

Matrix Orbital Corporation

VFD2021 **User Manual**



Important: Read page 2 before applying power.

Connecting VFD2021

Regular Voltage

Power is applied to the white or brown four pin SIP connector as follows:

- Pin 1: + 5Vdc
- Pin 2: = SCL (I²C clock)
- Pin 3: = SDA (I²C data)
- Pin 4: Gnd

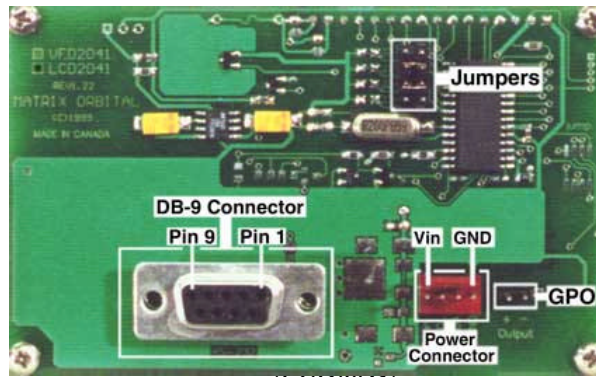
If the sole data source is via the RS-232, the data input is via the DB9 connector. Pins 2 and 3 are not used.

Wide Voltage Option (V)

Power is applied to the white or brown four pin SIP connector as follows:

- Pin 1: + 7 - + 15Vdc
- Pin 2: = SCL (I²C clock)
- Pin 3: = SDA (I²C data)
- Pin 4: Gnd

If the sole data source is via the RS-232, the data input is via the DB9 connector. Pins 2 and 3 are not used



(LCD2041)

WARNING:

DO NOT APPLY ANY POWER WITH A REVERSED CABLE.

DO NOT APPLY AN VOLTAGE OTHER THAN THE SPECIFIED VOLTAGE.

DO NOT USE ANY CABLES OTHER THAN THE CABLES SUPPLIED BY MATRIX ORBITAL, UNLESS YOU ARE AWARE OF THE MODIFICATIONS REQUIRED.

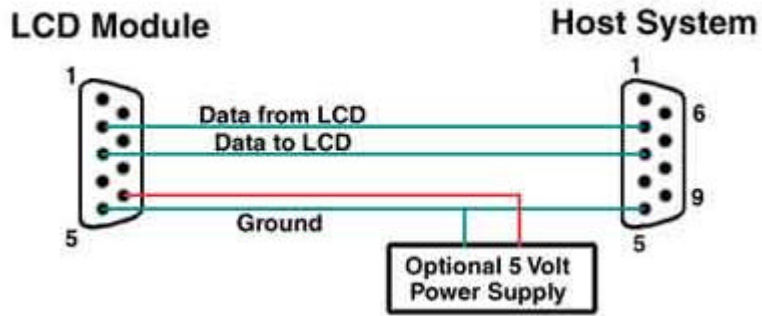
DO NOT UNDER ANY CIRCUMSTANCES USE AN UNMODIFIED FLOPPY DRIVE POWER CABLE.

DB9 Connector Pin Out

RS - 232 port: This connector is wired so that a standard “straight through” 9 pin D-sub cable may be used to connect the modules on a standard serial port such as comm ports on PCs. Note that this device complies to the EIA232 standard in that it uses signal levels from +/- 3V to +/- 12V. It will not operate correctly at TTL (0 to + 5V) levels.

Pin Number	Description
2	Data Out
3	Data In
5	Ground
9	+ 5Vdc

Note: Signals are shown as interpreted by the Liquid Crystal Display module.



Power may be provided to the module by pin 9 of the DB9 connector instead of through the 4-pin SIP. If power is to be applied using the DB9, it must be a regulated 5Vdc supply. If the user intends to use pin 9 as the power source, the user must solder the 5 volt jumper point beside the DB9 connector. If you have any further questions or concerns don't hesitate to contact Matrix Orbital at support@matrix-orbital.com.

