REFERENCE

4D SYSTEMS

TURNING TECHNOLOGY INTO ART

PICASO

SERIAL ENVIRONMENT COMMAND SET

PART OF THE WORKSHOP 4 IDE

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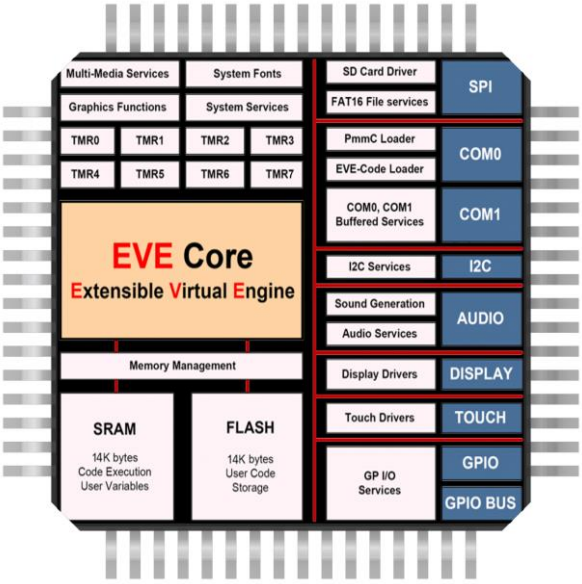
1. PICASO PROCESSOR

The PICASO Processor by 4D Labs is in a family of embedded graphics processors powered by a highly optimised soft core virtual engine, E.V.E. (Extensible Virtual Engine).

There are many 4D Products powered with the PICASO processor by 4D Labs, including:

- uLCD-24PT
- uLCD-24PTU
- uLCD-28PT
- uLCD-28PTU
- uLCD-32PT
- uLCD-32PTU
- uLCD-32WPTU
- uLCD-43P(/PT/PCT)
- uVGA-II
- uVGA-III

EVE is a proprietary, high performance virtual processor with an extensive byte-code instruction set optimised to execute compiled 4DGL programs. 4DGL (4D Graphics Language) was specifically developed from ground up for the EVE engine core. It is a high level language which is easy to learn and simple to understand yet powerful enough to tackle many embedded graphics applications.



PICASO Internal Block Diagram

The PICASO processor used in the above products can be configured in a number of ways, depending on the needs of the user. Using the Workshop 4 IDE by 4D Systems, the user has the choice of 4 programming environments, Designer, ViSi, ViSi-Genie and the Serial Environment.

This document targets the Serial Environment, how to configure a Display Module to be 'Serial Ready', and all the commands available in the Serial Environment to send the display from your Host Controller of choice.

For more information on the Workshop 4 Software in General or the other Environments available in Workshop 4, please refer to the Workshop 4 User Guide, available from the 4D Systems website, www.4dsystems.com.au

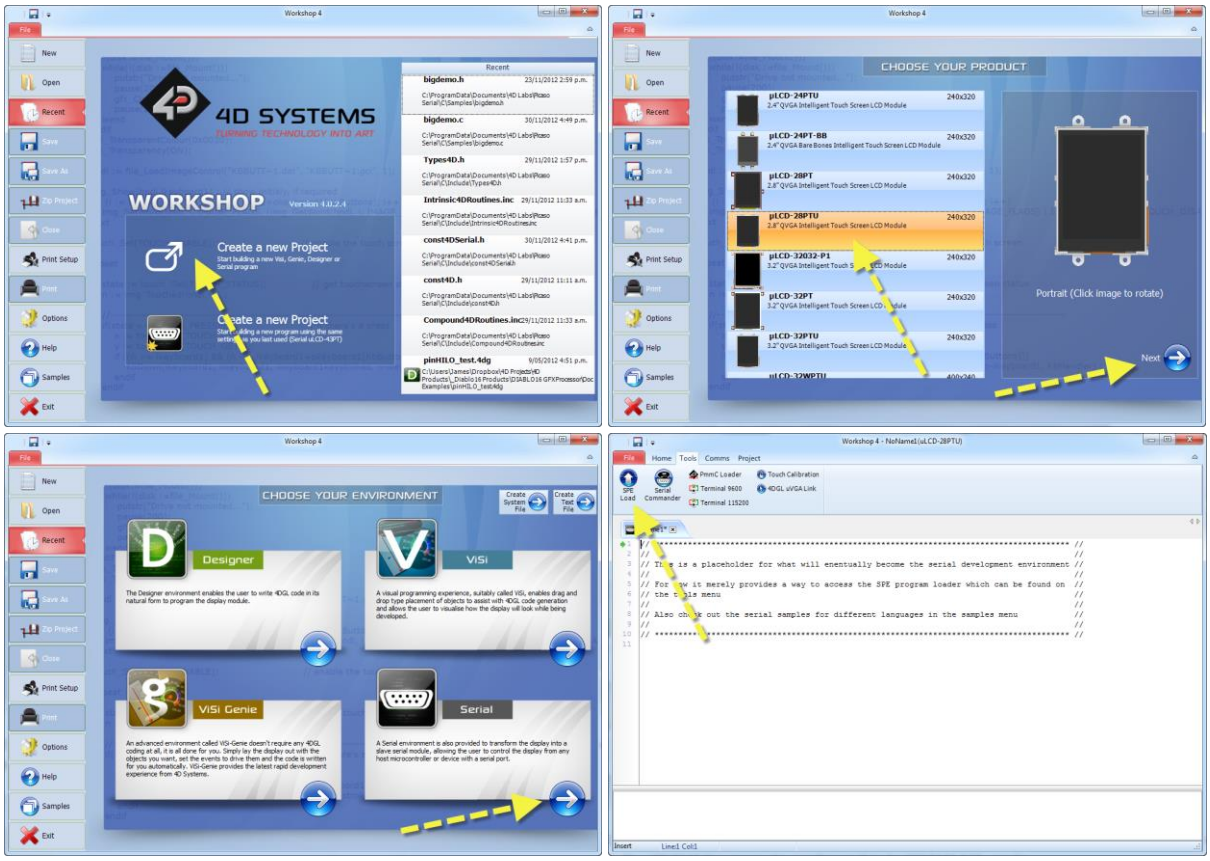
2. Introduction to using Workshop4 in the Serial Environment

The PICASO Processor can be programmed to act as a 'SERIAL SLAVE' device, responding to the Serial commands sent from virtually any Host Controller.

2.1. How to configure your Display Module as a Serial Slave

To set up your display module to be a Serial Display is a very simple process.

When a user starts the Workshop 4 IDE, starts a new project, selects their module of choice, and then selects the Serial Environment, the user is presented with a basic environment to get them started using their chosen display as a Serial Slave.



In the 'Tools' menu of the Serial Environment, is a button called 'SPE Load'. SPE stands for "Serial Platform Environment". If your display module is connected to the PC via the 4D Systems Programming Cable, clicking this button will load a special 4DGL application onto your module. This application is known as the SPE Application, and will enable your chosen module to run as a Serial Slave.

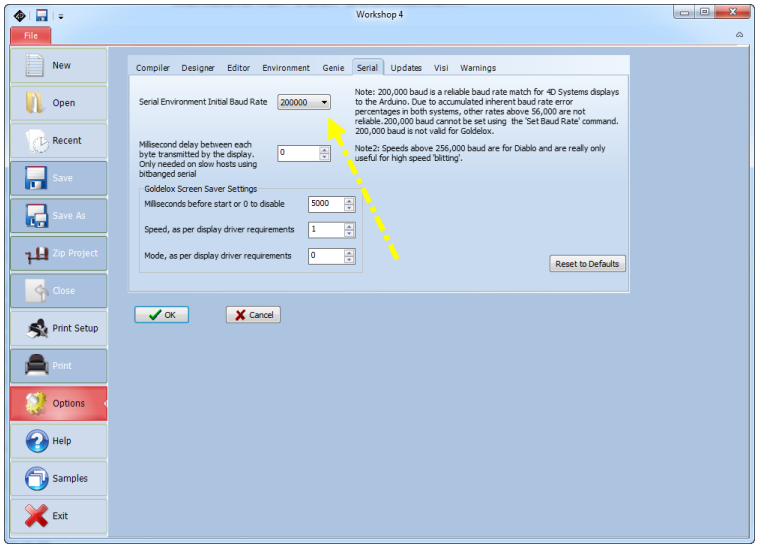
> The Display Modules are **SPE READY** by default, meaning the SPE Application has been loaded to each of the modules at the 4D Systems Factory. The user can reload the **SPE** Application if required, to update the **SPE Application** on board OR to move over to the **Serial Environment** from another Workshop 4 Environment such as Designer, ViSi or ViSi-Genie.

Once the chosen display module is 'SPE READY', either brand new out of the box, or programmed to have the SPE Application via the above instructions, the user can begin programming their Host of choice to communicate to the 4D Systems display module.

2.2. Additional configuration parameters for Serial Communication

When the SPE Application is loaded to the Display Module from the 4D Systems factory, the Baud Rate is set to the initial default of 9600.
This initial Baud Rate can be modified, so when the Display Module starts up, it is at the desired Baud Rate without having to send commands to change it from the Host.

To change the default Baud Rate, click on the Option button on the buttons down the left hand side of the Workshop 4 IDE, click on the Serial tab, and change the 'Serial Environment Initial Baud Rate' to be whatever is suitable for your application.

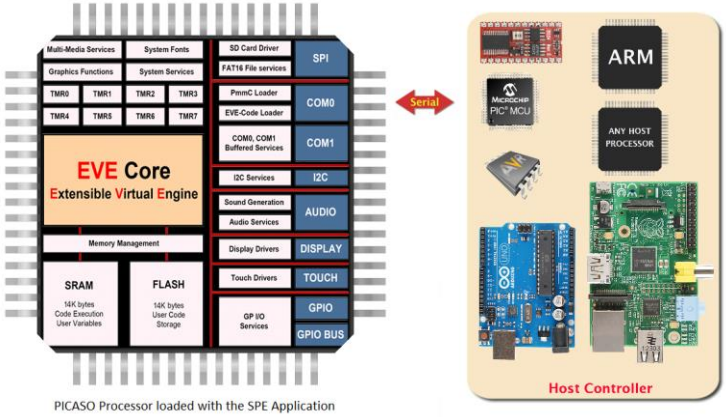


The initial Baud rate and 'slowdown' settings for slow systems can be set under 'options', 'serial' before loading SPE.

Once the desired Baud Rate has been set, along with any 'Slowdown' delay (where required), the Display Module needs to have the SPE Application loaded once again, so these settings can take effect.
Simply follow the instructions in Section 2, to load the updated SPE Application onto the Display Module.

2.3. Host Interface

When a Display Module is loaded with the SPE Application, it enables communication to a Serial Host over a bidirectional serial interface via its Serial UART. All communications between the host and the device occur over this serial interface. The protocol is simple and easy to implement.



