GLK12232-25-SM

User Manual

Table of Contents

1. Introduction

Your GLK12232-25-SM has the following features:

- 122 x 32 pixel graphics display
- text display using built-in or user-supplied fonts
- adjustable contrast
- backlighting
- keypad interface
- RS-232 or I^2C communications

This manual describes the basic use and overview of the GLK12232-25-SM. It also describes advanced functions, which may require soldering. We do expect you to be proficient with a soldering iron before attempting to modify the unit. Any damage resulting from soldering irons or modifications will not be covered under warrantee.

1.1 What it Does

The GLK12232-25-SM is designed as the display unit for an associated controller. The controller may be anything from a single board, special purpose microcontroller to a PC, depending on the application. This controller is responsible for what you see on the screen of the GLK12232-25-SM.

The GLK12232-25-SM provides a simple command structure to allow both text and graphics to be transferred to the screen. Text fonts (and graphics, if desired) are stored in the GLK12232-25-SM's flash ROM and may be regarded as "permanent" in that they survive power-off periods and don't change until explicitly reprogrammed.

The screen is backlit for low-light situations. Backlighting may be turned on or off under program control. Contrast is adjustable to compensate for differing lighting conditions and viewing angles.

1.2 What it Does Not Do

Since the GLK12232-25-SM is intended to be used with a controller, it does not have any built-in text editing functions. If you input a stream of ASCII characters they will be displayed, but the CR, LF, backspace, etc. will be ignored. If your application needs these functions, they must be provided by the software in your controller, which can issue the appropriate positioning commands to the GLK12232-25-SM.

1.3 Keypad Interface

The keypad interface takes row/column input and converts it to ASCII characters, which are delivered out the RS-232 or I^2C port to the associated controller. Note that the keypad is **not** used to directly control any aspect of the operation of the GLK12232-25-SM, which acts simply as a matrix to serial converter. If you want to use the keypad to control the GLK12232-25-SM display you must program your controller accordingly.

1.4 mogd.exe

Matrix-Orbital has developed an interface program which exercises all the features of the GLK12232-25-SM. It is also used to manage font and graphics downloads. The program, called "mogd.exe", is provided on CD and our website.

To install mogd.exe follow these steps:

1. Insert the Matrix Orbital CD-ROM into your CD drive.
2. Locate the file "mogd.zip" (should be in the Download directory).
3. Unzip mogd.zip to a temporary directory, using a program such as Winzip, Pkzip, etc.
4. Double click on "setup.exe".
5. Follow the instructions on the screen to complete the installation.

After installation is complete there will be a Matrix Orbital entry under Programs in your Start Menu. Click on this entry to run mogd.exe.

The first time you run mogd.exe you'll need to enter some information:

- The port number to be used (usually COM1 or COM2)
- The baud rate for the connection (use 19,200 for initial startup of the GLK12232-25-SM)
- The type of display unit (set to 240 x 64 for the GLK12232-25-SM)

Once this information is entered the program can be used to control all functions of the GLK12232-25-SM.

1.4.1 Installation

The GLK12232-25-SM is easy to install:

1. Connect the "Plug for GLK12232-25-SM" to the Power/RS-232 connector on the back of the GLK12232-25-SM.
2. Connect the RS-232 connector to an available PC COM port.
3. Connect the "Power from PC" connector to a 3.5" floppy drive power connector. A PC power "Y" cable may be used to connect to a 5.25" drive connector instead.
4. Turn on the PC. The backlight on the GLK12232-25-SM should come on.

Now you're ready to try it out. Go on to section xxx.

1.5 Setting up

Before setting up your application you may want to try out the GLK12232-25-SM. This is easily done with a PC, you'll need:

- A Serial Cable
- A 5 V power supply.
- A PC with a spare RS-232 port (COM1 or COM2).
- The mogd.exe program, installed as described in section 1.4.
- A power connector. The type used for 3.5" floppy drives works fine.
- A 9 or 25 pin RS-232 serial cable. If you use a 25 conductor cable you'll also need a 9 to 25 pin adapter.

* Make sure that you use the proper connector for the power and serial cable.

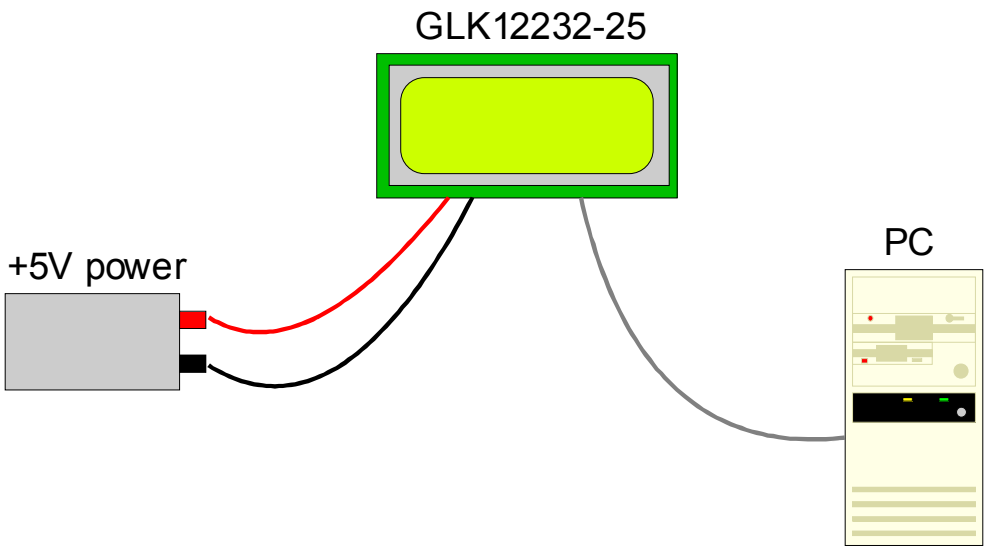

Figure 1-1 Connections for Testing

1. Refer to the diagram above for the following steps.
2. Wire the connector to the power supply. On most connectors the RED lead will go to +5V and the BLACK lead to GND. **Note: The manufacturer's warranty is void if the unit is subjected to over-voltage or reversed polarity.**
3. Connect the GLK12232-25-SM to the PC using the serial cable and adapter if required.
4. Connect the power connector, making sure that the +5V goes to V+ as shown in the diagram. Turn on the power: the LCD backlight should come on.

Now you're ready to try it out.

1.6 Trying Out your GLK12232-25-SM

The unit is connected to power and the PC and the backlight is on. You're ready to make sure it's working properly.

1. Use the mogd.exe program to exercise some of the features of the GLK12232-25-SM to make sure everything works properly.
2. To experiment with typing text, run a PC terminal program, such as Hyperterm. Make sure it's configured to use the correct port. Set the baud rate to 19,200.

If you type characters on the keyboard, they should now appear on the GLK12232-25-SM screen. Note that CR, backspace, etc., won't have any effect. Text will wrap around to the next line when you reach the end of a line.

If you've reached this point and operation is normal, you can be confident that your GLK12232-25-SM works properly.

1.7 Trying out a Keypad

Since a number of different keypad types can be connected to the GLK12232-25-SM, the results you get may be a little unpredictable. At this point all we need to do is make sure that your keypad and interface work, and possibly generate an ASCII map for your programming needs.

The keypad interface on the GLK12232-25-SM converts a row/column connection to an ASCII character. By default, a keypress is transmitted as serial data immediately. Keypad buffering can be selected using the appropriate commands.

1.7.1 Here's what to do:

1. Your PC should be running a terminal program, such as Hyperterm (as in the previous section).
2. With the GLK12232-25-SM connected to the PC, plug in your keypad. If your connector has fewer pins than the one on the GLK12232-25-SM, center it as well as possible.

Note 1: The keypad connector must be wired with columns on one side and rows on the other side of the center of the connector. If your keypad isn't wired this way you will need to make an adapter or rewire the connector to meet this requirement.

Note 2: The connector is reversible. Reversing the connector will not damage the keypad or the GLK12232-25-SM, but it will change the ASCII character map.

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3. Press a key on the keypad. An upper case ASCII character (A-Y) should appear on the PC screen. Different keys should generate different characters.

If you want to experiment, reverse the connector and see if it generates a more logical set of characters. Ultimately, the program in your controller will have to "map" these characters to the ones marked on the keypad, which will likely be different.

1.8 Manual Override

Manual override should only be required in one instance. If for some reason the module is set at a baud rate which cannot be produced by the host system and all communication to the display is lost, then the user should follow this simple procedure:

1. Turn off the display
2. Put a jumper on pins 5 and 6 of the keypad connector (C5 and R1).
3. Power up the display. The baud rate is now set to 19,200.
4. Remove the jumper and change the RS-232 port settings to the desired baud rate.
5. Turn off the display.
6. Power up the display.

Refer to the “Set RS-232 Port Speed” command (section 7.1.10) for acceptable baud rates.

Note: This procedure does not change settings in the memory chip, it uses default settings stored in the main processor. This allows the user to communicate with the display when all other communications are lost. Once able to communicate with the display, the user may then change the default settings in the memory chip.

2. Connections

2.1 Connector Pinout

Refer to the diagram below for this chapter.