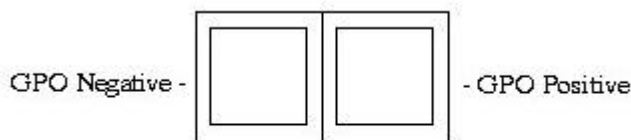
Warning: Use this method of power up at your own risk. Application of a voltage to pin 9 greater than 5.5volts will cause immediate destruction of unit and void the warranty.

Note: This applies to wide voltage units (V and VPT extensions) as well as to standard 5 volt units.

General Purpose Output (GPO)

The GPO is meant to be used as a pair. The positive side of the GPO is connected to a power source of + 5Vdc supplied by the module at 20mA. The negative side of the GPO is capable of finding a path to ground through a 240 ohm resistor. This resistor will limit the current flow through a GPO to approximately 20mA in the event of a short circuit. If the device which is being driven by a GPO requires a relatively high current (such as a relay) and has an internal resistance of it's own greater than 250 ohms, then the 240 ohm resistor may be shorted. You will find this resistor directly below the negative pin of the general purpose output.

Note: This operation requires soldering. The GPO does not have any over current or over/under voltage protection so care must be taken if the user decides to connect the negative side differently. For instance if the external device is a relay it must be fully clamped to absorb any generated back electromotive force (EMF).



Configuring VFD2021

Default configuration is J1 and J2 installed. This configures the RS-232 to 19 200 baud and I²C to slave address 0x5C - depending on which connector is used. Please refer to the Appendix of this manual for programming notes.

RS-232 port: J0, J1, J2 - control baud rate

RS-232 format is 8N1 (8 characters, no parity, one stop bit)

I²C port: J0, J1, J2, J3 - sets slave peripheral address

Baud Rate	Slave Address	J3	J2	J1	J0
1200	50H	Off	Off	Off	Off
	52H	Off	Off	Off	On
2400	54H	Off	Off	On	Off
	56H	Off	Off	On	On
9600	58H	Off	On	Off	Off
	5AH	Off	On	Off	On
19200	5CH	Off	On	On	Off
	5EH	Off	On	On	On
1200	60H	On	Off	Off	Off
	62H	On	Off	Off	On
2400	64H	On	Off	On	Off
	66H	On	Off	On	On
9600	68H	On	On	Off	Off
	6AH	On	On	Off	On
19200	6CH	On	On	On	Off
	6EH	On	On	On	On

VFD2021 Command Set

Write Text

This section of the manual allows the user to send commands to the VFD to alter the appearance or behavior of the display. To utilize a command, the user must send a command prefix followed by the command in the format described in this portion of the manual. Any characters sent without a command prefix will be interpreted as text and will be displayed on the module at the current cursor position. The current cursor position will be incremented for each character received. Please note that unless line wrap is turned on, the text will follow the memory map of the module.

The command set discusses in detail what the VFD's capabilities of and how to execute each command. The basic format of all the commands listed in this segment that do not require parameters is:
< command prefix> < command>

For commands that do require parameters however the format is as follows:
< command prefix> < command> [< parameter> < parameter>]

Basic Commands

All commands are prefixed by the command 0xFE, Hex FE, Decimal 254

Auto Line Wrap On

ASCII 'C', Hex 43, Decimal 67
Syntax 0xFE 0x43

This command enables the automatic line wrap function. Transmitted characters which overrun the width of the display will automatically wrap to the next line. The bottom line wraps to line 1 of the display. To carry out this command the user must send a command prefix followed the character 'C'.

Auto Line Wrap Off

ASCII 'D', Hex 44, Decimal 68
Syntax 0xFE 0x44

This command disables the automatic line wrapping function. To turn off the the auto line wrapping, send a command prefix followed by the character 'D'.

Auto Scroll On

ASCII 'Q', Hex 51, Decimal 81
Syntax 0xFE 0x51

To turn the automatic line scrolling on, send a command prefix followed by the character 'Q'. In combination with the "Auto Line Wrap" command the text will automatically wrap and scroll up.

Note: "Auto Line Wrap" must be enabled for "Auto Scroll" to work properly.