PICASO Processor loaded with the SPE Application

- **Serial Data Format: 8 Bits, No Parity, 1 Stop Bit. Serial data is true and not inverted.**

2.4. Introduction and Guidelines to the Serial Protocol

The Serial Protocol used with the SPE Application is a set of commands with associated parameters, to enable the Host Controller to display primitives, text, images, play audio, video or data log to micro-SD card, receive touch events etc on the 4D Systems Display Module, in the simplest manner available.

The Serial Protocol is made up of commands and parameters, sent over the Serial Port in byte format to the Display Module. Each command is unique, and has a specific set of parameters associated with it. Each command that is sent to the Display Module is replied to with a response. Some commands do not specifically require a response, so for these commands the Display will reply with an Acknowledge once successfully executed.

Commands that require a specific response may send back a varying number of bytes, depending on the command and what the response is.

Each Command sent to the display will require a certain amount of time before the response is sent, again dependent on the command and the operation that has to be performed.

Commands should only be sent and their response received, before another command is sent. If two commands are sent before the first response is received, incorrect operation may follow.

2.5. Power-Up and Reset

When the PICASO Display Module comes out of a power-up or external reset, a sequence of events is executed internally. The user should wait at least 3 seconds for the start-up to take place before attempting to communicate with the module.

2.6. Splash Screen

The splash screen appears on the screen 5 seconds after the start-up routines have been executed, provided there has been no serial activity.

2.7. Power Supply

When powering 4D System display modules, odd behaviour can be experienced if they are not supplied sufficient current. This is especially noticeable when powering the Host Controller board and the Display Module from the same USB port of your computer.

Please ensure you power your 4D System display from a suitable power supply, based on the requirements of the display module, specified in the individual datasheets.

3. The Serial Command Set - Explained

The Serial Protocol and associated Commands enable the user to send bytes serially from the chosen Host Controller, to the 4D Display module loaded with the SPE Application, and control or receive information from, the Display Module.

In the PICASO Serial Protocol Command Set, there are currently 135 Commands available to the user.
Each command send to the Display Module will incur a response of some description from the Display Module. This may be in the form of data, or a simple ACK that the command has been received.

Here is an example to better illustrate a few commands.

3.1. Example 1 – Moving the Cursor

Aim: Moving the Cursor to a specific location on the display, so text can originate from that point.

MoveCursor Command: HEX 0xFFE9 (2 bytes) – (Library Function txt_MoveCursor)
MoveCursor Parameters: Line Number (2 bytes), Row Number (2 bytes)
MoveCursor Returns: Acknowledge HEX 0x06

To Move the Cursor to Line Number=7, Row Number=12, firstly the 7 and 12 need to be converted into bytes. 7 is 0x7 and 12 is 0x0C. Because the command requires 2 bytes for each of these parameters to be sent, the first byte in this example will be 0x00 for both the Line and the Row.

The Bytes that will need to be sent will be: **0xFF, 0xE9, 0x00, 0x07, 0x00, 0x0C**
The Bytes that will be received back from the display will be: **0x06**

- Separation commas ',' between bytes that are shown in the Bytes to Send, and the Bytes Received syntax are purely for legibility purposes in this document and must not be considered as part of any transmitted/received data unless specifically stated.

3.2. Example 2 – Drawing a Hollow Rectangle

Aim: Draw a Hollow Rectangle at a specific location on the display, with a specific outline colour

Rectangle Command: HEX 0xFFC5 (2 bytes) – (Library Function gfx_Rectangle)
Rectangle Parameters: X1 Position (2 bytes), Y1 Position (2 bytes), X2 Position (2 bytes), Y2 Position (2 bytes), Colour (2 bytes)
Rectangle Returns: Acknowledge HEX 0x06

To draw a Blue rectangle starting with the top left corner at X=100, Y=100 and the bottom right corner at X=200, Y= 250, firstly the 100, 200 and 250 numbers need to be converted into bytes.
100 is 0x64, 200 is 0xC8 and 300 is 0x012C. Because the command requires 2 bytes for each of these parameters to be sent, the first byte in this example will be 0x00 for X1, Y1, and X2. Y2 utilises 2 bytes.
Finally, the colour needs to be sent as 2 bytes. The colour Blue is 0x001F.

The Bytes to be sent will be: **0xFF, 0xC5, 0x00, 0x64, 0x00, 0x64, 0x00, 0xC8, 0x01, 0x2C, 0x00, 0x1F**
The Bytes that will be received back from the display will be: **0x06**

- Separation commas ',' between bytes that are shown in the Bytes to Send, and the Bytes Received syntax are purely for legibility purposes in this document and must not be considered as part of any transmitted/received data unless specifically stated.

4. Using Serial with a Library

4.1. Available Libraries

4D Systems has created a set of libraries suitable for a range of microcontrollers on the market to use and communicate with 4D Systems' range of display modules, when configured to be Serial Slaves using the SPE application and the Serial Environment in Workshop 4.

The following libraries have been created and are **available from the Samples menu inside the Workshop 4 IDE Software**, where the Workshop 4 software is available from the 4D Systems website.

- Arduino Library
- C Library
- Pascal Library
- PicAxe Library

These libraries enable the programmer to have access to all of the Serial Commands, but in a format that is more suited for High Level Programming, such as the Arduino IDE.

4.2. Benefits to using a Library

The libraries created by 4D Systems enable the user to simply include the library file in the code of their chosen Host Controller, and call high level functions (very similar and often equivalent to the 4DGL set of functions) instead of having to deal with the low level serial data bytes.

Please refer to the individual application notes on each of the libraries (as they become available), for a better understanding of what they include and how they are used in a Host controller. Refer to the Workshop 4 product page on the 4D Systems website for more information, along with the modules product page.

4.3. Basic Example of using a library

If using the Arduino as the host controller of choice, by simply copying the library into the appropriate libraries folder for the Arduino IDE, and including the library in your sketch, the Arduino user will then have access to high level functions which provide many benefits over using the low level byte commands.

For example, to clear the display, and draw a rectangle from X1=10, Y1=110 to X2=200, Y2=220 in Red on the display, the following byte commands are required:

Send to the display: 0xFF, 0xCD
Receive from the display: 0x06
Send to the display: 0xFF, 0xC5, 0x00, 0x0A, 0x00, 0x6E, 0x00, 0xC8, 0x00, 0xDC, 0xF8, 0x00
Receive from the display: 0x06

Sending these commands from the Arduino would require each byte to be sent over the serial port to the display. 4D Systems has created a library to do this for you.

Using the Arduino library for example, the following functions would be required:

```
Display.gfx_Cls();
Display.gfx_Rectangle(10, 110, 200, 220, RED);
```

4.4. Library References

While this document is specifically for the Serial Command bytes, at the bottom of each command table is a reference to the relevant function that would be called if using the 4D Systems Serial Library.

4.5. Arduino Specific library commands

The following library commands are available to enable easy access to print formatting and display along the lines of their standard Arduino equivalents:-

- print
- println

4.5.1. print

Library Function	**print(val, format)**	
	val	The value to print, any format
	format	Specifies the optional number base, for integer types, or the number of decimal places, for float types.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **print** command converts the supplied parameter into standard ASCII text and calls the "Put string" command to print it to the screen in the current location and font.	
Example	print(F("Hello World")) ; print(int) ; print(int, OCT) ; print(int, HEX) ; print(float, 2) ; The Response will be **0x06** if the command is successfully executed Print needs to be prefixed with the library identifier. Eg Display.print(int) ;	
Library Function	**print**	
See Also	See the "**Put String**" command in the text and string Commands section. This is what is ultimately called to produce the displayed output from this command.	

4.5.2. println

Library Function	**println(val, format)**	
	Val	The value to print, any format
	Format	Specifies the optional number base, for integer types, or the number of decimal places, for float types.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **println** command converts the supplied parameter into standard ASCII text, appends a newline character ("\n") and calls the "Put string" command to print it to the screen in the current location and font.	
Example	println(F("Hello World")) ; println(int) ; println(int, OCT) ; println(int, HEX) ; println(float, 2) ; The Response will be **0x06** if the command is successfully executed println needs to be prefixed with the library identifier. Eg Display.println(int) ;	
Library Function	**println**	
See Also	See the "**Put String**" command in the text and string Commands section. This is what is ultimately called to produce the displayed output from this command.	

5. PICASO Serial Commands

The following sections detail each of the commands available in the 4D Systems Serial Environment, when communicating to a 4D Systems Display Module loaded with the SPE Application. Please refer to Section 2 for more information on how to do this.

5.1. Text and String Commands

The following is a summary of the commands available to be used for Text and Strings:

- Move Cursor
- Put Character
- Put String
- Character Width
- Character Height
- Text Foreground Colour
- Text Background Colour
- Set Fonts
- Text Width
- Text Height
- Text X-Gap
- Text Y-Gap
- Text Bold
- Text Inverse
- Text Italic
- Text Opacity
- Text Underline
- Text Attributes
- Text Wrap

5.1.1. Move Cursor

Serial Command	**cmd** (word), **line** (word)**, column** (word)	
	cmd	0xFFE9
	line	Holds a positive value for the required line position.
	column	Holds a positive value for the required column position.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Move Cursor** command moves the text cursor to a screen position set by line and column parameters. The line and column position is calculated, based on the size and scaling factor for the currently selected font. When text is outputted to screen it will be displayed from this position. The text position could also be set with "**Move Origin"** command if required to set the text position to an exact pixel location. Note that lines and columns start from 0, so line 0, column 0 is the top left corner of the display.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), line(MSB), line(LSB), column(MSB), column(LSB) **0xFF, 0xE9, 0x00, 0x05, 0x00, 0x03** This will move the cursor to Line=5, Column=3 Where 5 as 2 byes is 0x00 and 0x05, and 3 as 2 bytes is 0x00 and 0x03 The Response will be **0x06** if the command is successfully executed	
Library Function	**txt_MoveCursor**	
See Also	See also the "**Move Origin**" command in the Graphics Commands section to move the origin to an exact pixel on the screen, which is suitable for both text and graphics.	

5.1.2. Put Character

Serial Command	**cmd** (word), **character**(word)	
	cmd	0xFFFE
	character	Holds a positive value for the required character.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Put Character** command prints a single character to the display.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), character(MSB), character(LSB) **0xFF, 0xFE, 0x00, 0x39** This will send the character '9' (0x00, 0x39) to the display The response will be **0x06** assuming the command was successful executed	
Library Function	**putCH**	
See Also	See also the "**Move Origin**" command in the Graphics Commands section to move the origin to an exact pixel on the screen, which is suitable for both text and graphics.	

5.1.3. Put String

Serial Command	**cmd** (word), **string**(string)	
	cmd	0x0018
	string	Holds a Null terminated string. char0, char1, char2, …, charN, NULL **NOTE:** Maximum characters in the string is 511 + NULL
Response	**acknowledge** (byte)**, stringlength** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	stringlength	Length of the string printed
Description	The **Put String** command prints a string to the display. The argument can be a string constant or a pointer to a string. A string needs to be terminated with a NULL.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, …, charN, NULL **0x00, 0x18, 0x48, 0x65, 0x6C, 0x6C, 0x6F, 0x00** This will send the string “Hello” to the display, as H = 0x48, e = 0x65, l = 0x6C and o = 0x6F, followed by a NULL = 0x00. The response will be **0x06, 0x00, 0x05** indicating ACK followed by the number 5 for length expressed as 2 bytes (1 word).	
Library Function	**putstr**	
See Also	See also the “**Move Origin**” command in the Graphics Commands section to move the origin to an exact pixel on the screen, which is suitable for both text and graphics.	

