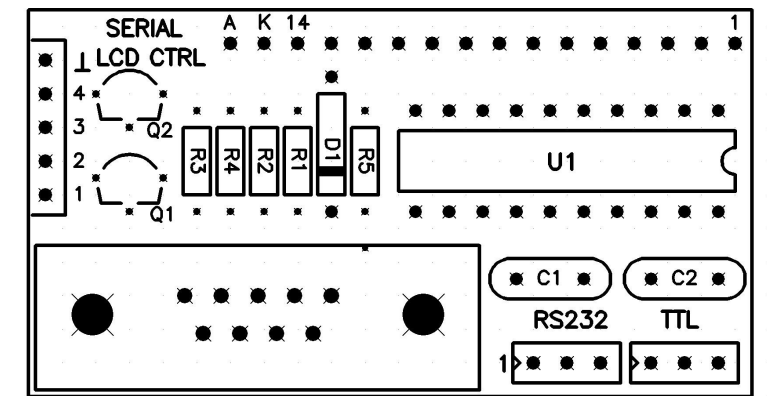
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4.1 Parts List.

Ref Des	Qty	Type
Capacitors		
C1, C2	2	0.33uF ceramic
Resistors		
R1, R4	2	5.1K 0.125W carbon film
R2	1	10K 0.125W carbon film
R3	1	36 0.125W carbon film
R5	1	220 0.125W carbon film
Semiconductors		
D1	1	1N4148 diode
U1	1	CY8C24224A-24PXI MCU
Q1, Q2	2	2N3904
Miscellaneous		
IC socket, 20 pin	1	Socket for U1
J1 (see note below)	1	14 pin header, 2.54 mm step
J2 (see note below)	1	2 pin header, 2.54 mm step
J3, J4	2	3 pin header, 2.54 mm step
J5	1	5 pin header, 2.54 mm step
J6	1	DB9 female connector

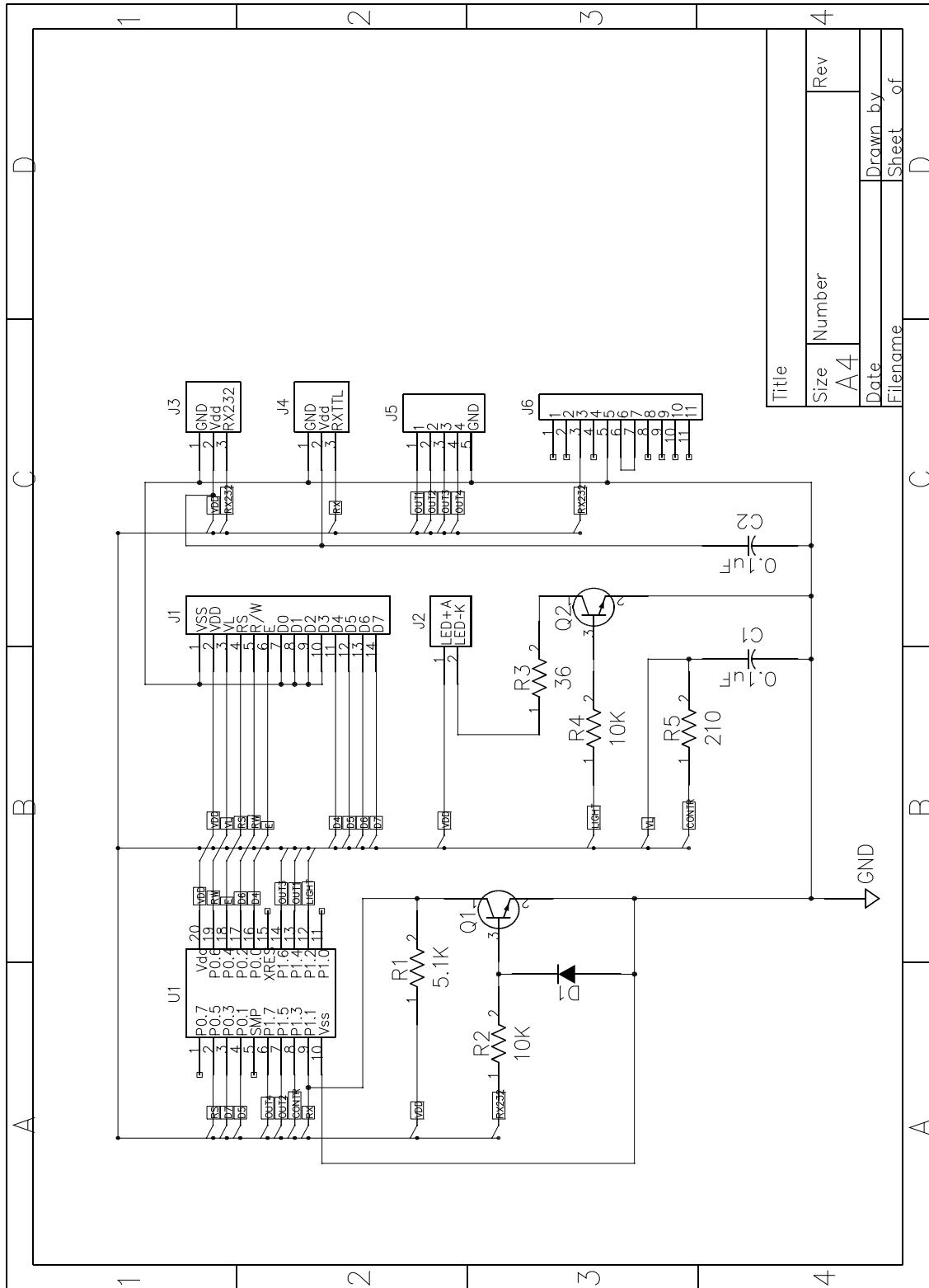
NOTE: A 16 pin header may be supplied that combines J1 and J2 into a single connector.

4.2 PCB



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4.3 Module Schematic.



Title	
Size	Number
A4	
Date	Drawn by
Filename	Sheet of