Auto Scroll Off

ASCII 'R', Hex 52, Decimal 82
Syntax 0xFE 0x82

To turn the automatic line scrolling off, send a command prefix followed by the character 'R'.

Backlight On

ASCII 'B', Hex 42, Decimal 66

Syntax 0xFE 0x42< number of minutes>

To turn the backlight on, send a command prefix followed by the character 'B' and the number of minutes for the backlight to remain on. If < minutes> is sent as zero then the backlight will remain on indefinitely. The maximum value for < minutes> is 100. Example:

```
< command prefix>      0xFE
< command>             0x42
< minutes>             0 to 100
```

Backlight Off

ASCII 'F', Hex 46, Decimal 70

Syntax 0xFE 0x46

To turn the backlight off, send a command prefix followed by the character 'F'.

Clear Display

ASCII 'X', Hex 58, Decimal 88

Syntax 0xFE 0x58

This command clears any text and graphics off the display. To clear the display, send a command prefix followed the character 'X'.

Set Brightness

ASCII 'Y', Hex 59, Decimal 89

Syntax 0xFE 0x89< hex value defining brightness>

This command sets the level of brightness for the text displayed on the VFD. The level of brightness that can be displayed is from 100% being the brightest and 25% being the dimmest. To execute this command the user must send a command prefix followed by the character 'Y' and a hex value between 0x00 and 0x03 defining the level of brightness. Please note that different lighting conditions and filter will affect the actual value used. Also note that on power up of module the brightness is set to 100% by default.

Hex Values	Brightness
0x00	25%
0x01	50%
0x02	75%
0x03	100%

Cursor On

ASCII 'J', Hex 4A, Decimal 74

Syntax 0xFE 0x4A

To turn the cursor on at the current position, send a command prefix followed by the character 'J'. Note cursor is on by default at power up.

Cursor Off

ASCII 'K', Hex 4B, Decimal 75

Syntax 0xFE 0x4B

To turn the cursor off at the current position , send a command prefix followed by the character 'K'.

Cursor Left

ASCII 'L', Hex 4C, Decimal 76

Syntax 0xFE 0x4C

To move the cursor one space to the left of current position, send a command prefix followed by the character 'L'.

Cursor Right

ASCII 'M', Hex 4D, Decimal 77

Syntax 0xFE x04D

To move the cursor one space to the right of the current position, send a command prefix followed by the character 'M'.

Cursor Blink On

ASCII 'S', Hex 53, Decimal 83

Syntax 0xFE 0x53

To turn on the blinking cursor at the current position, send a command prefix followed by the character 'S'. Please note that the blinking cursor is on by default at power up.

Cursor Blink Off

ASCII 'T', Hex 54, Decimal 84

Syntax 0xFE 0x54

To turn off the blinking cursor at the current position send a command prefix followed by the character 'T'.

Set Debounce Time

ASCII 'U', Hex 55, Decimal 85

Syntax 0xFE 0x55< number to define debounce time>

To set the time between key press and key read, send a command prefix followed by the character 'U' and a number to define the debounce time. All key types with the exception of latched piezo switches will "bounce" for a varying time, depending on their physical characteristics. The default debounce time for the module is about 65mS, which is adequate for most membrane keypads. This time equates to a setting of 8 using this command as there is a debounce time resolution of 8192 microseconds.

Create Custom Character

ASCII 'N', Hex 4E, Decimal 78

Syntax 0xFE 0x4E< character between 0x00 and 0x07> < 8 bytes>

This command creates a custom character. For the VFD2021 the user can have up to eight custom characters. To execute this command, send a command prefix followed by the character 'N'. The display will now await the number which identifies the custom character. This number must be between 0x00 and 0x07. When the module determines what character it's working on, then the user must send 8 bytes which define the display character. See the diagram below for an explanation of the display character structure.