5.1.4. Character Width

Serial Command	**cmd** (word), **char**(byte)	
	cmd	0x001E
	char	The ASCII character for the width calculation.
Response	**acknowledge** (byte)**, width** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	width	Width of a single character in pixel units.
Description	The **Character Width** command is used to calculate the width in pixel units for a character, based on the currently selected font. The font can be proportional or mono-spaced. If the total width of the character exceeds 255 pixel units, the function will return the 'wrapped' (modulo 8) value.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char **0x00, 0x1E, 0x65** This is requesting the width in pixels of the character ‘e’, as ASCII ‘e’ is Hex 0x65 Assuming for example the selected font is FONT3 The response will be **0x06, 0x00, 0x08** where 0x00, 0x08 is Decimal 8 (FONT 3 is a 12x8 font)	
Library Function	**charwidth**	

5.1.5. Character Height

Serial Command	**cmd** (word), **char**(byte)	
	cmd	0x001D
	char	The ascii character for the height calculation.
Response	**acknowledge** (byte)**, height** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	height	Height of a single character in pixel units.
Description	The **Character Height** command is used to calculate the height in pixel units for a character, based on the currently selected font. The font can be proportional or mono-spaced. If the total height of the character exceeds 255 pixel units, the function will return the 'wrapped' (modulo 8) value.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char **0x00, 0x1D, 0x65** This is requesting the height in pixels of the character ‘e’, as ASCII ‘e’ is Hex 0x65 Assuming for example the selected font is FONT3 The response will be **0x06, 0x00, 0x0C** where 0x00, 0x0C is Decimal 12 (FONT 3 is a 12x8 font)	
Library Function	**charheight**	

5.1.6. Text Foreground Colour

Serial Command	**cmd** (word), **colour**(word)	
	cmd	0xFFE7
	colour	Specifies the colour to be set.
Response	**acknowledge** (byte)**, colour** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	colour	Previous Text Foreground Colour.
Description	The **Text Foreground Colour** command sets the text foreground colour, and reports back the previous foreground colour	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), colour(MSB), colour(LSB) **0xFF, 0xE7, 0x00, 0x10** This is setting the Foreground colour to Navy, which is Hex 0x00, 0x10 The Response will be **0x06, 0x04, 0x00** assuming the previous colour was Green, which is 0x04, 0x00	
Library Function	**txt_FGcolour**	

5.1.7. Text Backround Colour

Serial Command	**cmd** (word), **colour**(word)	
	cmd	0xFFE6
	colour	Specifies the colour to be set.
Response	**acknowledge** (byte)**, colour** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	colour	Previous Text Background Colour.
Description	The **Text Background Colour** command sets the text background colour, and reports back the previous background colour	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), colour(MSB), colour(LSB) **0xFF, 0xE6, 0xF8, 0x00** This is setting the Background colour to Red, which is Hex 0xF8, 0x00 The Response will be **0x06, 0x00, 0x10** assuming the previous colour was Navy, which is 0x00, 0x10	
Library Function	**txt_BGcolour**	

5.1.8. Set Font

Serial Command	**cmd** (word), **id**(word)	
	cmd	0xFFE5
	id	0 for FONT1 = System font 1 for FONT2 2 for FONT3 = Default font **Note:** The value could also be the handle of a uSD based font obtained using file_LoadImageControl(). The font would generally have been generated using a Strings object in ViSi (easy) or from a the FONT TOOL (harder). (Please refer to the application Notes). Preferably use the FONT1, FONT2 and FONT3 predefined constants.
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Font ID.
Description	The **Set Font** command sets the required font using its ID, and report back the previous Font ID used	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), id(MSB), id(LSB) **0xFF, 0xE5, 0x00, 0x02** This will set the font to be FONT3 which is 0x00, 0x02 The response will be **0x06, 0x00, 0x00** assuming the previous font was FONT1, where FONT1 is 0x00, 0x00	
Library Function	**txt_FontID**	

5.1.9. Text Width

Serial Command	**cmd** (word), **multiplier** (word)	
	cmd	0xFFE4
	multiplier	Width multiplier 1 to 16 (Default =1)
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Multiplier value.
Description	The **Text Width** command sets the text width multiplier between 1 and 16, and returns the previous multiplier	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), multiplier(MSB), multiplier (LSB) **0xFF, 0xE4, 0x00, 0x05** This will set the Text Width to be 5x that of the default The response will be **0x06, 0x00, 0x01** assuming the previous Text width multiplier was 1 (0x00, 0x01)	
Library Function	**txt_Width**	

5.1.10. Text Height

Serial Command	**cmd** (word), **multiplier** (word)	
	cmd	0xFFE3
	multiplier	Height multiplier. 1 to 16 (Default =1)
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Multiplier value.
Description	The **Text Height** command sets the text height multiplier between 1 and 16, and returns the previous multiplier	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), multiplier(MSB), multiplier (LSB) **0xFF, 0xE3, 0x00, 0x02** This will set the Text Height to be 2x that of the default The response will be **0x06, 0x00, 0x01** assuming the previous Text height multiplier was 1 (0x00, 0x01)	
Library Function	**txt_Height**	

5.1.11. Text X-gap

Serial Command	**cmd** (word), **pixelcount** (word)	
	cmd	0xFFE2
	pixelcount	0 to 32(Default =0)
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous pixelcount value.
Description	The **Text X-gap** command sets the pixel gap between characters (x-axis), where the gap is in pixel units, and the response is the previous pixelcount value	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), pixelcount(MSB), pixelcount(LSB) **0xFF, 0xE2, 0x00, 0x02** This will set the text X-Gap to be 2 pixels, where 2 pixels is 0x00, 0x02 The response will be **0x06, 0x00, 0x00** assuming the previous text X-gap was 0	
Library Function	**txt_Xgap**	

5.1.12. Text Y-gap

Serial Command	**cmd** (word), **pixelcount** (word)	
	cmd	0xFFE1
	pixelcount	0 to 32(Default =0)
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous pixelcount value.
Description	The **Text Y-gap** command sets the pixel gap between characters (y-axis), where the gap is in pixel units, and the response is the previous pixelcount value. This command is required to be used if setting text to have an 'Underline' using the "**Text Underline**" command, or "**Text Attributes**" command with the suitable bits set. See these command for further information.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), pixelcount(MSB), pixelcount(LSB) **0xFF, 0xE1, 0x00, 0x05** This will set the text Y-Gap to be 5 pixels, where 5 pixels is 0x00, 0x05 The response will be **0x06, 0x00, 0x00** assuming the previous text Y-gap was 0	
Library Function	**txt_Ygap**	

5.1.13. Text Bold

Serial Command	**cmd** (word), **mode**(word)	
	cmd	0xFFDE
	mode	1 for ON. 0 for OFF.
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Bold status.
Description	The **Text Bold** command sets the Bold attribute for the text and report back the previous bold status	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xDE, 0x00, 0x01** This will set the text to be bold, Bold = ON The response will be **0x06, 0x00, 0x00** assuming the previous bold status was OFF which is 0x00, 0x00	
Library Function	**txt_Bold**	

5.1.14. Text Inverse

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFFDC
	mode	1 for ON. 0 for OFF.
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous 'Text Inverse' status.
Description	The **Text Inverse** command sets the text to be inverse, and return the previous inverse status	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xDC, 0x00, 0x01** This will set the text to be inverse, where inverse = ON = 0x00, 0x01 The response will be **0x06, 0x00, 0x00** assuming the previous inverse status was OFF, which is 0x00, 0x00	
Library Function	**txt_Inverse**	

5.1.15. Text Italic

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFFDD
	mode	1 for ON. 0 for OFF.
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Italic Text status.
Description	The **Text Italic** command sets the text to italic, and return the previous text italic status	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xDD, 0x00, 0x01** This will set the text to be italic, where italic = ON = 0x00, 0x01 The response will be **0x06, 0x00, 0x00** assuming the previous italic status was OFF, which is 0x00, 0x00	
Library Function	**txt_Italic**	

5.1.16. Text Opacity

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFFDF
	mode	1 for ON. (Opaque) 0 for OFF. (Transparent)
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Text Opacity status.
Description	The **Text Opacity** command selects whether or not the 'background' pixels are drawn, and returns the previous text opacity status. (Default mode is OPAQUE with BLACK background.)	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xDF, 0x00, 0x00** This will set the text to be transparent, where Opacity = OFF = 0x00, 0x00 The response will be **0x06, 0x00, 0x01** assuming the previous opacity status was ON, which is 0x00, 0x01	
Library Function	**txt_Opacity**	

5.1.17. Text Underline

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFFDB
	mode	1 for ON. 0 for OFF.
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Text Underline status.
Description	The **Text Underline** command sets the text to underlined, and return the previous text underline status. **Note:** The "**Text Y-gap**" command is required to be at least 2 for the underline to be visible, please refer to the "**Text Y-gap**" command for further information.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xDB, 0x00, 0x01** This will set the text to be underlined, where Underline = ON = 0x00, 0x01 The response will be **0x06, 0x00, 0x00** assuming the previous underline status was OFF, which is 0x00, 0x00	
Library Function	**txt_Underline**	

5.1.18. Text Attributes

Serial Command	**cmd** (word), **value** (word)	
	cmd	0xFFDA
	value	(bit 5 or) DEC 16 for BOLD (bit 6 or) DEC 32 for ITALIC (bit 7 or) DEC 64 for INVERSE (bit 8 or) DEC 128 for UNDERLINED Set or Clear the relevant bits to set the attributes for the text to be written. (bits can be combined by using logical 'OR' of bits) **NOTE:** bits 0-3 and 8-15 are reserved
Response	**acknowledge** (byte)**, value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Text Attributes status.
Description	The **Text Attributes** command controls the following functions grouped, Text Bold Text Italic Text Inverse Text Underlined Returns the previous Text Attributes status **Note:** The "**Text Y-gap**" command is required to be at least 2 for the underline (Text Underlined attribute) to be visible, please refer to the "**Text Y-gap**" command for further information.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), value(MSB), value(LSB) **0xFF, 0xDA, 0x00, 0x90** This will set the Text Attributes to be Bold and Underlined. Where Bold has the value 16 and Underlined has the value 128, so 16+128=144 which is 0x90 in Hex. The response will be **0x06, 0x00, 0x00** assuming the previous attributes were No Bold, No Italic, No Inverse and No Underline.	
Library Function	**txt_Attributes**	