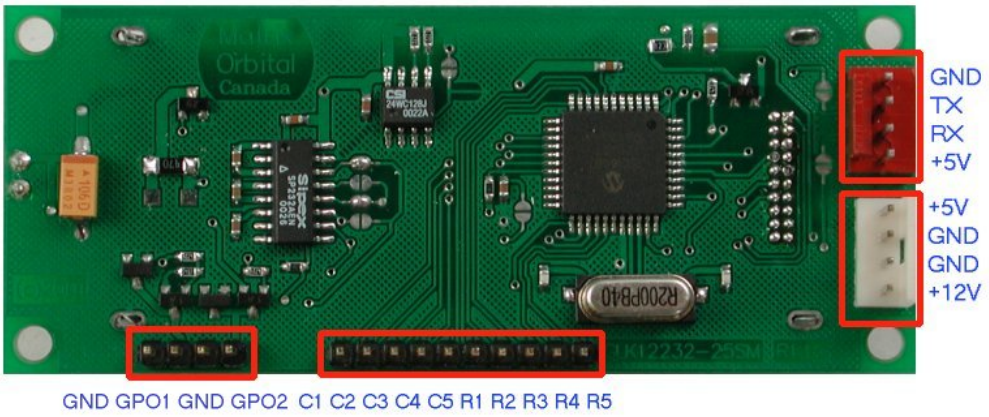


Figure 2-1 Electrical Connections

Pin	Function
GND	Ground for GPOs
GPO1	General Purpose Output 1
GND	Ground for GPOs
GPO 2	General Purpose Output 2
C1	Keypad column 1
C2	Keypad column 2
C3	Keypad column 3
C4	Keypad column 4
C5	Keypad column 5
R1	Keypad row 1
R2	Keypad row 2
R3	Keypad row 3
R4	Keypad row 4
R5	Keypad row 5

2.1.1 Power Connections

Power is applied to one of the two headers, depending on what style you may require. Power requirement is +5 VDC ±0.25V. Two connections are provided for convenience depending on the type of connector installed.

Warning:

- Do not apply any power with reversed polarization.
- Do not apply any 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 apply power to the DB-9 connector AND the power connector
- Do not apply more than +5Vdc to pin #9 on the DB-9 connector.

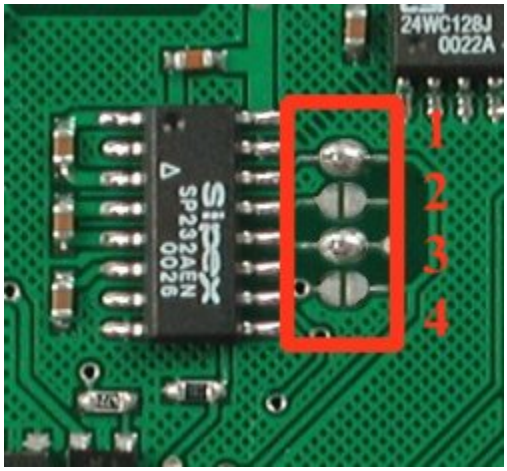
2.1.2 RS-232 Communications

A 4 pin SIP connector can be connected to a Matrix Orbital-supplied PC cable (see section 1.5 for description of this cable).

The RS-232 connector on the PC cable is wired so that a standard "straight through" 9 pin D-sub cable may be used to connect the modules to a standard serial port such as COM ports on PCs. Note that this device complies with the EIA232 standard in that it uses signal levels from +/-123V to +/- 12V. It will can also operate correctly at TTL (0 to +5V) levels. To use standard RS232 no modifications are required, for TTL, please see below.

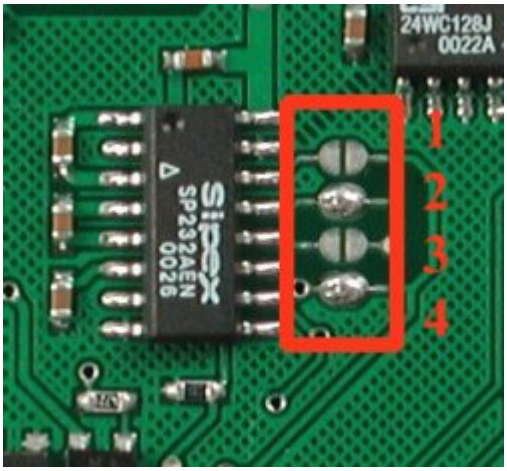
Pin Number	Direction	Description	LCD	Host
2	Data from LCD	Data out (LCD)	Tx	Rx
3	Data to LCD	Data in (LCD)	Rx	Tx
5	-	Ground	gnd	gnd

Standard RS232 and TTL configuration



Standard

mp 1 d 3 old d



TTL

mp d old d

2.1.3 I²C Communications

TheGLK12232-25-Sm I2C communications running at 100 kBps and up to 127 units on a single communications line. The I2C data line operates on 5 volts CMOS levels. The GLK12232-25-SM does not work on I2C by default, three modifications have to be done, as shown in the picture.

1 mo ll old mp

mo 1 o

3 mp o old mp

Now the unit will be able to communicate over I2C. It uses the same pins as RS232.

The idea of ACK is to indicate when the data has been received correctly. ACK does not indicate data incorrectly received. ACK simply fails to indicate when data is correctly received. Clearly, this is of limited usefulness and even less so with Matrix Orbital modules. Matrix orbital modules are not capable of failing to acknowledge an incorrectly received byte in response to that bytes transition. They are only capable of failing to acknowledge the bytes following the byte, which was not received. To fully understand the reasons for this one needs to understand something about how a Matrix Orbital module processes data. Basically the reason why a Matrix Orbital module might fail to receive a byte correctly is that it was unable to process the byte previous before the failed byte was transmitted. Because the module cannot possibly know that it would be unable to store the byte before the next byte was received it cannot know to not ACK. The reason for this situation in deference to situations you might be familiar with (i.e. memory chips, etc…) is that the Matrix Orbital module employs a microprocessor to perform these data storage functions. A memory chip takes care of these things entirely with in hardware subsystems that operate at the same speed as the transmission themselves.

The LK404-55 uses a standard Phillips 7bit address as defined by Phillips. How ever, we at Matrix Orbital specify I2C address in 8bits. The 8th bit, least significant bit (LSB or Low Order Bit) of the 8bit address is read/write bit. If we take a standard Phillips 7bit address of 45hex this would be in binary 1000101. This is 7bits. If one adds the read write bit to this 7bit address and you assume that you are writing one gets 10001010. Matrix Orbital would describe the Philips I2C address of 45hex as 8Ahex. The read address would be 8Bhex. Much more detail on this basic I²C function can be found in the I²C specification by Philips. A good reference is also available at...

http://www.ping.be/~ping0751/i2cfaq/i2cindex.htm

2.2 General Purpose Outputs

The GLK12232-25-SM has two general purpose outputs, G1 and G2. These are provided to control relays or other electronic devices. This allows external devices to be turned on or off using your PC or controller and software commands. (See sections 7.1.6 and 7.1.7 for the command syntax.)

The two outputs differ slightly in specification:

- G1 provides an output which is switched LOW when ON. When G1 is OFF it is pulled up to +5V through 150 kohms, in other words it can only be used to "ground" an external device. Maximum current is 250 mA.
- G2 provides an output which is switched LOW when ON. When G2 is OFF it is pulled up to +5V, supplied by the module. Maximum current is 250 mA.

Both outputs are referenced to ground.

Typical use of these outputs is shown in Figure 2-2.

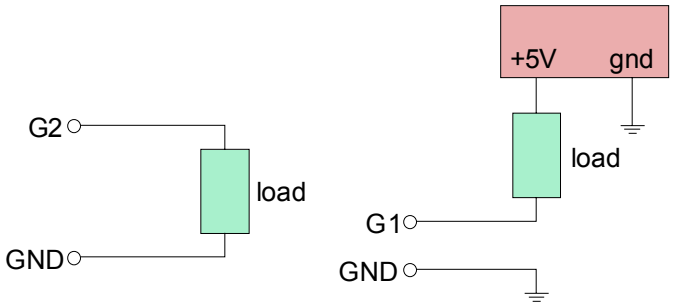


Figure 2-2 Using the General Purpose Outputs

If the device which is being driven by a GPO requires a relatively high current (such as a relay) it must have an internal resistance greater than 250 ohms, or must be current limited to 20 mA by means of a suitable resistor.

Note: The GPOs do not have any over current or over/under voltage protection so care must be taken when using them. For instance if the external device is a relay it must be fully clamped (using a diode and capacitor) to absorb any generated back electro-motive force (EMF).

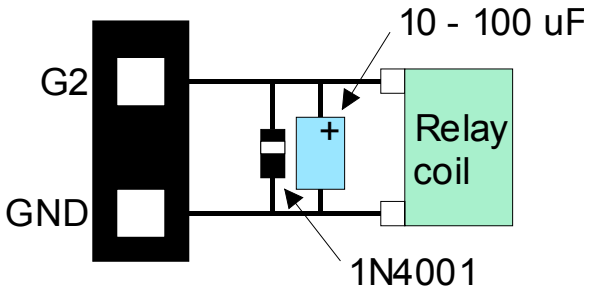


Figure 2-3 Clamping a Relay

3. Displaying Text

This chapter describes the various text-display commands in detail. A quick reference summary of all text commands is found in section 8.3.