Diagram A

MSB										LSB	
*	*	*	1	2	3	4	5		Data Byte 1		
*	*	*	6	7	8	9	10		Data Byte 2		
*	*	*	11	12	13	14	15		Data Byte 3		
*	*	*	16	17	18	19	20		Data Byte 4		
*	*	*	21	22	23	24	25		Data Byte 5		
*	*	*	26	27	28	29	30		Data Byte 6		
*	*	*	31	32	33	34	35		Data Byte 7		
*	*	*	36	37	38	39	40		Data Byte 8		

Pixel Layout of Display Characters

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
Cursor Line				

General Purpose Output On

ASCII 'V', Hex 56, Decimal 86

Syntax 0xFE 0x56 < hex number corresponding to output >

To turn a general output purpose on, send a command prefix followed by the character 'V' and hex number which corresponds to the output which will be turned on. To turn on output five, the sequence would be:

< command prefix > 0xFE
< command > 0x56
< hex number corresponding to output > 05H

General Purpose Output Off

ASCII 'W', Hex 57, Decimal 87

Syntax 0xFE 0x57 < hex number corresponding to output >

To turn a general output purpose off, send a command prefix followed by the character 'W' and a hex number which corresponds to the output which will be turned off.

Go To Position

ASCII 'G', Hex 47, Decimal 71

Syntax 0xFE 0x47 < column number > < row number >

To set the current cursor position, send a command prefix followed by the character 'G' and two values defining the column and row of the desired cursor position.

Go To Top Left

ASCII 'H', Hex 48, Decimal 72

Syntax 0xFE 0x48

This command resets the current cursor position to the top left of the VFD screen. To execute this command send a command prefix followed by character 'H'.

Initialize Horizontal Bar Graph

ASCII 'h', Hex 68, Decimal 104

Syntax 0xFE 0x68

Before any horizontal bar graphs may be created, this command must be executed. It only needs to be sent once to initialize the custom characters for bar graph creation. Due to the fact bar graphs use custom characters, no user custom characters may be displayed or created while bar graphs are in use.

Make Horizontal Bar Graph

ASCII '|', Hex 7C, Decimal 124

Syntax 0xFE 0x7C < column number > < row number > < direction > < bar length >

This command places a horizontal bar graph at the specified column and row with the specified width. The format of the command is as follows:

< command prefix >	0xFE
< command >	0x7C
< column number >	0x01 to 0x14 for a twenty column display
< row number >	0x01 to 0x02 for a two line display
< direction >	0 for left to right, 1 for right to left
< bar length >	0x00 to 0x64 (0 to 100) for a twenty column display

Bar length is in pixel widths. On a twenty column display the maximum bar graph width is one hundred (if the bar graph starts at the edge). This is due to the fact that each of the twenty columns on the display are five pixels wide. The width of the space between columns is not taken into account.

Initialize Thick Vertical Bar Graph

ASCII 'v', Hex 76, Decimal 118

Syntax 0xFE 0x76

Before any thick vertical bar graphs may be created, this command must be executed. It only needs to be sent once to initialize the custom characters required for bar graph creation. Bar graphs use custom characters, therefore no user custom characters may be displayed or created while bar graphs are in use.

Initialize Thin Bar Vertical Graph

ASCII 's', Hex 73, Decimal 115

Syntax 0xFE 0x73

This command is executed in exactly the same manner as the 'Initialize Thick Bar Graph' command.

Make Vertical Bar Graph

ASCII '=', Hex 3D, Decimal 61

Syntax 0xFE 0x3D < column number > < bar length >

This command places a bar graph at the specified column with the specified height. The style of the vertical bar graph whether it be thick or thin is selected by the initialize vertical bar graph command. If thick bar graphs are preferred, the 'v' command should be sent to initialize the bar graph. If a thin vertical bar graph is desired, the 's' command should be sent to initialize the bar graph. The format for the command is as follows:

< command prefix >	0xFE
< command >	0x3D
< column number >	0x01 to 0x14 for an twenty column display
< bar length >	0x00 to 0x20 (1 to 32) for a two line display.

Bar height is in pixel widths. On a two line display the maximum bar graph height is sixteen, this is because each of the lines in the display are eight pixels high. The width of the space between the lines is not taken into account.

Note: Vertical bar graphs may not be used with horizontal bar graphs, and thick bar graphs may not be used with thin bar graphs. This is because all these functions make use of the same "custom character" spaces. As a result, custom characters are also unavailable while any of these functions are in use.