5.1.19. Text Wrap

Serial Command	**cmd** (word), **value** (word)	
	cmd	0xFFD9
	value	0 for OFF. 1 to N for ON, in Pixels.
Response	**acknowledge** (byte)**, previous** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	previous	Returns the previous wrap position
Description	The **Text Wrap** command sets the pixel position where text wrap will occur at RHS. The feature automatically resets when screen mode is changed. The value is in pixel units. Default value is 0.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xD9, 0x01, 0xA4** This will set the wrap position to be at Pixel 420 from the left of the display, where Wrap = ON at pixel 420 = 0x01, 0xA4 The response will be **0x06, 0x00, 0x00** assuming the previous wrap position was OFF, which is 0x00, 0x00	
Library Function	**txt_Wrap**	

5.2. Graphics Commands

The following is a summary of the commands available to be used for Graphics:

- Clear Screen
- Change Colour
- Draw Circle
- Draw Filled Circle
- Draw Line
- Draw Rectangle
- Draw Filled Rectangle
- Draw Polyline
- Draw Polygon
- Draw Filled Polygon
- Draw Triangle
- Draw Filled Triangle
- Calculate Orbit
- Put Pixel
- Read Pixel
- Move Origin
- Draw Line and Move Origin
- Clipping
- Set Clip Window
- Extend Clip Region
- Draw Ellipse
- Draw Filled Ellipse
- Draw Button
- Draw Panel
- Draw Slider
- Screen Copy Paste
- Bevel Shadow
- Bevel Width
- Background Colour
- Outline Colour
- Contrast
- Frame Delay
- Line Pattern
- Screen Mode
- Transparency
- Transparent Colour
- Set Graphics Parameters
- Get Graphics Parameters

5.2.1. Clear Screen

Serial Command	**cmd** (word)	
	cmd	0xFFCD
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Clear Screen** command clears the screen using the current background colour. This command brings some of the settings back to default; such as, • Transparency turned OFF • Outline colour set to BLACK • Opacity set to OPAQUE • Pen set to OUTLINE • Line patterns set to OFF • Right text margin set to full width • Text magnifications set to 1 • All origins set to 0:0 The alternative to maintain settings and clear screen is to draw a filled rectangle with the required background colour.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0xCD** The following will clear the display and restore the settings back to their defaults. The response will be **0x06** if the command is successful	
Library Function	**gfx_Cls**	

5.2.2. Change Colour

Serial Command	**cmd** (word), **oldColour** (word), **newColour** (word)	
	cmd	0xFFB4
	oldColour	Specifies the sample colour to be changed within the clipping window.
	newColour	Specifies the new colour to change all occurrences of old colour within the clipping window.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Change Colour** command changes all **oldColour** pixels to **newColour** within the clipping window area.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), oldColour(MSB), oldColour (LSB), newColour(MSB), newColour (LSB) **0xFF, 0xB4, 0x00, 0x00, 0x00, 0x1F** This will change all pixels coloured Black (0x00, 0x00) to be coloured Blue (0x00, 0x1F) within the clipping area. (Refer to the Clip Window command for more information on this.) The Response will be **0x06** if the command is successful	
Library Function	**gfx_ChangeColour**	

5.2.3. Draw Circle

Serial Command	**cmd** (word), **x** (word), **y** (word), **rad** (word), **colour** (word)	
	cmd	0xFFC3
	x, y	Specifies the centre of the circle.
	rad	Specifies the radius of the circle.
	colour	Specifies the colour of the circle.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Circle** command draws a circle with centre point x, y with radius r using the specified colour.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), rad(MSB), rad(LSB), colour(MSB), colour(LSB) **0xFF, 0xC3, 0x00, 0x64, 0x01, 0x2C, 0x00, 0x14, 0x80, 0x10** This will draw a Circle at X=100 (Hex 0x00, 0x64), Y=300 (Hex 0x01, 0x2C), of Radius=20 (0x00, 0x14), and of Colour=Purple (0x80, 0x10). The response will be **0x06** if the command is successful	
Library Function	**gfx_Circle**	

5.2.4. Draw Filled Circle

Serial Command	**cmd** (word), **x** (word), **y** (word), **rad** (word), **colour** (word)	
	cmd	0xFFC2
	x, y	Specifies the centre of the circle.
	rad	Specifies the radius of the circle.
	colour	Specifies the colour of the circle.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Circle** command draws a solid circle with centre point x1, y1 with radius using the specified colour. The outline colour can be specified with the **"Outline Colour"** command. If **"Outline Colour"** is set to 0, no outline is drawn.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), rad(MSB), rad(LSB), colour(MSB), colour(LSB) **0xFF, 0xC2, 0x00, 0x96, 0x00, 0xE6, 0x00, 0x32, 0x84, 0x10** This will draw a Solid Filled Circle at X=150 (Hex 0x00, 0x96), Y=230 (Hex 0x00, 0xE6), of Radius=50 (0x00, 0x32), and of Colour=Grey (0x84, 0x10). The response will be **0x06** if the command is successful	
Library Function	**gfx_CircleFilled**	

5.2.5. Draw Line

Serial Command	**cmd** (word), **x1** (word), **y1** (word), **x2** (word), **y2** (word), **colour** (word)	
	cmd	0xFFC8
	x1, y1	Specifies the starting coordinates of the line.
	x2, y2	Specifies the ending coordinates of the line.
	colour	Specifies the colour of the line.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Line** command draws a line from x1,y1 to x2,y2 using the specified colour. The line is drawn using the current object colour. The current origin is not altered. The line may be tessellated with the "**Line Pattern**" command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x1(MSB), x1(LSB), y1(MSB), y1(LSB), x2(MSB), x2(LSB), y2(MSB), y2(LSB), colour(MSB), colour(LSB) **0xFF, 0xC8, 0x00, 0x0A, 0x00, 0x0F, 0x00, 0x28, 0x00, 0x50, 0x04, 0x10** This will Line from X1=10 (Hex 0x00, 0x0A), Y1=15 (Hex 0x00, 0x0F), to X2=40 (0x00, 0x28), Y2=80 (0x00, 0x50) of Colour=Teal (0x04, 0x10). The response will be **0x06** if the command is successful	
Library Function	**gfx_Line**	

5.2.6. Draw Rectangle

Serial Command	**cmd** (word), **x1** (word), **y1** (word), **x2** (word), **y2** (word), **colour** (word)	
	cmd	0xFFC5
	x1, y1	Specifies the top left corner of the rectangle.
	x2, y2	Specifies the bottom right corner of the rectangle.
	colour	Specifies the colour of the rectangle.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Rectangle** command draws a rectangle from x1, y1 to x2, y2 using the specified colour. The line may be tessellated with the "**Line Pattern**" command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x1(MSB), x1(LSB), y1(MSB), y1(LSB), x2(MSB), x2(LSB), y2(MSB), y2(LSB), colour(MSB), colour(LSB) **0xFF, 0xC5, 0x00, 0x0A, 0x00, 0x6E, 0x00, 0xC8, 0x00, 0xDC, 0xF8, 0x00** The will draw a Rectangle from X1=10 (0x00, 0x0A), Y1=110 (0x00, 0x6E), to X2=200 (0x00, 0xC8), Y2=220 (0x00, 0xDC), of colour=Red (0xF8, 0x00). The response will be **0x06** if the command is successful	
Library Function	**gfx_Rectangle**	

5.2.7. Draw Filled Rectangle

Serial Command	**cmd** (word), **x1** (word), **y1** (word), **x2** (word), **y2** (word), **colour** (word)	
	cmd	0xFFC4
	x1, y1	Specifies the top left corner of the rectangle.
	x2, y2	Specifies the bottom right corner of the rectangle.
	colour	Specifies the colour of the rectangle.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Filled Rectangle** command draws a solid rectangle from x1, y1 to x2, y2 using the specified colour. The line may be tessellated with the "**Line Pattern**" command. The outline colour can be specified with the "**Outline Colour**" command. If "**Outline Colour**" is set to 0, no outline is drawn.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x1(MSB), x1(LSB), y1(MSB), y1(LSB), x2(MSB), x2(LSB), y2(MSB), y2(LSB), colour(MSB), colour(LSB) **0xFF, 0xC4, 0x00, 0x32, 0x00, 0x3C, 0x00, 0x5A, 0x00, 0x64, 0x07, 0xE0** The will draw a Solid Filled Rectangle from X1=50 (0x00, 0x32), Y1=60 (0x00, 0x3C), to X2=90 (0x00, 0x5A), Y2=100 (0x00, 0x64), of colour=Lime (0x07, 0xE0). The response will be **0x06** if the command is successful	
Library Function	**gfx_RectangleFilled**	

5.2.8. Draw Polyline

Serial Command	**cmd** (word), **n** (word), **vx1** (word)…**vxN** (word), **vy1** (word)…**vyN** (word), **colour** (word)	
	cmd	0x0015
	n	Specifies the number of elements in the x and y arrays specifying the vertices for the polyline.
	vx, vy	Specifies the array of elements for the x/y coordinates of the vertices. Vx1, vx2, …, vxN, vy1, vy2, …, vyN
	colour	Specifies the colour of the polyline.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Polyline** command plots lines between points specified by a pair of arrays using the specified colour. The lines may be tessellated with the "**Line Pattern**" command. The "**Draw Polyline**" command can be used to create complex raster graphics by loading the arrays from serial input or from MEDIA with very little code requirement.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), n(MSB), n(LSB), vx1(MSB), vx1(LSB), vx2(MSB), vx2(LSB), vx3(MSB), vx3(LSB), vy1(MSB), vy1(LSB), vy2(MSB), vy2(LSB), vy3(MSB), vy3(LSB), colour(MSB), colour(LSB) **0x00, 0x15, 0x00, 0x03, 0x00, 0x0A, 0x00, 0x50, 0x00, 0xB4, 0x00, 0x05, 0x00, 0xC8, 0x00, 0x50, 0x80, 0x00** The following will draw a 3 point Polyline from X1=10 (0x00, 0x0A), Y1=5 (0x00, 0x05), to X2=80 (0x00, 0x50), Y2=200 (0x00, 0xC8), and finally to X3=180 (0x00, 0xB4), Y3=80 (0x00, 0x50) of Colour=Maroon (0x80, 0x00) The response will be **0x06** if the command is successful	
Library Function	**gfx_Polyline**	