3.1 General

Text is displayed on the GLK12232-25-SM using fonts saved in its internal flash memory. The GLK12232-25-SM is supplied with a 5 x 7 font installed. If this suits your needs you don't need to install any other fonts. If you prefer to install your own fonts, instructions are given in section 6.2.

3.2 Writing Text to the Display

When the display receives a character, it displays that character at the position currently defined. The next character sent to the module then advances to the following position on the display. Characters are drawn using the currently selected font, and only characters defined in the current font are actually processed. Characters that are not defined by the current font are ignored, and the positioning is not advanced for the next character.

The position where text is to be displayed is a single pixel location stored in the GLK's volatile memory and maintained internally by the GLK's firmware. It can be manually manipulated with two commands:

Set current text position (254 71 [col] [row]) positions the characters using a text oriented coordinate system, dividing the display into character cells.

Set text cursor - pixel values (254 121 [x][y]) Sets text cursor to position (x,y), where x and y are in pixels. Value is top left corner of next text character. This positions the character at a specific pixel, allowing more "fine grained" control when needed.

3.3 Text Commands

In this section commands are identified by their names and decimal values. Hex and ASCII equivalents are given in the summary (Table 8-1).

3.3.1 Auto scroll on (254 81)

When auto scrolling is on, it causes the GLK to shift the entire display's contents up to make room for a new line of text when the text reaches the scroll position defined by the "Set Font Metrics" command in the GLK memory (normally the bottom right character position - default value for the GLK12232-25-SM is 32).

3.3.2 Auto scroll off (254 82)

When auto scrolling is disabled, text will wrap to the top left corner of the display area. Existing graphics or text in the display area are not erased before text is placed; when using proportional fonts without auto scrolling, care should be taken to clear areas where text is being written, particularly when wrapping occurs. This may be done using the Draw Solid Rectangle command (see section 4.2.6) with the colour set to white.

3.3.3 Set text insertion point (254 71 [col] [row])

This command sets the insertion point to the [column] and [row] specified. The insertion point is positioned using the base size of the current font (this command does not position the insertion point at a specific pixel). The pixel column used is determined by multiplying the width of the widest character in the font by [column]. The pixel row used is determined by multiplying the height of the font by [row + interline

spacing] (see Set font metrics, below). If precise pixel-based text positioning is required, see "Set text insertion point – pixel values", below.

3.3.4 Set current text insertion point to top Left (254 72)

This command moves the text insertion point to the top left of the display area, based on the metrics of the current font. Refer to the "Set Font Metrics" command below for more details.

3.3.5 Set text insertion point using pixel values (254 121 [x][y])

This command sets the next position for text placement to an individual pixel location. The coordinate ([x position],[y position]) defines a pixel on the screen where the top left corner of the screen is defined as (0,0). This pixel location will be used as the top left corner of the next character of text which is sent to the module without any regard to "font metrics" like character spacing or line spacing.

3.3.6 Set current font (254 49 [font ID])

This command instructs the GLK12232-25-SM to use the font specified by [font identifier] as the default font. The value specified should refer to a font already present in the GLK12232-25-SM's memory.

Note: the font ID is established when the font is saved to the GLK12232-25-SM, normally using the mogd.exe program. The installed 5x7 font ID is “1”, unless changed by user.

3.3.7 Set font metrics (254 50 [metrics])

Where [metrics] = [left margin][top margin][x space][y space][scroll row]

This command defines the metrics of a font already present in the GLK12232-25-SM's memory.

- [left margin] specifies the first pixel column to use for the first character in a row. In some instances, a font may not evenly fit on the screen, and dividing the extra space between the margins will improve the overall appearance of the font.
- [top margin] specifies the top pixel row to begin drawing the first row of text on the display area.
- [x space] specifies the number of pixels to place between characters (i.e. character spacing).
- [y space] specifies the number of pixels to place between rows of text (i.e. line spacing).
- [scroll row] specifies the pixel row where scrolling should start (or, if auto scrolling is off, where wrapping should occur). Typically, this value should be set to the first pixel row immediately below the last row of text that will fit the display.

4. Displaying Graphics

This chapter describes the various graphics-display commands in detail. A quick reference summary of all graphics commands is found in section 8.4.

4.1 General

Since the GLK12232-25-SM is a bit mapped device, it may be used to display graphics. Graphic images may be created by means of a pixel-oriented graphics program, saved as bitmaps, and loaded into the GLK12232-25-SM using the mogd.exe program. Images may be saved in the GLK12232-25-SM's memory, and displayed upon command, or they may be downloaded "on the fly" (inline) during GLK12232-25-SM operation.

Note that "saved" and "on the fly" graphics images are processed differently. These differences must be taken into account when processing graphics.

Saved bitmaps use each byte (8 bits) to represent a vertical column of 8 pixels. The next byte represents the next column to the right If the graphic is "taller" than 8 pixels, the LSB of the next data byte will be the next pixel. Orientation is top to bottom – LSB to MSB. Pixels/bits are “packed” – that is, if the height of the graphic is not an even multiple of 8, the leftover bits go on the next X column to the right), etc. (see the figure below).

Inline bitmaps are processed horizontally, and each byte represents a horizontal row of 8 bits, with the next byte representing the next 8 bits to the right Orientation is left to right – MSB to LSB, which is the opposite to the serial transmission sequence (bytes are sent LSB first).

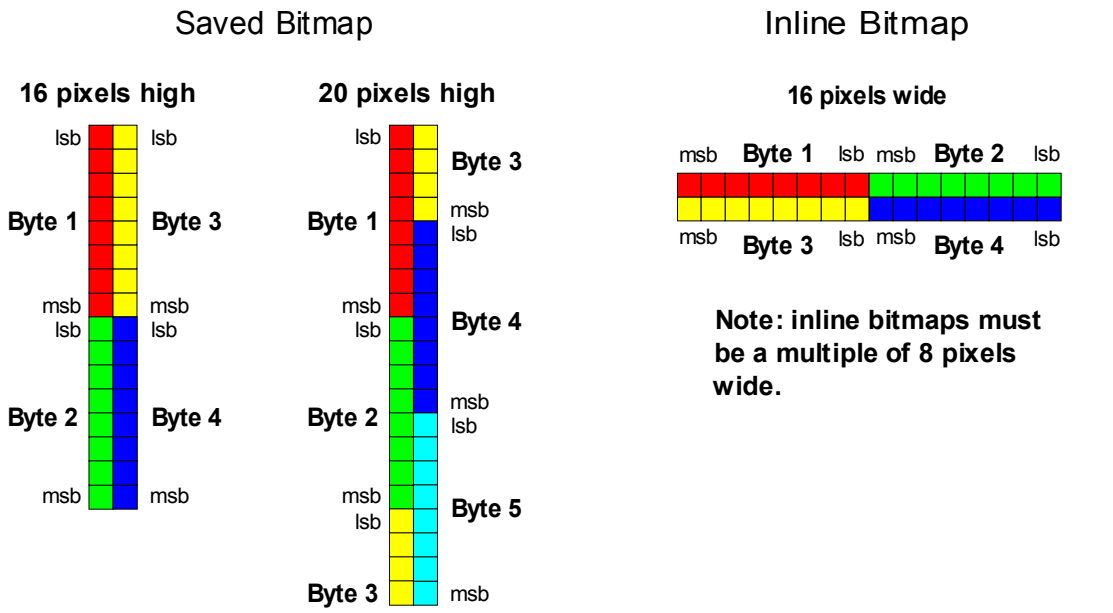


Figure 4-1 Graphic bitmaps

Each pixel in a bitmap is described by a single bit, and may only have the values ON or OFF, i.e. shades of gray are not supported.

4.2 Graphics Commands

In this section commands are identified by their names and decimal values. Hex and ASCII equivalents are given in the summary (Table 8-2).

The coordinate origin (0,0) is at the top left corner of the display. X values go from 0 to 121 (increasing towards the right) and Y values go from 0 to 31 (increasing towards the bottom).

4.2.1 Set drawing color (254 99 [color])

This command sets the drawing color for subsequent graphic commands that do not have the drawing color passed as a parameter. The parameter [color] is the value of the color where white 0 Hex, and black is 255 Hex. *Note: All non-zero values will display as black.*

4.2.2 Draw line (254 108 [x_1][y_1][x_2][y_2])

This command will draw a line from (x_1,y_1) to (x_2,y_2) using the current drawing color. Lines may be drawn from any part of the display to any other part, but may be important to note that the line may interpolate differently right to left, or left to right. This means that a line drawn in white from right to left may not fully erase the same line drawn in black from left to right.

4.2.3 Continue line (254 101 [x][y])

This command will draw line with the current drawing color from the last line end (x_2,y_2) to (x,y). This command uses the global drawing color so the Set Drawing Color command should be used before the first line segment if required.

4.2.4 Put pixel (254 112 [x][y])

This command will draw a pixel at (x,y) using the current drawing color. The unit processes these requests fast enough to keep up with a steady stream at 115 kbaud, so flow control is not required.

4.2.5 Draw outline rectangle (254 114 [color][x_1][y_1][x_2][y_2])

This command draws a rectangular box in the specified color (0 = white, non-zero = black). The top left corner is specified by (x_1,y_1) and the bottom right corner by (x_2,y_2).