VFD Character Font Chart

D7	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1		
D6	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1		
D5	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1		
D4	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1		
D3 D2 D1 D0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
0 0 0 0	0	|		0	Q	P	`	P	Ä	ff		一	夕	≡	Ω	P		
0 0 0 1	1	|	!	1	Q	a	q	A	æ	ä	ä	ア	チ	△	△	Q		
0 0 1 0	2	|	"	2	R	b	r	ä	é	「	」	イ	ツ	×	β	θ		
0 0 1 1	3	|	#	3	S	c	s	ä	é	」	」	ウ	テ	モ	ε	∞		
0 1 0 0	4	|	\$	4	T	d	t	ä	é	、	、	エ	ト	ヤ	ト	Ω		
0 1 0 1	5	|	%	5	U	e	u	E	O	・	・	オ	ナ	ユ	ε	Ü		
0 1 1 0	6	|	&	6	F	f	v	ö	+	ヲ	カ	ニ	ヨ	ル	Σ	Σ		
0 1 1 1	7	|	?	7	G	w	w	ö	+	ア	キ	ヌ	ラ	ヨ	π	π		
1 0 0 0	8	|	(	8	H	x	x	ø	!	イ	ク	ネ	リ	ル	Σ	Σ	
1 0 0 1	9)	9	I	y	y	ø	!	ウ	ケ	ル	ル	ル	Σ	Σ		
1 0 1 0	A		"	*	:	J	Z	j	z	ü	△	エ	コ	ハ	レ	J	キ	
1 0 1 1	B		"	+	:	K	[k	{	ü	△	エ	サ	ヒ	ロ	*	万	
1 1 0 0	C		▼	:	:	く	L	¥	l	l	\	△	カ	シ	フ	ワ	Φ	円
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Specifications
Environmental Specifications

	Standard Temp.	Extended Temp.
Operating Temperature	-20° to +70° C	-40° to +85° C
Storage Temperature	-40° to +80° C	-50° to +85° C
Operating Relative Humidity	20 - 80% max non-condensing	
Vibration (non-operating)	10 to 55 to 10Hz (Frequency)	
	1.0 mm (Total Amplitudes)	
	30 minutes (Duration)	
	X, Y, Z, each direction	
Shock (non-operating)	539m/S ² , 10mS	

Electrical Specifications

Supply Voltage	4.75 - 5.25 Vdc (optional 7 - 15Vdc)
Supply Current (all dots on)	130mA typical
Supply Current (display off)	9mA typical
Supply Current (power up)	Up to 250mA inrush

Optical Characteristics

Number of characters	40 (20 Characters x 2 Lines)
Matrix format	5 x 7 with underline
Display area	70.80 x 11.50 mm (XxY)
Character size	2.40 x 4.70 mm (XxY), not including underline
Character pitch	3.60 mm
Line pitch	6.10 mm
Dot size	0.40 x 0.50 mm (XxY)
Dot pitch	0.50 x 0.70 mm (XxY)
Luminance	350cd/m ² (100fL) min.
Color of illumination	Bluish Green

Appendix

Important VFD Precautions

All VFD modules contain MOS LSI. Antistatic handling procedures are always required.