5.2.9. Draw Polygon

Serial Command	**cmd** (word), **n** (word), **vx1** (word)…**vxN** (word), **vy1** (word)…**vyN** (word), **colour** (word)	
	cmd	0x0013
	n	Specifies the number of elements in the x and y arrays specifying the vertices for the polygon.
	vx, vy	Specifies the array of elements for the x/y coordinates of the vertices. Vx1, vx2, …, vxN, vy1, vy2, …, vyN
	colour	Specifies the colour of the polygon.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Polygon** command plots lines between points specified by a pair of arrays using the specified colour. The last point is drawn back to the first point, completing the polygon. The lines may be tessellated with "**Line Pattern**" command. The **Draw Polygon** command can be used to create complex raster graphics by loading the arrays from serial input or from MEDIA with very little code requirement.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), n(MSB), n(LSB), vx1(MSB), vx1(LSB), vx2(MSB), vx2(LSB), vx3(MSB), vx3(LSB), vx4(MSB), vx4(LSB), vy1(MSB), vy1(LSB), vy2(MSB), vy2(LSB), vy3(MSB), vy3(LSB), vy4(MSB), vy4(LSB), colour(MSB), colour(LSB) **0x00, 0x13, 0x00, 0x04, 0x00, 0x0A, 0x00, 0x50, 0x00, 0xB4, 0x00, 0xDC, 0x00, 0x05, 0x00, 0xC8, 0x00, 0x50, 0x00, 0x04, 0xFF, 0xE0** The following will draw a 4 point Polyline from X1=10 (0x00, 0x0A), Y1=5 (0x00, 0x05), to X2=80 (0x00, 0x50), Y2=200 (0x00, 0xC8), to X3=180 (0x00, 0xB4), Y3=80 (0x00, 0x50), and finally to X4=220 (0x00, 0xDC), Y4=4 (0x00, 0x04) of Colour=Yellow (0xFF, 0xE0) The response will be **0x06** if the command is successful	
Library Function	**gfx_Polygon**	

5.2.10. Draw Filled Polygon

Serial Command	**cmd** (word), **n** (word), **vx1** (word)…**vxN** (word), **vy1** (word)…**vyN** (word), **colour** (word)	
	cmd	0x0014
	n	Specifies the number of elements in the x and y arrays specifying the vertices for the polygon.
	vx, vy	Specifies the array of elements for the x/y coordinates of the vertices. Vx1, vx2, …, vxN, vy1, vy2, …, vyN
	colour	Specifies the colour of the polygon.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Filled Polygon** command draws a solid Polygon between specified vertices: x1, y1 x2, y2, ... , xn, yn using the specified colour. The last point is drawn back to the first point, completing the polygon. Vertices must be a minimum of 3 and can be specified in any fashion.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), n(MSB), n(LSB), vx1(MSB), vx1(LSB), vx2(MSB), vx2(LSB), vx3(MSB), vx3(LSB), vx4(MSB), vx4(LSB), vy1(MSB), vy1(LSB), vy2(MSB), vy2(LSB), vy3(MSB), vy3(LSB), vy4(MSB), vy4(LSB), colour(MSB), colour(LSB) **0x00, 0x14, 0x00, 0x04, 0x00, 0x0A, 0x00, 0x50, 0x00, 0xB4, 0x00, 0xDC, 0x00, 0x05, 0x00, 0xC8, 0x00, 0x50, 0x00, 0x04, 0x04, 0x00** The following will draw a 4 point Polyline from X1=10 (0x00, 0x0A), Y1=5 (0x00, 0x05), to X2=80 (0x00, 0x50), Y2=200 (0x00, 0xC8), to X3=180 (0x00, 0xB4), Y3=80 (0x00, 0x50), and finally to X4=220 (0x00, 0xDC), Y4=4 (0x00, 0x04) of Colour=Green (0x04, 0x00) The response will be **0x06** if the command is successful	
Library Function	**gfx_PolygonFilled**	

5.2.11. Draw Triangle

Serial Command	**cmd** (word), **x1** (word), **y1** (word), **x2** (word), **y2** (word), **x3** (word), **y3** (word), **colour** (word)	
	cmd	0xFFBF
	x1, y1	Specifies the first vertice of the triangle.
	x2, y2	Specifies the second vertice of the triangle.
	x3, y3	Specifies the third vertice of the triangle.
	colour	Specifies the colour of the triangle.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Triangle** command draws a triangle outline between vertices x1,y1 , x2,y2 and x3,y3 using the specified colour. The line may be tessellated with the "**Line Pattern**" command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x1(MSB), x1(LSB), y1(MSB), y1(LSB), x2(MSB), x2(LSB), y2(MSB), y2(LSB), x3(MSB), x3(LSB), y3(MSB), y3(LSB), colour(MSB), colour(LSB) **0xFF, 0xBF, 0x00, 0x32, 0x00, 0x3C, 0x00, 0x14, 0x00, 0xAA, 0x00, 0x46, 0x00, 0xAA, 0x07, 0xFF** This will draw a Triangle from X1=50 (0x00, 0x32), Y1=60 (0x00, 0x3C), to X2=20 (0x00, 0x14), Y2=170 (0x00, 0xAA), to X3=70 (0x00, 0x46), Y3=170 (0x00, 0xAA) of colour=Aqua (0x07, 0xFF) The response will be **0x06** if the command is successful	
Library Function	**gfx_Triangle**	

5.2.12. Draw Filled Triangle

Serial Command	**cmd** (word), **x1** (word), **y1** (word), **x2** (word), **y2** (word), **x3** (word), **y3** (word), **colour** (word)	
	cmd	0xFFA9
	x1, y1	Specifies the first vertice of the triangle.
	x2, y2	Specifies the second vertice of the triangle.
	x3, y3	Specifies the third vertice of the triangle.
	colour	Specifies the colour of the triangle.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Filled Triangle** command draws a solid triangle between vertices x1, y1, x2, y2 and x3, y3 using the specified colour.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x1(MSB), x1(LSB), y1(MSB), y1(LSB), x2(MSB), x2(LSB), y2(MSB), y2(LSB), x3(MSB), x3(LSB), y3(MSB), y3(LSB), colour(MSB), colour(LSB) **0xFF, 0xA9, 0x00, 0x32, 0x00, 0x3C, 0x00, 0x14, 0x00, 0xAA, 0x00, 0x46, 0x00, 0xAA, 0x00, 0x1F** This will draw a Triangle from X1=50 (0x00, 0x32), Y1=60 (0x00, 0x3C), to X2=20 (0x00, 0x14), Y2=170 (0x00, 0xAA), to X3=70 (0x00, 0x46), Y3=170 (0x00, 0xAA) of colour=Blue (0x00, 0x1F) The response will be **0x06** if the command is successful	
Library Function	**gfx_TriangleFilled**	

5.2.13. Calculate Orbit

Serial Command	**cmd** (word), **angle** (word)**, distance** (word)	
	cmd	0x0012
	angle	Specifies the angle from the origin to the remote point. The angle is specified in degrees.
	distance	Specifies the distance from the origin to the remote point in pixel units.
Response	**acknowledge** (byte), **Xdist** (word)**, Ydist** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	Xdist	X coordinate from the current origin.
	Ydist	Y coordinate from the current origin.
Description	The **Calculate Orbit** command calculates the x, y coordinates of a distant point relative to the current origin, where the only known parameters are the ***angle*** and the ***distance*** from the current origin. The new coordinates are calculated and then placed in the destination variables Xdest and Ydest.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), angle(MSB), angle(LSB), distance(MSB), distance(LSB) **0x00, 0x12, 0x00, 0x28, 0x00, 0x3C** This will calculate the x and y coordinates based on the Angle=40 degrees (0x00, 0x28) and the Distance=60 pixels (0x00, 0x3C) from the current origin. The response will be **0x06, 0x00, 0x2D, 0x00, 0x25** assuming the origin is at X=0, Y=0. New coordinates are X=45 (0x00, 0x2D) and Y=37 (0x00, 0x25)	
Library Function	**gfx_Orbit**	

5.2.14. Put pixel

Serial Command	**cmd** (word), **x** (word), **y** (word), **colour** (word)	
	cmd	0xFFC1
	x, y	Specifies the pixel x, y coordinates.
	colour	Specifies the colour of the pixel.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Put Pixel** command draws a pixel at position x, y using the specified colour.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), colour(MSB), colour(LSB) **0xFF, 0xC1, 0x00, 0x28, 0x00, 0x64, 0xFF, 0xE0** This will put a pixel at X=40 (0x00, 0x28), Y=100 (0x00, 0x64), and colour the pixel Yellow (0xFF, 0xE0). The response will be **0x06** if the command is successful	
Library Function	**gfx_PutPixel**	

5.2.15. Read Pixel

Serial Command	**cmd** (word), **x** (word), **y** (word)	
	cmd	0xFFC0
	x, y	Specifies the pixel x, y coordinates.
Response	**acknowledge** (byte), **colour** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	colour	16bit colour of the pixel
Description	The **Read Pixel** command reads the colour value of the pixel at position x,y.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB) **0xFF, 0xC0, 0x00, 0x28, 0x00, 0x64** This will read the colour of a pixel at X=40 (0x00, 0x28), Y=100 (0x00, 0x64) The response will be **0x06, 0xFF, 0xE0** if the command is successful, assuming the pixel being read is coloured Yellow (0xFF, 0xE0)	
Library Function	**gfx_GetPixel**	

5.2.16. Move Origin

Serial Command	**cmd** (word), **xpos** (word)**, ypos** (word)	
	cmd	0xFFCC
	xpos, ypos	Specifies the horizontal and vertical position of the new origin.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Move Origin** command moves the origin to a new position, which is suitable for specifying the location for both graphics and text.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), xpos(MSB), xpos(LSB), ypos(MSB), ypos(LSB) **0xFF, 0xCC, 0x00, 0x32, 0x00, 0x5A** This will move the Origin to be X=50 (0x00, 0x32), Y=90 (0x00, 0x5A) The response will be **0x06** if the command is successful	
Library Function	**gfx_MoveTo**	

5.2.17. Draw Line & Move Origin

Serial Command	**cmd** (word), **xpos** (word)**, ypos** (word)	
	cmd	0xFFCA
	xpos, ypos	Specifies the horizontal and vertical position of the line end as well as the new origin.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Line & Move Origin** command draws a line from the current origin to a new position. The Origin is then set to the new position. The line is drawn using the current object colour, using the "**Set Graphics Parameters" – "Object Colour"** command. The line may be tessellated with the "**Line Pattern**" command. **Note:** this command is mostly useful with the "**Calculate Orbit**" command, and usually the "**Draw Line**" command would be used	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), xpos(MSB), xpos(LSB), ypos(MSB), ypos(LSB) **0xFF, 0xCA, 0x00, 0xC8, 0x00, 0xFA** This will draw a line from the current origin (assuming this is X=0, Y=0 for this example) to X=200 (0x00, 0xC8), Y=250 (0x00, 0xFA) and set the origin to be this point (X=200, Y=250). The response will be **0x06** if the command is successful	
Library Function	**gfx_LineTo**	

5.2.18. Clipping

Serial Command	**cmd** (word), **value** (word)	
	cmd	0xFFA2
	value	0 = Clipping Disabled, 1 = Clipping Enabled
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Clipping** command Enables or Disables the ability for Clipping to be used. The clipping points are set with **"Set Clip Window"** and must be set first.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), value(MSB), value(LSB) **0xFF, 0xA2, 0x00, 0x01** This will Enable Clipping The response will be **0x06** if the command is successful	
Library Function	**gfx_Clipping**	