4.2.6 Draw solid rectangle (254 120 [color][x1][y1][x2][y2])

This command draws a solid rectangle in the specified color (0 = white, non-zero = black). The top left corner is specified by (x_1,y_1) and the bottom right corner by (x_2,y_2). Since this command involves considerable processing overhead, we **strongly recommend** the use of flow control, particularly if the command is to be repeated frequently (see section 4.3).

This procedure is common for monitoring applications where there is a “field” on the display that is constantly being updated from, say, a temperature sensor.

4.2.7 Initialize bar graph (254 103 [ref][type][x_1][y_1][x_2][y_2])

This command initializes a bar graph referred to by number [reference number] of type [type] with size from (x_1,y_1) (top left) to (x_2,y_2) (bottom right). A maximum of 16 bar graphs with reference numbers from 0 to 15 can be initialized as:

[type = 0]	Vertical, bottom referenced
[type = 1]	Horizontal left referenced
[type = 2]	Vertical top referenced
[type = 3]	Horizontal right referenced

The bar graphs may be located anywhere on the display, but if they overlap, they will not display properly. Note: it is important that [x_1] is less than [x_2], and [y_1] is less than [y_2].

This command doesn't actually draw the graph, it must be "filled in" using the Write to bar graph command, described below. The unit saves time by only drawing that part of the bar graph which has changed from the last write, so the representation on the screen may not survive a screen clear or other corrupting action. A write of value zero, followed by new values will restore the proper look of the bar graph.

4.2.8 Write to bar graph (254 105 [reference number][value])

Once the bar graph has been initialized it can be "filled in" using this command. This command sets the bar graph [reference number] to value [value]. [value] is given in pixels and should not exceed the available height/width of the graph. (If it does, the graph will simply be written to its maximum size.)

4.2.9 Display saved bitmap (254 98 [reference number][x][y])

This command causes a previously stored bitmap referenced by [reference number] to be displayed to the screen at pixel location (x, y) where this location defines the top left corner of the bitmap. *Note: The reference number is established when the bitmap is saved, normally using mogd.exe.* Bitmaps and fonts may use the same reference numbers, i.e. you can have both a bitmap 1 and a font 1.

4.3 Flow Control

The GLK12232-25-SM has built-in flow control which is very useful during multiple pixel placement. Flow control is enabled or disabled by two commands (see Table 8-5 and the next two sections). If flow control is enabled, the GLK12232-25-SM will return an "almost full" message (0xFE) to the controller when its internal buffer fills to a defined level, and an "almost empty" message (0xFF) when the buffer contents drop to a defined level.

4.3.1 Enter Flow Control Mode (254 58 [full][empty])

Note: Flow control applies only to the RS-232 interface. It is not available for I^2C.

This command enables flow control. When the buffer fills so that only [full] bytes are available the GLK12232-25-SM will return an "almost full" message (0xFE) to the controller. When the buffer empties so that only [empty] bytes remain the GLK12232-25-SM will return an "almost empty" message (0xFF) to the controller.

The GLK12232-25-SM will return the "almost full" message for every byte sent to the GLK12232-25-SM until the used buffer space once more drops below the [full] level.

Whether the user is in ‘Flow Control Mode’ or not, the module will ignore display or command bytes which would overrun the buffer. While in ‘Flow Control Mode’ the unit will return 0xFE when buffer is almost full even though it may have already thrown rejected data away. The buffer size for the GLK12232-25-SM is 96 bytes.

When using this command in an application, selection of the value for the buffer almost full should be considered very carefully. This is a critical aspect of using this command to it’s full potential. When using a host system or PC which contains a FIFO, the user should set the value of equal to or greater than the size of the FIFO. The reason for this is that the FIFO may be full when the host system receives 0xFE. In the case of 16550 UART the size at its maximum is 16, therefore the value of should be set to 16 or greater.

This mode must not be used during loading of fonts and bitmaps. It is highly recommended for use with direct screen write and multiple pixel placements.

4.3.2 Exit Flow Control Mode (254 59)

This command turns off flow control. Bytes may overflow the buffer without warning.

5. Keypad Interface

This chapter describes the keypad interface and associated commands in detail.

5.1 General

The GLK12232-25-SM keypad interface processes the keypad row/column matrix into a serial (RS-232 or I^2C) data byte stream. Aside from this processing, the keypad has no effect on the GLK12232-25-SM display. If you need to send keystrokes to the display, they must be routed through your controller.

5.2 Connections

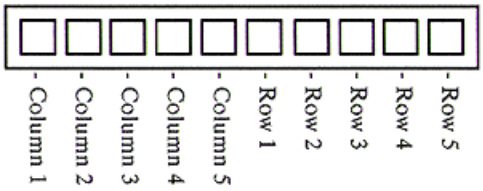


Figure 5-1 Keypad Connector

The connector is not "keyed" so your keypad will probably plug in either of two ways. The GLK12232-25-SM will not be damaged by reversing the connector, but your keypad will generate a different ASCII character mapping for each position. If your connector has fewer than 10 pins it should probably be centered on the GLK12232-25-SM connector.

The returned key codes are as follows, but note that your keypad may be laid out in a different pattern. If this is the case, you will need to interpret the key codes differently. The diagram 1 shows the logical layout (row 1, column 1 in upper left). The connector for the keypad is a 10 pin 0.1" spacing male header. Pin 1 is indicated in

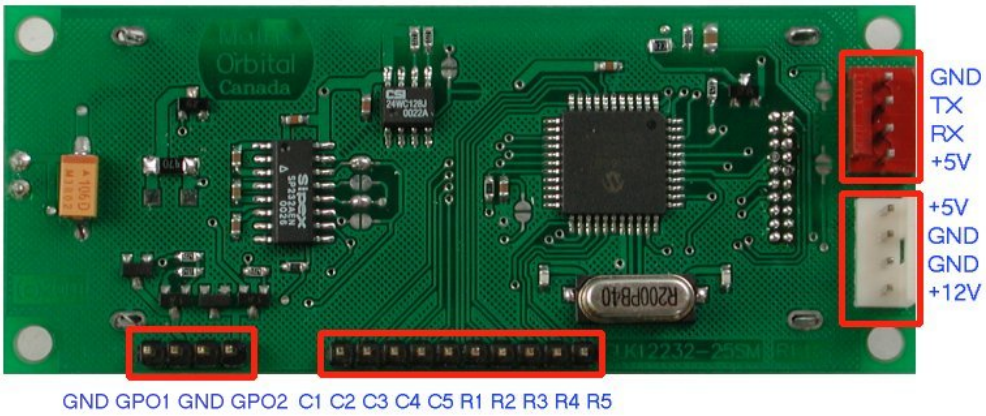


Figure 2-1. Pins 1 through 5 are columns and pins 6 through 10 are rows. The keypad is scanned whenever a key is pressed: there is no continuous key scan. This means that key presses are dealt with immediately without any appreciable latency. This also prevents electrical noise which is often caused by continuous key scans.

		Columns				
		1	2	3	4	5
Rows	1	A	B	C	D	E
	2	F	G	H	I	J
	3	K	L	M	N	O
	4	P	Q	R	S	T
	5	U	V	W	X	Y

Note: The keypad connector must be wired with columns on one side and rows on the other side of the center of the connector. If your keypad isn't wired this way you will need to make an adapter or rewire the connector to meet this requirement.

5.3 I²C Interface

The keypad is read by I²C master read. In short, this means that a read of the module will always return the first unread key press. A read is initiated by writing to the module with its base address plus 1, then clocking the module's return byte after the module releases the SDA line. Much more detail on this basic I²C function can be found in the I²C specification by Philips. A good reference is also available at

http://www.ping.be/~ping0751/i2cfaq/i2cindex.htm

The module contains a ten key press buffer so that it can be polled for key presses at an infrequent rate (every 500 to 1000 mS is typical). All returned key presses indicate the presence or absence of additional logged key presses by the most significant bit (MSB - bit 7). If the user has pressed two keys since the last poll of the keypad interface, the first read will return the key code with bit 7 set and the second read will return the key code with bit 7 clear. The application must take into account this bit to keep up with user key presses. If there are no keypresses detected, the module will return zero (0x00).

5.4 RS-232 Interface

By default on any press of a key, the module will immediately send out the key code at the selected baud rate. This behavior can be modified using commands found in the next section.

5.5 Commands

5.5.1 Auto repeat mode on (254 126 [mode])

[mode] = 0 gives Resend Key Code mode

[mode] = 1 gives Key down / Key up code mode

Two Modes of auto repeat are available and are set via the same command.

1. ***Resend Key Code:*** This mode is similar to the action of a keyboard on a PC. In this mode, when a key is held down, the key code is transmitted immediately followed by a 1/2 second delay. After this delay, key codes will be sent via the RS - 232 interface at a rate of about 5 codes per second. This mode has no effect if polling or if using the I²C interface.

2. ***Key down / Key up codes:*** This mode may be used when the typematic parameters of the Resend Key code mode are unacceptable or if the unit is being operated in polled mode. The host system detects the press of a key and simulates an auto repeat inside the host system until the key release is detected.

In this mode, when a key is held down, the key code is transmitted immediately and no other codes will be sent until the key is released. On the release of the key, the key release code transmitted will be a value equal to the key down code plus 20 hex. For example, the key code associated with key 'P' (0x50) is pressed, the release code is 'p' (0x70).