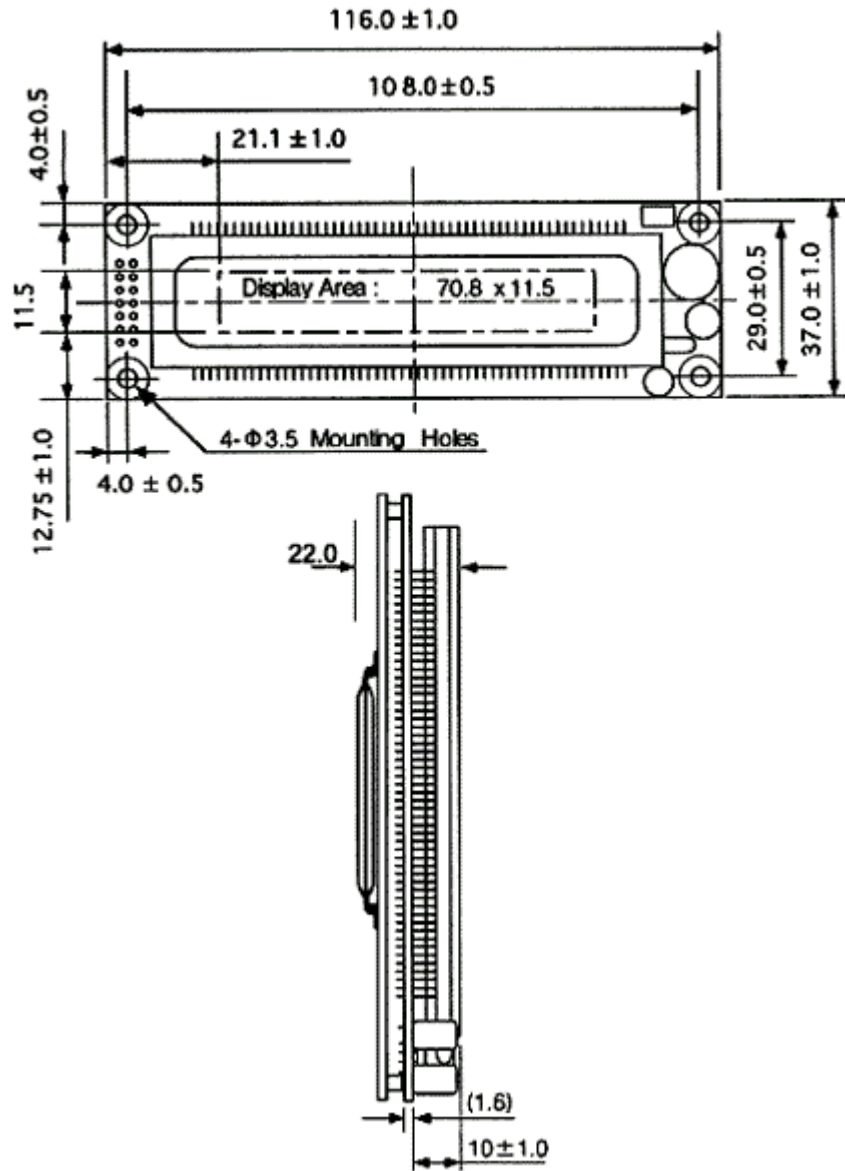
VFD displays consist of Soda-lime glass. Heavy shocks of more than 100G, thermal shock greater than 10°C/minute or a direct hit with hard material to the glass surface - especially to the EXHAUST PIPE - may CRACK the glass.

Do not PUSH the display strongly. When mounting to the system frame, a slight gap between the display glass face and front panel is necessary to avoid a contact failure of lead pins of the display. Twisting or warping during mounting will make the glass CRACK around the lead pin of the display.

Do not apply slow-start power. Provide a sufficient output current power source to avoid problems with INRUSH CURRENT at power up. Power supply current capability should be at least equal to the "Supply Current (power up)" as listed in the Electrical Specifications.

Steady repeating of a fixed (static) message display for longer than 5 hours in a day may cause the phosphor to "burn in". An automatic shut down using the timed power down function (display on/off) is recommended.

VFD2021



NORTH AMERICA

CANADA

HVW Technologies

Suite 473, 300 - 8120 Beddington Blvd. N.W.
Calgary, Alberta T3K 2A8 Canada
Telephone: + 1 403 730 8603
Facsimile: + 1 403 730 8903
Email: info@hvwtech.com
WWW: <http://www.hvwtech.com/>

Tri-M Systems Inc.