5.2.19. Set Clip Window

Serial Command	**cmd** (word), **x1** (word), **y1** (word), **x2** (word), **y2** (word)	
	cmd	0xFFB5
	x1, y1	Specifies the horizontal and vertical position of the top left corner of the clipping window.
	x2, y2	Specifies the horizontal and vertical position of the bottom right corner of the clipping window.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Set Clip Window** command specifies a clipping window region on the screen such that any objects and text placed onto the screen will be clipped and displayed only within that region. For the clipping window to take effect, the clipping setting must be enabled separately using the "**Clipping**" command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x1(MSB), x1(LSB), y1(MSB), y1(LSB), x2(MSB), x2(LSB), y2(MSB), y2(LSB) **0xFF, 0xB5, 0x00, 0x00, 0x00, 0x00, 0x00, 0x28, 0x00, 0x28** This will set the top left of the Clipping Window Region to be X1=0 (0x00, 0x00), Y1=0 (0x00, 0x00), and bottom right to be X2=40 (0x00, 0x28), Y2=40 (0x00, 0x28) The response will be **0x06** if the command is successful	
Library Function	**gfx_ClipWindow**	

5.2.20. Extend Clip Region

Serial Command	**cmd** (word)	
	cmd	0xFFB3
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Extend Clip Region** command forces the clip region to the extent of the last text that was printed, or the last image that was shown.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0xB3** This will extend the clip region to the extent of the last text or image that was shown. The response will be **0x06** if the command is successful	
Library Function	**gfx_SetClipRegion**	

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5.2.21. Draw Ellipse

Serial Command	**cmd** (word), **x** (word), **y** (word), **xrad** (word), **yrad** (word), **colour** (word)	
	cmd	0xFFB2
	x, y	Specifies the horizontal and vertical position of the centre of ellipse.
	xrad	Specifies x-radius of the ellipse.
	yrad	Specifies y-radius of the ellipse.
	colour	Specifies the colour of the ellipse.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Ellipse** command plots a coloured Ellipse on the screen at centre x, y with x-radius = xrad and y-radius = yrad.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), xrad(MSB), xrad(LSB), yrad(MSB), yrad(LSB), colour(MSB), colour(LSB) **0xFF, 0xB2, 0x00, 0x5A, 0x00, 0x3C, 0x00, 0x14, 0x00, 0x0F, 0xFF, 0xDE** This will draw an Ellipse at X=90 (0x00, 0x5A), Y=60 (0x00, 0x3C), where the x-Radius is 20 (0x00, 0x14), and the y-Radius is 15 (0x00, 0x0F), where the colour is Cream (0xFF, 0xDE) The response will be **0x06** if the command is successful	
Library Function	**gfx_Ellipse**	

5.2.22. Draw Filled Ellipse

Serial Command	**cmd** (word), **x** (word), **y** (word), **xrad** (word), **yrad** (word), **colour** (word)	
	cmd	0xFFB1
	x, y	Specifies the horizontal and vertical position of the centre of ellipse.
	xrad	Specifies x-radius of the ellipse.
	yrad	Specifies y-radius of the ellipse.
	colour	Specifies the colour of the ellipse.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Filled Ellipse** command plots a solid coloured Ellipse on the screen at centre x,y with x-radius = xrad and y-radius = yrad	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), xrad(MSB), xrad(LSB), yrad(MSB), yrad(LSB), colour(MSB), colour(LSB) **0xFF, 0xB1, 0x00, 0x5A, 0x00, 0x3C, 0x00, 0x14, 0x00, 0x0F, 0xFD, 0x20** This will draw an Ellipse at X=90 (0x00, 0x5A), Y=60 (0x00, 0x3C), where the x-Radius is 20 (0x00, 0x14), and the y-Radius is 15 (0x00, 0x0F), where the colour is Orange (0xFD, 0x20) The response will be **0x06** if the command is successful	
Library Function	**gfx_EllipseFilled**	

5.2.23. Draw Button

Serial Command	**cmd** (word), **state** (word), **x** (word), **y** (word), **buttoncolour** (word), **txtcolour** (word), **font** (word), **txtWidth** (word), **txtHeight** (word), **text** (string)	
	cmd	0x0011
	state	Appearance of button, 0 = Button depressed; 1 = Button raised.
	x, y	Specifies the top left corner position of the button on the screen.
	buttonColour	Button colour
	txtColour	Text Colour
	font	Specifies the Font ID.
	txtWidth	Specifies the width of the text. This value is the font width multiplier and minimum value must be 1.
	txtHeight	Specifies the height of the text. This value is the font height multiplier and minimum value must be 1.
	text	Specifies the text string. The text string must be within the range of printable ASCII character set. The string may have \n characters embedded to create a multiline button. String must be Null terminated. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Button** command draws a 3 dimensional Text Button at screen location defined by x, y parameters (top left corner). The size of the button depends on the font, width, height and length of the text. The button can contain multiple lines of text by having the \n character embedded in the string for the end of line marker. In this case, the widest text in the string sets the overall width, and the height of the button is set by the number of text lines. In the case of multiple lines, each line is left justified. If you wish to centre or right justify the text, you will need to prepare the text string according to your requirements.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), state(MSB), state(LSB), x(MSB), x(LSB), y(MSB), y(LSB), buttoncolour(MSB), buttoncolour(LSB), txtcolour(MSB), txtcolour(LSB), font(MSB), font(LSB), txtWidth(MSB), txtWidth(LSB), txtHeight(MSB), txtHeight(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, NULL **0x00, 0x11, 0x00, 0x00, 0x00, 0x50, 0x00, 0x50, 0x07, 0xFF, 0x90, 0x1A, 0x00, 0x01, 0x00, 0x01, 0x00, 0x01, 0x50, 0x72, 0x65, 0x73, 0x73, 0x20, 0x4D, 0x65, 0x00** This will create a Button with the Up State being OFF, positioned at X=80 (0x00, 0x50), Y=80 (0x00, 0x50), where the Button Colour is Aqua (0x07, 0xFF), and the Text Colour is Dark Violet (0x90, 0x1A), the text Font is FONT2 (0x00, 0x01), the Text Width multiplier is 1 (0x00, 0x01), and the Text Height multiplier is also 1 (0x00, 0x01), and the Text states “Press Me” and is Null Terminated. The response will be **0x06** if the command is successful	
Library Function	**gfx_Button**	

5.2.24. Draw Panel

Serial Command	**cmd** (word), **state** (word), **x** (word)**, y** (word)**, Width** (word)**, Height** (word), **colour** (word),	
	cmd	0xFFAF
	state	Appearance of panel, 0 = recessed; 1 = raised.
	x, y	Specifies the top left corner position of the panel on the screen.
	Width	Specifies the width of the panel.
	Height	Specifies the Height of the panel.
	colour	Specifies the colour of the panel.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Panel** command draws a 3 dimensional rectangular panel at a screen location defined by x, y parameters (top left corner). The size of the panel is set with the width and height parameters. The colour is defined by colour. The state parameter determines the appearance of the panel, 0 = recessed, 1 = raised.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), state(MSB), state(LSB), x(MSB), x(LSB), y(MSB), y(LSB), Width(MSB), Width(LSB), Height(MSB), Height(LSB) colour(MSB), colour(LSB) **0xFF, 0xAF, 0x00, 0x01, 0x00, 0xC8, 0x00, 0xB4, 0x00, 0x01, 0x00, 0x01, 0xFF, 0x9C** This will draw a Rectangular Panel which has a Raised Profile, located at X=200 (0x00, 0xC8), Y=180 (0x00, 0xB4), where the Text Width multiplier is 1 (0x00, 0x01) and the Text Height multiplier is 1 (0x00, 0x01), and the colour is Linen (0xFF, 0x9C). The response will be **0x06** if the command is successful	
Library Function	**gfx_Panel**	

5.2.25. Draw Slider

Serial Command	**cmd** (word), **mode** (word), **x1** (word), **y1** (word), **x2** (word), **y2** (word), **colour** (word), **scale** (word), **value** (word)	
	cmd	0xFFAE
	mode	mode = 0 : Slider Indented, mode = 1 : Slider Raised, mode 2, Slider Hidden (background colour).
	x1, y1	Specifies the top left corner position of the slider on the screen.
	x2, y2	Specifies the bottom right corner position of the slider on the screen.
	colour	Specifies the colour of the Slider bar.
	Scale	scale = n : sets the full scale range of the slider for the thumb from 0 to n.
	Value	If value positive, sets the relative position of the thumb on the slider bar, else set thumb to ABS position of the negative number.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Draw Slider** command draws a vertical or horizontal slider bar on the screen. The **Draw Slider** command has several different modes of operation. In order to minimise the amount of graphics functions we need, all modes of operation are selected naturally depending on the parameter values. Selection rules: **1a)** if x2-x1 > y2-y1 slider is assumed to be horizontal (ie: if width > height, slider is horizontal) **1b)** if x2-x1 <= y2-y1 slider is assumed to be vertical (ie: if height <= width, slider is horizontal) **2a)** If value is positive, thumb is set to the position that is the proportion of value to the scale parameter.(used to set the control to the actual value of a variable) **2b)** If value is negative, thumb is driven to the graphics position set by the ABSolute of value. (used to set thumb to its actual graphical position (usually by touch screen) **3)** The thumb colour is determine by the "**Set Graphics Parameters" – "Object Colour"** command, however, if the current object colour is BLACK, a darkened shade of the colour parameter is used for the thumb .	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB), x1(MSB), x1(LSB), y1(MSB), y1(LSB), x2(MSB), x2(LSB), y2(MSB), y2(LSB), colour(MSB), colour(LSB), scale(MSB), scale(LSB), value(MSB), value(LSB) **0xFF, 0xAE, 0x00, 0x01, 0x00, 0x1E, 0x00, 0x28, 0x00, 0xD2, 0x00, 0x5A, 0x89, 0x5C, 0x00, 0x64, 0x00, 0x00** This will create a Slider with a Raised Profile, with top left corner positioned at X1=30 (0x00, 0x1E), Y1=40 (0x00, 0x28), and bottom right corner positioned at X2=210 (0x00, 0xD2), Y2=90 (0x00, 0x5A), where the slider colour is Blue Violet (0x89, 0x5C), Full scale is 100 (0x00, 0x64), and the value of the Thumb Slider is at 0 (0x00, 0x00) The response will be **0x06** if the command is successful	
Library Function	**gfx_Slider**	