In RS-232 polled mode (see 5.5.4 below) or via the I²C interface, the key down / key up codes are used; however, the user should be careful of timing details. If the poll rate is slower than the simulated auto – repeat it is possible that polling for a *key up* code will be delayed long enough for an unwanted key repeat to be generated (see Figure 5-2).

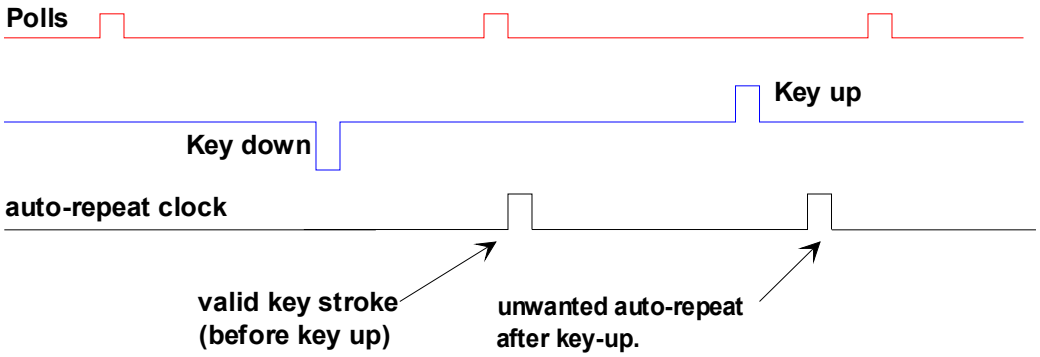


Figure 5-2 Poll timing

5.5.2 Auto repeat mode off (254 96)

This command turns off auto repeat mode.

5.5.3 Auto transmit keypresses on (254 65)

In this mode, all keypresses are sent immediately to the host system without the use of poll keypad command. This is the default mode on power up.

5.5.4 Auto transmit keypresses off (254 79)

In this mode, up to 10 keypresses are buffered until the unit is polled by the host system via the poll keypad command. Issuing this command places the unit in *polled mode.*

5.5.5 Clear key buffer (254 69)

This command clears any unread keypresses. In a menuing application, if the user presses a key which changes the menu context, any following key presses may be inaccurate and can be cleared out of the buffer between menu changes to prevent jumping around the menu tree. It may also be used to, in effect, reset the keypad in case the host application resets for whatever reason.

5.5.6 Poll keypad (254 38)

This command returns any unbuffered keypresses via the RS - 232 interface. The host system must be set up to receive the key codes. When the GLK12232-25-SM receives this command it will immediately return any unbuffered keypresses which may have not been read already. If there is more than one keypress buffered, then the high order bit (MSB) of this returned keycode will be set (1). If this is the only buffered keypress, then the MSB will be reset (0). If there are no buffered keypresses, then the returned code will be 0x00. Please note to make use of this command the “Auto Transmit Keypress” mode should be off.

5.5.7 Set debounce time (254 85 [time])

[time] is in increments of 6554 microseconds.

This command sets the time between key press and key read. 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 52 mS, 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 6554 microseconds.

6. Fonts and Graphics Files

6.1 General

Matrix Orbital graphic modules contain a sophisticated file system for storing and retrieving font information, bitmaps and system parameters; not unlike the way that a computer deals with files on a hard drive. However, the modules use no moving parts, therefore, data is stored far more reliably than data on a home PC.

Operationally, there is one important difference between the Matrix Orbital file system and that of a PC. While a PC will allow fragmentation of its files across the available file space, the Matrix Orbital file system takes great care to ensure that all parts of a file are stored together. This system works well to maximize storage space and operational efficiency, however, during file downloads, the modules may need to spend considerable time moving files to make room for the new file. This delay during download can be as much as a minute, but generally it will not exceed 10 seconds.

When a file is being downloaded with the same "name" or reference number as previously existing file, the old file needs to be deleted first. Since we cannot know if the new file is exactly the same size as the old file, that space vacated by the old files filled by moving previously existing files down to fill up the vacated space. This ensures that no file space is wasted.

Of course, the average module will simply have files loaded into it and it will then get to work, without ever having to perform this file reorganization task. The file space may be rewritten up to 100 000 times, but most users will simply load in their fonts and bitmaps once and that will be it.

6.2 Using mogd.exe

The Matrix Orbital Interface program "mogd.exe", which is provided on the disk and the website, generates and saves fonts larger than 14 pixels in height. It is also used to save graphic images (bitmaps) to the GLK12232-25-SM.

To make use of smaller fonts it is recommended that you use a pre-generated font. You will find these fonts on the disk or the website. Unfortunately, integrating these fonts is not as straight forward as generating the fonts yourself. To make use of these fonts you must place the font files in your font directory as defined in the interface program. You can find and define this directory under "settings".

A font file consists of a single file with an extension .mgf and a directory which contains bitmaps for every character. All .mgf files are contained within the font directory and all bitmap directories are sub directories of the font directory. After download of a font file use a “Zip” program to “UnZip” the .mgf file and bitmap sub-directory into your font directory. Start or restart mogd.exe and click on the font tab. You should now see your new pre-generated font listed in the font list of mogd.

6.3 Commands

In addition to the commands listed below, you may use the mogd.exe program to save fonts and bitmaps to the GLK12232-25-SM's flash memory.

6.3.1 Erase file (254 45 [type] [ref])

This command erases a file within the GLK12232-25-SM memory. This command erases a single file at a time.

This command needs to be given two parameters: [type] and [ref]. The file type and reference number are defined when the file is saved to the GLK12232-25-SM using mogd.exe. Since there is no command to list files in memory, the user must keep track of the memory contents.

[type] = 1 is a font file

[type] = 5 is a bitmap

Once this command is completed all files “move up” and recover the empty space for efficient memory management.

6.3.2 Purge memory (254 33 89 33)

This command completely erases the GLK12232-25-SM's non-volatile memory. This removes all fonts, font metrics, bitmaps, and settings (current font, cursor position, communication speed, etc.). It is an "odd" command in that it is three bytes in length. This is to prevent accidental execution.

6.3.3 Upload Font (254 36 [ref] [file size] [file data])

This command begins a font upload to the GLK12232-25-SM's non-volatile memory. [ref] is the reference number to be used for this font. File size is a 2 byte value that must be calculated by the host before the transfer takes place. See section 6.4 for details.

6.3.4 Upload Bitmap (254 94 [ref] [file size] [file data])

This command begins a bitmap upload to the GLK12232-25-SM's non-volatile memory. [ref] is the reference number to be used for this bitmap. File size is a 2 byte value that must be calculated by the host before the transfer takes place. See section 6.5 for details.

6.4 Working with Font Files

A font file consists of a header, a character list, and character bitmaps.

The header consists of:

- Placeholder for actual EOF (2 bytes, use 0xFF 0xFF – these bytes will be set to their final value by the module)
- Nominal character width (1 byte)
- Absolute font height (1 byte)
- ASCII value of first character defined in this file (1 byte)
- ASCII value of last character defined in this file (1 byte)

The character list consists of groups of 3 bytes per character:

- Offset to character bitmap (2 bytes)
- Actual width of this character (1 byte)

The character bitmaps are described in section 6.4.3.

6.4.1 Font File in Table Form

The table below shows the layout of a font file in table form.

File Format (Font)

0xFF	0xFF	X size	Y size	Start	End	O-High	O-Low
Width	O-High	O-Low	Width	O-High	O-Low	Width	O-High

O-Low	Width	O-High	O-Low	Width	O-High	O-Low	Width
O-High	O-Low	Width	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data	Data	Data	Data
Data	Data	Data	Data	Data			

6.4.2 Uploading the File to the Module

The Upload Font command is used to actually upload the font file. Recall that the syntax for this command is:

0xFE 0x24 [ref] [file size] [file data]

In this example the file size is 94 bytes (0x5E) and the reference number is 2. The communications exchange between the host and the module looks like this:

Host sends	Module sends
0xfe	
'$' (command)	
'2' (reference)	
	'2' (echo reference)
0x01 (host confirms echo)	
0x5e (low size)	
	0x5e (echo)
0x01 (host confirms echo)	
0x00 (high size)	
	0x00 (echo)
	0x01 (file fits)*
0xFF (first byte of data)	
	0xFF (echo)
0x01 (host confirms echo)	
0xFF (second byte of data)	
	0xFF (echo)
0x01 (host confirms echo)	
0x20 (third byte of data)	
	0x20 (echo)
0x01 (host confirms echo)	
etc	

* If the module detects that the file will not fit in the available memory when the file size has been transmitted, it will send 0x08 instead of 0x01. In this case, the host should cease transmission. The module will return to a ready state.

From this point, the module treats all data as raw and just stores it away. The module will store the data, then read it back from memory and send the read value back to the host. If the host system receives an incorrect echo, it should send status as 0x08 instead of 0x01. This will terminate the transfer. Upon termination, the module will delete the partially completed file and return to a ready state.

6.4.3 A Sample Font File

Let's look at a short sample font file containing only the letters "h", "i" and "j". First we need to define the font size. For this example we'll use a 5 x 7 pixel font. Next, we have to draw the bitmaps for each of the characters. We'll use the examples shown in Figure 6-1.