6-1301 Ketch Court
Coquitlam, BC V3K 6X7 Canada
Toll Free Telephone: 1 800 665 5600
Alternate Telephone: + 1 604 527 1100
Facsimile: + 1 604 527 1110
Email: info@tri-m.com
WWW: <http://www.tri-m.com/>

UNITED STATES

EMJ Embedded Systems

Suite 100-1434 Farrington Road
Apex, North Carolina 27502 USA
Toll Free Telephone: 1 800 436 5872
Facsimile: + 1 919 363 4425
Email: sales@emjembedded.com
WWW: <http://www.emjembedded.com/>

Jameco Electronic Components

1355 Shoreway Road
Belmont, California 94002-4100 US
Toll Free Telephone: 1 800 831 4242
Toll Free Facsimile: 1 800 237 6948
Email: sales@jameco.com
WWW: <http://www.jameco.com/>

Note: Currently only carries LCD2041, LK204-25

Linux Central

Suite T2 37060 Garfield
Clinton Township, Michigan 48036 USA
Telephone: + 1 810 226 8200
Toll Free Telephone: 1 877 LINUX CD (546 8923)
Facsimile: + 1 810 226 8600
Email: sales@linuxcentral.com
WWW: <http://linuxcentral.com/>

EUROPE

AUSTRIA

MEGATON Ges.m.b.H.

Franz-Schubert-Gasse 12, A-2372 GIESSHÜBL
Telephone : + 43 0 2236 43179
Facsimile : + 43 0 2236 4317921
Email: oesterreich@elektronikladen.de

FINLAND

Symmetric Oy

Maria Jotunin Tie 11
Helinski, Finland 00400
Telephone: + 358 9 5885 322
Facsimile: + 358 9 5885 578
Email: symmetric@symmetric.fi
WWW: <http://www.symmetric.fi/>

GERMANY

Elektronikladen Mikrocomputer GmbH

Offices throughout Germany
Telephone : + 49 0 5232 8171
Facsimile : + 49 0 5232 86197
Email: sales@elektronikladen.de
WWW: <http://www.elektronikladen.de/>

THE NETHERLANDS

Antratek Electronics

Kanaalweg 33,
NL-2903LR Capelle aan den IJssel, The Netherlands
Telephone : + 31 10 4504949
Facsimile : + 31 10 4514955
Email: info@antratek.nl
WWW: <http://www.antratek.nl>

ITALY

QuadriviumNET

Via Circonvalazione Sud, 76
33033 Codriopo, Udine, Italy
Telephone : + 39 0 432 906062
Facsimile : + 39 0 432 901514
Email: info@qnet.it
WWW: <http://www.qnet.it/>

SCANDINAVIA

Lawicel

Klubbgatan 3
SE-282 32 Tyringe, Sweden
Telephone: + 46 0 451 598 77
Facsimile: + 46 0 451 598 78
Email: info@lawicel.com
WWW: <http://www.lawicel.com>

Lilla Fabriken

Box 1003
SE-172 21 Sundbyberg, Sweden
Telephone: + 46 8 287 286
Facsimile: + 46 8 288 802
Email: info@lillfab.se
WWW: <http://www.lillfab.se>

SWITZERLAND

Bernhard Elektronik

Aarauer Str. 20,
CH-5734 Reinach AG
Telephone : + 41 0 62 7716944
Facsimile : + 41 0 62 7716944
Email : schweiz@elektronikladen.de

MIDDLE EAST

ISRAEL

Alpha Terminals & Printers Ltd.

7 Ha'Mifalm St.
Petach - Tikva, Israel 49250
Telephone: + 972 3 9214422
Facsimile: + 972 3 9219966
Email: alpha99@ibm.net

AUSTRALIA

AUSTRALIA

Alfa-Tek

Unit 7, 42 - 50 Stud Road
Bayswater, Victoria, Australia, 3111
Telephone: + 61 39 720 5344
Facsimile: + 61 39 720 5268
Email: will@alfatek.com.au
WWW: <http://www.alfatek.com.au/>

ASIA

INDIA

AL Systems

105, 3rd Street,
Tatabad, Coimbatore - 641012
Tamil Nadu, India
Telephone: +91-422-233166, 493960
Facsimile: +91-422-230958, 213849
Email: also@vsnl.com
WWW:http://business.vsnl.com/al_systems

AFRICA

EGYPT

AmGroup 13

Sheraton Heliopolis
Zone 8, Cairo EGYPT
Email: amgrou@link.com.eg