5.2.26. Screen Copy Paste

Serial Command	**cmd** (word), **xs** (word), **ys** (word), **xd** (word), **yd** (word), **width** (word), **height** (word)	
	cmd	0xFFAD
	xs, ys	Specifies the horizontal and vertical position of the top left corner of the area to be copied (source).
	xd, yd	Specifies the horizontal and vertical position of the top left corner of where the paste is to be made (destination).
	width	Specifies the width of the copied area.
	height	Specifies the height of the copied area.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Screen Copy Paste** command copies an area of a screen from xs, ys of size given by width and height parameters and pastes it to another location determined by xd, yd.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), xs(MSB), xs(LSB), ys(MSB), ys(LSB), xd(MSB), xd(LSB), yd(MSB), yd(LSB), width(MSB), width(LSB), height(MSB), height(LSB) **0xFF, 0xAD, 0x00, 0x0A, 0x00, 0x1E, 0x00, 0x5A, 0x01, 0x0E, 0x00, 0x5A, 0x00, 0x1E** This will copy a section of the screen from X1=10 (0x00, 0x0A), Y1=30 (0x00, 0x1E) and paste it at X2=90 (0x00, 0x5A), Y2=270 (0x01, 0x0E), where the Width to copy/paste is 90 (0x00, 0x5A) and the Height is 30 (0x00, 0x1E) The response will be **0x06** if the command is successful	
Library Function	**gfx_ScreenCopyPaste**	

5.2.27. Bevel Shadow

Serial Command	**cmd** (word), **value** (word)	
	cmd	0xFF98
	value	0 = No Bevel Shadow 1-4 = Number of Pixels Deep (Default = 3)
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	Previous Bevel Shadow status.
Description	The **Bevel Shadow** command changes the graphics "**Draw Button"** commands bevel shadow depth	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), value(MSB), value(LSB) **0xFF, 0x98, 0x00, 0x02** This will set the Bevel Shadow depth to be 2 pixels The response will be **0x06, 0x00, 0x03** assuming the previous Bevel Shadow Depth was set to 3 (0x00, 0x03) and if the command is successful	
Library Function	**gfx_BevelShadow**	

5.2.28. Bevel Width

Serial Command	**cmd** (word), **value** (word)	
	cmd	0xFF99
	value	0 = No Bevel 1-15 = Number of Pixels Wide (Default = 2)
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	Previous Bevel Width status.
Description	The **Bevel Width** command changes the graphics "**Draw Button**" commands bevel width	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), value(MSB), value(LSB) **0xFF, 0x98, 0x00, 0x0B** This will set the Bevel Width to be 11 pixels The response will be **0x06, 0x00, 0x02** assuming the previous Bevel Shadow Depth was set to 2 (0x00, 0x04) and if the command is successful	
Library Function	**gfx_BevelWidth**	

5.2.29. Background Colour

Serial Command	**cmd** (word), **colour** (word)	
	cmd	0xFFA4
	colour	Specifies the colour to be set (0-65535 or HEX 0x0000-0xFFFF)
Response	**acknowledge** (byte), **colour** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	colour	Previous Background Colour.
Description	The **Background Colour** command sets the screen background colour	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), colour(MSB), colour(LSB) **0xFF, 0xA4, 0x00, 0x10** This will set the Background Colour to be Navy (0x00, 0x10) The response will be **0x06, 0x00, 0x00** assuming the previous Background Colour was Black (0x00, 0x00) and if the command is successful	
Library Function	**gfx_BGcolour**	

5.2.30. Outline Colour

Serial Command	**cmd** (word), **colour** (word)	
	cmd	0xFF9D
	colour	Specifies the colour to be set (0-65535 or HEX 0x0000-0xFFFF), set to 0 for no effect
Response	**acknowledge** (byte), **colour** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	colour	Previous Outline Colour.
Description	The **Outline Colour** command sets the outline colour for rectangles and circles.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), colour(MSB), colour(LSB) **0xFF, 0x9D, 0xF8, 0x1F** This will set the Outline Colour to be Fuchsia (0xF8, 0x1F) The response will be **0x06, 0x00, 0x1F** assuming the previous Outline Colour was Blue (0x00, 0x1F) and if the command is successful	
Library Function	**gfx_OutlineColour**	

5.2.31. Contrast

Serial Command	**cmd** (word), **contrast** (word)	
	cmd	0xFF9C
	contrast	Contrast 0 = display OFF, non-zero = display ON **EXCEPTION:** uLCD-43 supports Contrast values from 1-15 and 0 to turn the Display off. 3202X-P1 supports Contrast values from 1 to 9 and 0 to turn the Display off. **Note**: Does not apply to uVGA-II/III modules.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Contrast value.
Description	The **Contrast** Command sets the contrast of the display, or turns it On/Off depending on display model	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), contrast(MSB), contrast(LSB) **0xFF, 0x9C, 0x00, 0x06** This will set the Contrast of the display (example is a uLCD-43PT) to be 6 The response will be **0x06, 0x00, 0x00** assuming the previous Contrast was Display Off (0x00, 0x00) and if the command is successful	
Library Function	**gfx_Contrast**	

5.2.32. Frame Delay

Serial Command	**cmd** (word), **Msec** (word)	
	cmd	0xFF9F
	Msec	0-255 milliseconds
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Frame Delay value.
Description	The **Frame Delay** command sets the inter frame delay for the "**Media Video"** command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), Msec(MSB), Msec(LSB) **0xFF, 0x9F, 0x00, 0x05** This will set the Contrast of the display (example is a uLCD-43PT) to be 5 milliseconds The response will be **0x06, 0x00, 0x00** assuming the previous Frame Delay value was 0 (0x00, 0x00) and if the command is successful	
Library Function	**gfx_FrameDelay**	

5.2.33. Line Pattern

Serial Command	**cmd** (word), **pattern** (word)	
	cmd	0xFF9B
	pattern	0 = all line pixels are on (Default) 0-65535 (or HEX 0x0000-0xFFFF) = number of bits in the line are turned off to form a pattern
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Line Pattern value.
Description	The **Line Pattern** command sets the line draw pattern for line drawing. If set to zero, lines are solid, else each '1' bit represents a pixel that is turned off.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), pattern(MSB), pattern(LSB) **0xFF, 0x9B, 0x00, 0x08** This will set the Line Pattern of the line to be drawn to have 8 bits out of the 65535 turned off. The response will be **0x06, 0x00, 0x00** assuming the previous Line Pattern value was 0 (0x00, 0x00) and if the command is successful	
Library Function	**gfx_LinePattern**	

5.2.34. Screen Mode

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFF9E
	mode	0 = LANDSCAPE 1 = LANDSCAPE REVERSE 2 = PORTRAIT 3 = PORTRAIT REVERSE
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Screen Mode value.
Description	The **Screen Mode** command alters the graphics orientation LANDSCAPE, LANDSCAPE_R, PORTRAIT, PORTRAIT_R	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0x9E, 0x00, 0x00** This will set the Screen Mode of the display to be Landscape. The response will be **0x06, 0x00, 0x02** assuming the previous Screen Mode value was Portrait (0x00, 0x02) and if the command is successful	
Library Function	**gfx_ScreenMode**	

5.2.35. Transparency

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFFA0
	mode	0 = Transparency OFF 1 = Transparency ON
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Transparency value.
Description	The **Transparency** command turns the transparency ON or OFF. Transparency is automatically turned OFF after the next image or video command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xA0, 0x00, 0x01** This will set the Transparency of the display to be ON. The response will be **0x06, 0x00, 0x00** assuming the previous Transparency value was OFF (0x00, 0x00) and if the command is successful	
Library Function	**gfx_Transparency**	

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5.2.36. Transparent Colour

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFFA1
	mode	0-65535 (or HEX 0x0000-0xFFFF) = colour to make transparent
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Previous Transparent Colour value.
Description	The **Transparent Colour** command alters the colour that needs to be made transparent.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xA1, 0x84, 0x00** This will set the Transparent Colour of the display to be Olive (0x84, 0x00). The response will be **0x06, 0x00, 0x00** assuming the previous Transparent Colour value was Black (0x00, 0x00) and if the command is successful	
Library Function	**gfx_TransparentColour**	

5.2.37. Set Graphics Parameters

Serial Command	**cmd** (word), **function** (word), **value** (word)	
	cmd	0xFFCE
	function	See the list below
	value	See the list below

function	value
Function = 18 Object Colour Sets the Object colour used in various functions such as Draw Slider and Draw Line & Move Origin	0 – 65535 or 0 - 0xFFFF
Function = 32 Screen Resolution Set VGA Screen resolution. Applies to uVGA-II and uVGA-III only	0 for 320x240 1 for 640 x 480 2 for 800 x 480
Function = 33 Page Display Choose Page to be displayed. Value depends on the resolution set. Applies to uVGA-II, uVGA-III and uLCD-43 range only.	e.g. 0-4 for 320x240 resolution on a uVGA-II and uVGA-III
Function = 34 Page Read Choose the Page to be read. Value depends on the resolution set. Applies to uVGA-II, uVGA-III and uLCD-43 range only..	e.g. 0-4 for 320x240 resolution on a uVGA-II and uVGA-III
Function = 35 Page Write Choose the Page to be written. Value depends on the resolution set. Applies to uVGA-II, uVGA-III and uLCD-43 range only.	e.g. 0-4 for 320x240 resolution on a uVGA-II and uVGA-III

Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Returns various graphics parameters to the caller.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), function(MSB), function(LSB), value(MSB), value(LSB) **0xFF, 0xCE, 0x00, 0x12, 0x04, 0x00** This will call the **Object Colour** command and set the object colour to be Green (0x04, 0x00) The response will be **0x06** if successful	
Library Function	**gfx_Set**	

5.2.38. Get Graphics Parameters

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFFA6
	mode	mode = 0 : Current orientations maximum X value (X_MAX) mode = 1 : Current orientations maximum Y value (Y_MAX) mode = 2 : Left location of last Object mode = 3 : Top location of Object mode = 4 : Right location of last Object mode = 5 : Bottom location of Object
Response	**acknowledge** (byte), **value**(word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	**Mode0:** Returns the maximum horizontal resolution of the display, minus 1. X_MAX returns Horizontal Resolution - 1 **Mode1:** Returns the maximum vertical resolution of the display, minus 1. Y_MAX returns Vertical Resolution - 1 **Mode2:** Returns the left location of the last drawn object **Mode3:** Returns the top location of the last drawn object **Mode4:** Returns the right location of the last drawn object **Mode5:** Returns the bottom location of the last drawn object
Description	Returns various graphics parameters to the caller.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0xA6, 0x00, 0x01** This will request the display current maximum Y value based on the screens orientation. The response will be **0x06, 0x00, 0xEF** which is ACK followed by 239 (0x00, 0xEF) assuming the display is in Landscape mode, with 239 Pixels in the Y Direction. The return is 0 based, so it's the resolution – 1.	
Library Function	**gfx_Get**	

5.3. Media Commands (SD/SDHC Memory Cards)

The following is a summary of the commands available to be used for Media:

- Media Init
- Set Byte Address
- Set Sector Address
- Read Sector
- Write Sector
- Read Byte
- Read Word
- Write Byte
- Write Word
- Flush Media
- Display Image (RAW)
- Display Video (RAW)
- Display Video Frame (RAW)

5.3.1. Media Init

Serial Command	**cmd** (word)	
	cmd	0xFF89
Response	**acknowledge** (byte), **value**(word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	**1** if memory card is present and successfully initialised. **0** if no card is present or not able to initialise.
Description	The **Media Init** command initialises a uSD/SD/SDHC memory card for further operations. The SD card is connected to the SPI (serial peripheral interface) of the PICASO-GFX2 chip.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x89** This command will initialize a uSD/SD/SDHC memory card so it can be used for further operations. The response will be **0x06** if the command is successful	
Library Function	**media_Init**	