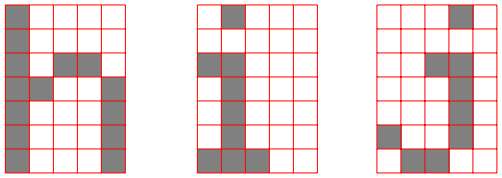


Figure 6-1 Bitmaps for h, i and j

Now the bitmaps have to be converted to bytes. If the font is 8 bits high, this is a pretty simple job because each vertical column is simply one byte (lsb at the top). In this case, however, the font is only 7 bits high so the bytes "wrap around" as shown in Figure 6-2.

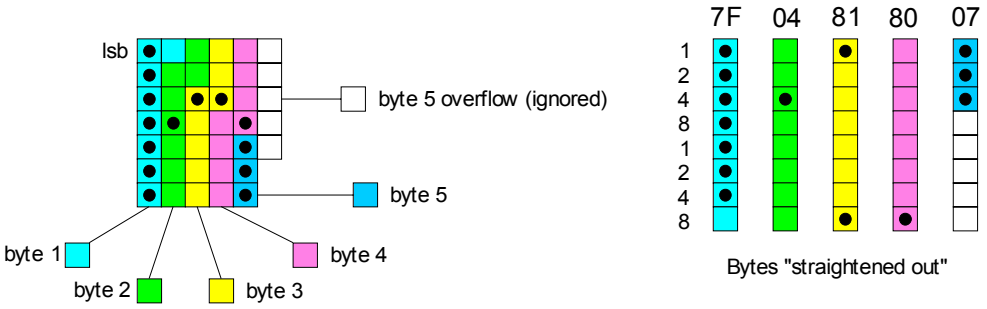


Figure 6-2 Bytes for a 7 bit high font

We've marked in the bits that are set for the letter "h". Remember that the bytes are "inverted", i.e. the LSB is at the top. Each byte is shown in a different colour in the diagram. When the bytes are straightened out, it's simple enough to find their hex values, which are shown in the diagram above each byte. Trailing zero bytes at the end of narrow characters are not included in the file.

Now let's look at the file itself.

Example Font File (27 bytes)

0xFF	0xFF	0x05	0x07	0x68	0x6A	0x00	0x0F
0x05	0x00	0x14	0x03	0x00	0x17	0x04	0x7F
0x04	0x81	0x80	0x07	0xC4	0x3E	0x10	0x02
0x20	0xB1	0x07					

The colours refer to: Font information header, character 'h', character 'i', character 'j'.

Explanation of the bytes in the file:

(All values below are in hex)

FF FF	placeholders for actual EOF
05	font width
07	font height
68	first ASCII character defined

70	last ASCII character defined
00 0F	offset to definition of first character (h)
05	number of bytes in definition of first character
00 14	offset to definition of second character (i)
03	number of bytes in definition of second character
00 17	offset to definition of third character (j)
04	number of bytes in definition of third character
7F 04 81 80 07	definition of first character
C4 3E 10	definition of second character
02 20 B1 07	definition of third character

6.5 Working with Bitmap Files

Uploading a bitmap is the same as uploading a font file except that the character header information is not required.

The bitmap file consists of a header followed by the bitmap data. The header format is as follows:

- Placeholder for actual EOF (2 bytes, use 0xFF 0xFF – these bytes will be set to their final value by the module)
- x size of bitmap (1 byte)
- y size of bitmap (1 byte)

Bitmap data follows with the bits organized vertically from the top left (see Figure 4-1). The last byte may be padded with zeros.

Aside from the different header, bitmap file operations are identical to those described for font files in section 6.4.

7. Miscellaneous Commands

The commands listed in this chapter don't readily fit in any of the other categories, or are used in more than one category.

7.1.1 Clear display (254 88)

This command clears the display and resets the text write position to the top left of the screen.

7.1.2 Set contrast (254 80 [contrast])

This command sets the display's contrast to [contrast], where [contrast] is a value between 0x00 and 0xFF (between 0 and 255). Lower values cause "on" elements in the display area to appear lighter, while higher values cause "on" elements to appear darker.

Lighting conditions will affect the actual value used for optimal viewing. Individual GLK12232-25-SM modules will also differ slightly from each other in appearance. In addition, values for optimal viewing while the GLK12232-25-SM backlight is on may differ from values used when backlight is off.

7.1.3 Set contrast and save (254 145 [contrast])

This command works in exactly the same way as the “Set Contrast” command. The only difference is it saves the contrast value in the memory of the module, whereas, the previous command only changes the value for the duration of use.

7.1.4 Backlight on (254 66 [minutes])

This command turns on the backlight for a time of [minutes] minutes. (this specifies how long the backlight will remain on after receipt of the command). If [minutes] is zero (0), the backlight will remain on indefinitely. Note: backlight is always on by default on power up.

7.1.5 Backlight off (254 70)

This command turns the backlight of the GLK12232-25-SM off.

7.1.6 General purpose output off (254 86 [gpo #])

This command turns OFF either of the General Purpose Outputs (see section 2.2 for a description of the GPO). [gpo #] is 1 for G1 or 2 for G2. For G1 OFF allows the output to "float". For G2 OFF pulls the output to +5V.

7.1.7 General purpose output on (254 87 [gpo #])

This command turns ON either of the General Purpose Outputs. [gpo #] is 1 for G1 or 2 for G2. Note that ON means that the output is pulled low.

7.1.8 Set I^2C address 254 51 [address])

This command sets the I²C write address of the module. This value must be an even number and the read address is one higher. For example if the I²C write address is set to 0x50, then the read address is 0x51. The change in address is immediate. This address is 0x50 by default, and is reset temporarily back to that value when the "Manual Over-ride" jumper is used on power up (see section **Error! Reference source not found.**).

7.1.9 Read module type (254 55)

This command will return, over the RS-232 interface, the model type value of the module. Value will be 1-byte hex. Values for various modules at the time of this publication are as follows:

LCD0821 - 0x01	LCD2021 - 0x03	LCD1641 - 0x04
LCD2041 - 0x05	LCD4021 - 0x06	LCD4041 - 0x07
LK202-25 - 0x08	LK204-25 - 0x09	LK404-55 - 0x0A
VFD2021 - 0x0B	VFD2041 - 0x0C	VFD4021 - 0x0D
VK202-25 - 0x0E	VK204-25 - 0x0F	GLC12232 - 0x10
GLC12864 - 0x11	GLC128128 - 0x12	GLC24064 - 0x13
GLK12864-25 - 0x14	GLK24064-25 - 0x15	GLK128128-25 - 0x21
GLK12232-25 - 0x22	LK404-AT - 0x31	VFD1621 - 0x32
LK402-12 - 0x33	LK162-12 - 0x34	LK204-25PC - 0x35
GLK12232-25-SM - 0x24		

7.1.10 Set RS232 port speed (254 57 [speed])

This command sets the GLK's RS232 port to the specified [speed]. The change takes place immediately. [speed] is a single byte specifying the desired port speed. Valid speeds are shown in the table below. The GLK can be manually reset to 19,200 baud in the event of an error during transmission (including transmitting a value not listed below) by setting the "manual override" jumper on the GLK controller board during power up (see section **Error! Reference source not found.**). This command is ignored until this jumper is removed again.

Speed Value	Speed
20 Hex	9600 baud
0F Hex	**19200 baud**
95 Hex	57600 baud
03 Hex	76800 baud
8A Hex	115000 baud

7.1.11 Set Serial Number (254 52 [byte1] [byte2]

Modules may be delivered with the serial number blank. In this case the user may set the desired 2 byte serial number using this **one time only** command.

Upon the execution of this command, the module will echo these two bytes back over the RS-232 interface. The serial number may be set only once. Any future attempt to execute this command will result in no change and the module will return to the originally set serial number.

7.1.12 Read Serial Number (254 53)

This command will return, over the RS-232 interface, the two-byte serial number of the module as it was previously stored.

7.1.13 Read Version Number 254 54)

This command will return the firmware version number of the GLK12232-25-SM. It will be a 1-byte hex value.

8. Appendix: Command Summary

8.1 General

The operation of the GLK12232-25-SM is controlled by a simple and consistent command set. Commands control

- text display
- graphics display
- keypad interface
- the GLK12232-25-SM file system
- miscellaneous operating parameters

This chapter includes summary tables of all commands. Individual commands are discussed in detail in Chapters 3 to 7.

8.2 Issuing Commands

Commands are issued to the GLK12232-25-SM by the controller. In a test setup, commands can be issued to the GLK12232-25-SM by means of a BASIC program, using the chr$( ) function. In the tables below, we've shown commands in hex, ASCII and decimal form. All commands begin with the prefix character 0xFE (254 decimal). These commands are issued on the serial communications link (I^2C or RS-232) at the currently defined baud rate.

For example (using BASIC in a test setup), you could issue the command to clear the screen on the GLK12232-25-SM by including the line:

```
PRINT#1,chr$(254);chr$(88)
```

in your BASIC program. Or with C you could (using Zcomm serial library)

```
ZComm1->WriteCommByte(0xfe);
ZComm1->WriteCommByte('X');
```

8.3 Text Commands

See Chapter 3 for command descriptions.

Table 8-1 Text Commands

Command	Syntax	Default	Notes
Auto scroll on	FE 51 254 81 254 'Q'	off	Enables scroll at bottom of screen. Text will push display up one line to make room for new line.
Auto scroll off	FE 52 254 82 254 'R'	off	Disables auto scroll. Text will wrap to top left and overwrite existing text.

Command	Syntax	Default	Notes
Set text insertion point	FE 47 [col] [row] 254 71 [col] [row] 254 'G' [col] [row]	n/a	Sets text insertion point using the base size of the current font
Set text insertion point to top left	FE 48 254 72 254 'H'		This command moves the text insertion point to the top left of the display area, based on the metrics of the current font. See "Set font metrics" (section 3.3.7) for more details.
Set text insertion point using pixel values	FE 79 [x][y] 254 121 [x][y] 254 'y' [x][y]	n/a	Sets text insertion point to position (x,y), where x and y are in pixels. Value is top left corner of next text character.
Set current font	FE 31 [font id] 254 49 254 '1'	n/a	Sets font to [font id]. Font must be in memory.
Set font metrics	FE 32 [metrics] 254 50 [metrics] 254 '2' [metrics]	n/a	For definition of [metrics] see section 3.3.7.

8.4 Graphics Commands

Table 8-2 Graphics Commands

Command	Syntax	Notes
Set drawing color	FE 63 [color] 254 99 [color] 254 'c' [color]	Sets color (0 = white, 255 = black) for the various drawing commands.
Draw line	FE 6C [x_1][y_1][x_2][y_2] 254 108 [x_1][y_1][x_2][y_2] 254 'l' [x_1][y_1][x_2][y_2]	Draws a line from x1,y1 to x2, y2. x values are from 0 – 31 (decimal) and y values from 0 – 121 (decimal).
Continue line	FE 65 [x][y] 254 101 [x][y] 254 'e' [x][y]	Continues line from last line end (x2,y2) to (x,y). Uses current drawing color.
Put pixel	FE 70 [x][y] 254 112 [x][y] 254 'p' [x][y]	Puts pixel in position (x,y). Uses current drawing color.
Draw outline rectangle	FE 72 [color][x_1][y_1][x_2][y_2] 254 114 [color][x_1][y_1][x_2][y_2] 254 'r' [color][x1][y1][x2][y2]	Draws a rectangular outline using color [color].
Draw solid rectangle	FE 78 [color][x1][y1][x2][y2] 254 120 [color][x1][y1][x2][y2] 254 'x' [color][x_1][y_1][x_2][y_2]	Draws a solid rectangle using color [color].
Initialize bar graph	FE 67 [ref][type][x_1][y_1][x_2][y_2] 254 103 [ref][type][x_1][y_1][x_2][y_2] 254 'g' [ref][type][x_1][y_1][x_2][y_2]	Sets aside space for a bar graph. [ref] is reference number (0-15) for use by the Write to Bar Graph command. [type] has values: 0 = vertical, starting from bottom 1 = horizontal, starting from left 2 = vertical, starting from top 3 = horizontal, starting from right

Command	Syntax	Notes
Write to bar graph	FE 69 [ref][value] 254 105 [ref][value] 254 'i' [ref][value]	Fills the bar graph referred to as [ref] from start to [value]. [value] is in pixels.
Display saved bitmap	FE 62 [ref][x][y] 254 98 [ref][x][y] 254 'b' [ref][x][y]	Causes bitmap [ref] to be displayed with its top left corner starting at position (x,y).

8.5 Keypad Interface Commands

Table 8-3 Keypad Interface Commands

Command	Syntax	Default	Notes
Auto repeat mode on	FE 7E [0|1] 254 126 [0|1] 254 '~' [0|1]	off	Applies to keypad only. 0 = 200 ms typematic, 1 = key down/key up codes sent.
Auto repeat mode off	FE 60 254 96 254 '`'	off	Applies to keypad only.
Auto transmit keypresses on	FE 41 254 65 254 'A'	on	Sets auto transmit mode for keypad. Keypresses are transmitted to host without polling.
Auto transmit keypresses off	FE 4F 254 79 254 'O'	off	Up to 10 keypresses buffered until polled.
Clear key buffer	FE 45 254 69 254 'E'	n/a	Clear unread keypresses.
Poll keypad	FE 26 254 38 254 '&'	n/a	Returns buffered keypresses to application. Returns 0x00 if no keypresses. High order bit set unless this is the last/only keypress.
Set debounce time	FE 55 [time] 254 85 [time] 254 'U' [time]	52 ms	Resolution: 1 = 6.554 ms

8.6 File System Commands

In addition to these commands, the mogd.exe program (see section 1.4) is used to download fonts and graphics to the GLK12232-25-SM.

Table 8-4 File System Commands

Command	Syntax	Default	Notes
Erase file	FE B0 [type] [ref] 254 45 [type] [ref]	n/a	Erases file in memory. Type = 1 is font, type = 5 is bitmap. [ref] is reference number.
Purge memory	FE 21 59 21 254 33 89 33	n/a	Removes all fonts, font metrics, bitmaps and settings from memory.
Upload bitmap	FE 5E [ref] [size] [data] 254 94 [ref] [size] [data] 254 '^' [ref] [size] [data]	n/a	Uploads a bitmap to the memory of the GLK12232-25-SM. See section 6.5.
Upload font	FE 24 [ref] [size] [data] 254 36 [ref] [size] [data] 254 '$' [ref] [size] [data]	n/a	Uploads a font to the memory of the GLK12232-25-SM. See section 6.4.

8.7 Miscellaneous Commands

Table 8-5 Miscellaneous Commands

Command	Syntax	Default	Notes
Clear display	FE 58 254 88 254 'X'	n/a	Clears screen of text and graphics, places text cursor at top left.
Set contrast	FE 50 [contrast] 254 80 [contrast] 254 'P' [contrast]	128	Sets display contrast. Compensates for viewing angle. Contrast is a value between 0 and 255 (hex 0 to FF). Larger = darker.
Set contrast and save	FE 91 [contrast] 254 145 [contrast]	128	Same as "set contrast" but saves [contrast] as default.
Backlight on	FE 42 [minutes] 254 66 [minutes] 254 'B' [minutes]	on	Backlight will stay on for [minutes]. If [minutes] = 0 backlight will stay on permanently.
Backlight off	FE 46 254 70 254 'F'	on	Turns off backlight.
General purpose output off	FE 56 [gpo #] 254 86 [gpo #] 254 'V' [gpo #]	off	Turns a general purpose output OFF. [gpo #] is 1 for G1 or 2 for G2. See section 2.2 for further details.

General purpose output on	FE 57 [gpo #] 254 87 [gpo #] 254 'W' [gpo #]	off	Turns a general purpose output ON. [gpo #] is 1 for G1 or 2 for G2. See section 2.2 for further details.
Set I^2C address	FE 33 [address] 254 51 [address] 254 '3' [address]	0x50	Value is write address and must be even, read address is 1 higher.
Read module type	FE 37 254 55 254 '7'	see table	Reads the module type. See table in section 7.1.9. Returns a 1-byte hex value.
Set RS232 port speed	FE 39 [speed] 254 57 [speed] 254 '9' [speed]	19,200	Sets RS232 speed. See table in section 7.1.10.
Enter flow control mode	FE 3A [full] [empty] 254 58 [full] [empty] 254 ':' [full] [empty]	off	Sets "full" and "empty" marks for the 96 byte display buffer. When buffer reaches [full] display will return 0xFE to host. When buffer reaches [empty] display will return 0xFF.
Exit flow control mode	FE 3B 254 59 254 ';'		Turns off flow control (buffer handshaking).
Set Serial Number	FE 34 [byte1][byte2] 254 52 [byte1][byte2] 254 '4' [byte1][byte2]		This is a one-time-use command which works only on units without factory set serial numbers.
Read Serial Number	FE 35 254 53 254 '5'		Reads the two byte serial number of the module.
Read Version Number	FE 36 254 54 254 '6'		Reads the firmware version number of the module. Returns a 1-byte hex value.

9. Appendix: Specifications

Environmental Specifications	
	Standard Temperature
Operating Temperature	0°C to +50°C
Storage Temperature	-20°C to +70°C
Operating Relative Humidity	90% max non-condensing
Vibration (Operating)	4.9 m/s² XYZ directions
Vibration (Non-Operating)	19.6 m/s² XYZ directions
Shock (Operating)	29.4 m/s² XYZ directions
Shock (Non-Operating)	490 m/s² XYZ directions

Electrical Specifications	
Supply Voltage	4.75 - 5.25 Vdc
Supply Current	18 mA typical
Supply Backlight Current	110 mA typical

Optical Characteristics	
Pixel Layout	122 x 32 pixels XxY
Number of Characters	80 (maximum 20 characters x 4 Lines with 5x7 font)
Display Area	53.20 x 13.60mm XxY
Dot Size	0.40 x 0.40mm (XxY)
Dot Pitch	0.44 x 0.44mm (XxY)
LED Backlight Life	100,000 hours typical
Color of Illumination	White/ Ice Blue

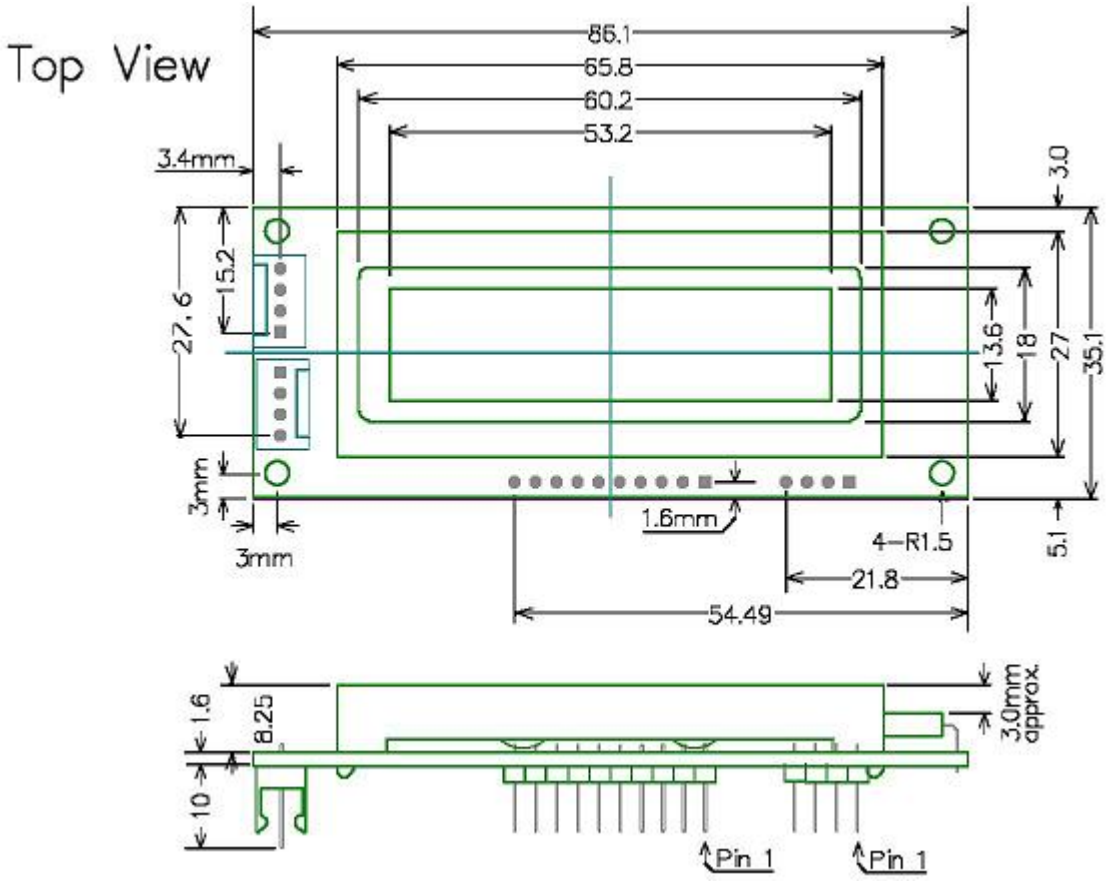


Figure 9-1 Physical Layout

10. Appendix: Glossary

ASCII	American Standard Code for Information Interchange. A 7 bit binary code representing the english alphabet, decimal numbers and common punctuation marks. "Also includes control characters" such as carriage return or end of text. An 8 bit superset of the standard ASCII codes is often used today to include foreign characters and other symbols. These supersets are often called extended ASCII character sets.
Backlight	A backlit display is illuminated from behind to provide nighttime and improved daytime readability.
Baud Rate	The (data and signaling) bit transmission rate of an RS232 device.
Binary Number	A number written using binary notation which only uses zeros and ones
Bit	The smallest unit of information a computer can work with. Each bit is either 0 or 1. Binary digit.
Bitmap	A representation, consisting of rows and columns of dots, of a graphics image in computer memory. The value of each dot (whether it is filled in or not) is stored in one or more bits of data.
Byte	A grouping of eight binary bits
CCFL	Cold Cathode Fluorescent Lamp. A high brightness backlighting source consists of a fluorescent tube powered by a high voltage A.C. source.
Configuration	The way a system is set up, or the assortment of components that make up the system. Configuration can refer to either hardware or software, or the combination of both.
Contrast	The ratio of luminance between the light state of the display to the dark state of the display.
Controller	The microcontroller or PC used to control the Matrix Orbital display unit.
DB-9	The designation of a connector used in the RS232 interface: 9 pin connector
Firmware	Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. ROMs, PROMs and EPROMs and flash EEPROMs that have data or programs recorded on them are firmware.
Font	A design for a set of characters. A font is the combination of typeface and other qualities, such as size, pitch, and spacing.
Font Metric	A definition of where font is to be placed, such as margins and spacing between characters and lines.
Hexadecimal	Refers to the base-16 number system, which consists of 16 unique symbols: the numbers 0 to 9 and the letters A to F. For example, the decimal number 15 is represented as F in the hexadecimal numbering system. The hexadecimal system is useful because it can represent every byte (8 bits) as two consecutive hexadecimal digits. It is easier for humans to read hexadecimal numbers than binary numbers.
I²C	Short for Inter-IC, a type of bus designed by Philips Semiconductors in the early 1980s, which is used to connect integrated circuits (ICs). I²C is a multi-master bus, which means that multiple chips can be connected to the same bus and each one can act as a master by initiating a data transfer.
Interface	A means by which two systems interact.

LCD	Liquid Crystal Display
Module Type Value	This refers to the model number of the module.
Pixel	The smallest individually controllable element of a display.
Pre-Generated Fonts	Pre-determined fonts which can be downloaded into graphic liquid crystal displays.
Primitive	A low-level object or operation from which higher-level, more complex objects and operations can be constructed. In graphics, primitives are basic elements, such as lines, curves, and polygons, which you can combine to create more complex graphical images
RS-232	Short for recommended standard-232C, a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices.
Scroll	To view consecutive lines of data on the display screen. The term scroll means that once the screen is full, each new line appears at the bottom edge of the screen and all other lines move up one position.
Serial Number	A number that is one of a series and is used for identification of the module
Serial Port	A port, or interface, that can be used for serial communication, in which only 1 bit is transmitted at a time.
Version Number	This refers to the firmware revision number of the module.
Volatile Memory	Temporary memory. Once the power supply is turned off volatile memory is then erased.

11. List of Distributors

North America

Canada

HVW Technologies
Suite 473, 300 - 8120 Beddington Blvd. NW
Calgary, Alberta, Canada T3K 2A8
Telephone: +1 403 730 8603
Facsimile: +1 403 730 8903
Email: info@hvwtech.com

Tri-M Systems Inc.
6-1301 Ketch Court
Coquitlam, BC V3K 6X7 Canada
Toll Free Telephone: 800-665-5600
Alternate Telephone: 604-527-1100
Facsimile: 604-527-1110
Email: info@tri-m.com

United States

EMJ Embedded Systems
Suite 100-1434 Farrington Road
Apex, North Carolina, USA, 27502
Toll Free Telephone: 1 800 436 5872
Facsimile: +1 919 363 4425
Email: sales@emjembedded.com

Jameco Electronic Components
1355 Shoreway Road
Belmont, California, USA, 94002-4100
Toll Free Telephone: 1 800 831 4242
Toll Free Facsimile: 1 800 237 6948
Email: sales@jameco.com
Carries a selection of Matrix Orbital Displays for more
information visit the Official Jameco Website.

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

United States (continued)

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11246 South Post Oak #205
Houston, Texas, USA, 77035
Telephone: +1 713 661 4214
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General Information: info@bipom.com
Technical Support: tech@bipom.com
Sales: sales@bipom.com

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Facsimile : +43 0 2236 431792
Email: oesterreich@elektronikladen.de

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Antratek Electronics
Cipalstraat 3,
2440 Geel Belgium
Telephone: +32 14 570557
Facsimile: +32 14 570556
Email: info@antratek.com

Finland

Symmetric Oy
Maria Jotunin Tie 11
Helinski, Finland 00400
Telephone: + 358 9 5885 322
Facsimile: + 358 9 5885 578
Email: symmetric@symmetric.fi

Europe (continued)

Germany

Elektronikladen Mikrocomputer Gmbh
Offices throughout Germany
Head Office: Wilhelm - Mellies - STR. 88,
D - 32758, Detmold
Telephone: +49 0 5232 8171
Facsimile : +49 0 5232 86197
Email: sales@elektronikladen.de

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Qnet
Via Circonvalazione Sud, 76
Codriopo, Udine, Italy, 33033
Telephone : +39 0 432 906062
Facsimile : +39 0 432 901514
Email: info@qnet.it

The Netherlands

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Kanaalweg 33,
NL-2903LR Capelle aan den Ijssel
The Netherlands
Telephone : +31 10 4504949
Facsimile: +31 10 4514955
Email: info@antratek.nl

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

Lilla Fabriken
Box 1003
SE-172 21 Sundbyberg, Sweden
Telephone: +46 8 287 286
Facsimile: +46 8 288 802
Email: info@lillfab.se

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Bernhard Elektronik
Aarauer Str. 20,
CH-5734 Reinach AG
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Unit 7, 42 - 50 Stud Road
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Telephone: + 61 39 720 5344
Facsimile: + 61 39 720 5268
Email: tim@alfatek.com.au