5.3.2. Set Byte Address

Serial Command	**cmd** (word), **HIword** (word), **LOword** (word)	
	cmd	0xFF93
	HIword	Specifies the high word (upper 2 bytes) of a 4 byte media memory byte address location.
	LOword	Specifies the low word (lower 2 bytes) of a 4 byte media memory byte address location.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Sey Byte Address** command sets the media memory internal Address pointer for access at a non-sector aligned byte address.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), HIword(MSB), HIword(LSB), LOword(MSB), LOword(LSB) **0xFF, 0x93, 0x00, 0x00, 0x02, 0x01** This will set the media address to byte 513 (0x00, 0x00, 0x02, 0x01) (which is sector #1, 2nd byte in sector) for subsequent operations. The response will be **0x06** if the command is successful	
Library Function	**media_SetAdd**	

5.3.3. Set Sector Address

Serial Command	**cmd** (word), **HIword** (word), **LOword** (word)	
	cmd	0xFF92
	HIword	Specifies the high word (upper 2 bytes) of a 4 byte media memory sector address location.
	LOword	Specifies the low word (lower 2 bytes) of a 4 byte media memory sector address location.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The **Set Sector Address** command sets the media memory internal Address pointer for sector access.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), HIword(MSB), HIword(LSB), LOword(MSB), LOword(LSB) **0xFF, 0x92, 0x00, 0x00, 0x00, 0x0A** This will set the media address to the 11th (0x00, 0x00, 0x00, 0x0A) sector (which is also byte address 5120) for subsequent operations The response will be **0x06** if the command is successful	
Library Function	**media_SetSector**	

5.3.4. Read Sector

Serial Command	**cmd** (word)	
	cmd	0x0016
Response	**acknowledge** (byte) , **status** (word), **block** (sector)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	1 for successful media response. 0 for attempt failed.
	block	512 bytes (256 words)
Description	The **Read Sector** command reads and returns 512 bytes (256 words) pointed to by the internal Sector pointer, determined by the "**Set Sector Address"** command. After the read the Sector pointer is automatically incremented by 1.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0x00, 0x16** This will initiate the read and return of 512 bytes starting where the **Set Sector Address** command was set to. The response will be **0x06** if the command is successful	
Library Function	**media_RdSector**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Sector Address**" command to define where reading is to occur.	

5.3.5. Write Sector

Serial Command	**cmd** (word), **block** (sector)	
	cmd	0x0017
	block	512 bytes (256 words) to be written to the media sector address.
Response	**acknowledge** (byte) , **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	1 for successful media response. 0 for attempt failed.
Description	The **Write Sector** command writes 512 bytes (256 words) from a source memory block into the uSD card. After the write the Sect pointer is automatically incremented by 1.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), block(sector) **0x00, 0x17, 0x…(*512 Bytes worth of data*)…** This will transfer a 512 bytes block of data to the address pointed to by the "**Set Sector Address"** command. The response will be **0x06** if the command is successful	
Library Function	**media_WrSector**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Sector Address**" command to define where writing is to occur.	

5.3.6. Read Byte

Serial Command	**cmd** (word)	
	cmd	0xFF8F
Response	**acknowledge** (byte) , **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Byte value in the LSB.
Description	The **Read Byte** command returns the byte value from the current media address, set by the "**Set Byte Address**" command. The internal byte address will then be internally incremented by one.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x8F** This will read and return the byte value from the media address set by the Set Byte Address command. The response will be **0x06, 0x00, 0xFF** assuming the value being read was 255 (0x00, 0xFF). Due to the Picaso being a 16bit system, each byte is reported in word format (2 bytes).	
Library Function	**media_ReadByte**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Byte Address**" command to define where reading is to occur.	

5.3.7. Read Word

Serial Command	**cmd** (word)	
	cmd	0xFF8E
Response	**acknowledge** (byte) , **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Word value.
Description	The **Read Word** command returns the word value (2 bytes) from the current media address, set by the "**Set Byte Address**" command. The internal byte address will then be internally incremented by one. If the address is not aligned, the word will still be read correctly.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x8E** This will read and return the byte value from the media address set by the Set Byte Address command. The response will be **0x06, 0x3B, 0xAF** assuming the value being read was 15279 (0x3B, 0xAF).	
Library Function	**media_ReadWord**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Byte Address**" command to define where reading is to occur.	

5.3.8. Write Byte

Serial Command	**cmd** (word), **value** (word)	
	cmd	0xFF8D
	value	Byte value, in the LSB, to be written at the current byte address location.
Response	**acknowledge** (byte) , **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	Non Zero for successful media response. 0 for attempt failed.
Description	Writes a byte to the current media address that was initially set with the **"Set Sector Address"** command. **Note:** Writing bytes or words to a media sector must start from the beginning of the sector. All writes will be incremental until the "**Flush Media"** command is executed, or the sector address rolls over to the next sector. When the "**Flush Media"** command is called, any remaining bytes in the sector will be padded with **0xFF**, destroying the previous contents. An attempt to use the "**Set Byte Address"** command will result in the lower 9 bits being interpreted as zero. If the writing rolls over to the next sector, the "**Flush Media"** command is issued automatically internally.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), value(MSB), value(LSB) **0xFF, 0x8D, 0x00, 0x61** This will write the ASCII character 'a' (0x00, 0x61) as a byte to the media address set by **Set Sector Address**. The response will be **0x06, 0x00, 0x01** assuming the value being written was successful.	
Library Function	**media_WriteByte**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Sector Address**" command to define where writing is to occur.	

5.3.9. Write Word

Serial Command	**cmd** (word), **value** (word)	
	cmd	0xFF8C
	value	The 16 bit word to be written at the current media address location.
Response	**acknowledge** (byte) , **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	Non Zero for successful media response. 0 for attempt failed.
Description	Writes a word to the current media address that was initially set with the **"Set Sector Address"** command. **Note:** Writing bytes or words to a media sector must start from the beginning of the sector. All writes will be incremental until the "**Flush Media"** command is executed, or the sector address rolls over to the next sector. When "**Flush Media"** command is called, any remaining bytes in the sector will be padded with 0xFF, destroying the previous contents. An attempt to use the "**Set Byte Address"** command will result in the lower 9 bits being interpreted as zero. If the writing rolls over to the next sector, the "**Flush Media"** command is issued automatically internally.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), value(MSB), value(LSB) **0xFF, 0x8C, 0x00, 0x41** This will write the ASCII character 'A' (0x00, 0x41) as a word to the media address set by **Set Sector Address**. The response will be **0x06, 0x00, 0x01** assuming the value being written was successful.	
Library Function	**media_WriteWord**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Sector Address**" command to define where writing is to occur.	

5.3.10. Flush Media

Serial Command	**cmd** (word)	
	cmd	0xFF8A
Response	**acknowledge** (byte) , **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	Non Zero for successful media response. 0 for attempt failed.
Description	After writing any data to a sector, the **Flush Media** command should be called to ensure that the current sector that is being written is correctly stored back to the media else write operations may be unpredictable.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x8A** This command will ensure data written to the current sector is correctly stored to the media. The response will be **0x06, 0xFF, 0xFF** if the command is successful (see Status above)	
Library Function	**media_Flush**	

5.3.11. Display Image (RAW)

Serial Command	**cmd** (word), **x** (word), **y** (word)	
	cmd	0xFF8B
	x, y	Specifies the top left position where the image will be displayed.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Displays an image from the media storage at the specified co-ordinates. The image address is previously specified with the **"Set Byte Address"** command or **"Set Sector Address"** command. If the image is shown partially off screen, it may not be displayed correctly.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB) **0xFF, 0x8B, 0x00, 0x0A, 0x00, 0x14** This will display an image at X=10 (0x00, 0x0A), Y=20 (0x00, 0x14) from the media storage location specified. The response will be **0x06** if the command is successful	
Library Function	**media_Image**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Byte Address**" or "**Set Sector Address**" commands to define where reading is to occur.	

5.3.12. Display Video (RAW)

Serial Command	**cmd** (word), **x** (word), **y** (word)	
	cmd	0xFF95
	x, y	Specifies the top left position where the video clip will be displayed.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Displays a *video* clip from the media storage device at the specified co-ordinates. The *video* address location in the media is previously specified with the **"Set Byte Address"** or **"Set Sector Address"** commands. If the *video* is shown partially off screen, it may not be displayed correctly. Note that showing a *video* blocks all other processes until the video has finished showing. See the **"Display Video Frame"** command for alternatives.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB) **0xFF, 0x95, 0x00, 0x32, 0x00, 0x0A** This will display a video clip at X=50 (0x00, 0x32), Y=10 (0x00, 0x0A) from the media storage device location specified. The response will be **0x06** if the command is successful	
Library Function	**media_Video**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Byte Address**" or "**Set Sector Address**" commands to define where reading is to occur. See the "**Display Video Frames**" command for an alternative.	

5.3.13. Display Video Frame (RAW)

Serial Command	**cmd** (word), **x** (word), **y** (word), **frameNumber** (word)	
	cmd	0xFF94
	x, y	Specifies the top left position of the video frame to be displayed.
	frameNumber	Specifies the required frame number to be displayed.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Displays a *video* from the media storage device at the specified co-ordinates. The *video* address is previously specified with the "**Set Byte Address"** command or "**Set Sector Address"** command. If the *video* is shown partially off it may not be displayed correctly. The frames can be shown in any order. This function gives you great flexibility for showing various icons from an image strip, as well as showing videos while doing other tasks The **Display Video Frame (RAW)** command will now show an error box for out of range video frames. Also, if frame is set to -1, just a rectangle will be drawn in background colour to blank an image. It applies to PmmC R29 or above.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), frameNumber(MSB), frameNumber(LSB) **0xFF, 0x94, 0x00, 0x23, 0x00, 0x05, 0x00, 0x2D** This will display frame number 45 (0x00, 0x2D) of the video clip stored at the address specified, and display it at location X=35 (0x00, 0x23), Y=5 (0x00, 0x05). The response will be **0x06** if the command is successful	
Library Function	**media_VideoFrame**	
See Also	See also the "**Media Init**" command to enable the media to be ready for access, and "**Set Byte Address**" or "**Set Sector Address**" commands to define where reading is to occur.	

5.4. Serial (UART) Communications Commands

The following is a summary of the commands available to be used for Serial (UART) Communications:

- Set Baud Rate

5.4.1. Set Baud Rate

Serial Command	**cmd** (word), **index** (word)				
	cmd	0x0026			
	index	Specifies the baud rate index value.			
		index	**Required Baud Rate**	**% Error**	**Actual Baud Rate**
		0	110	0.00%	110
		1	300	0.00%	300
		2	600	0.01%	600
		3	1200	0.03%	1200
		4	2400	0.07%	2402
		5	4800	0.16%	4808
		6	9600	0.33%	9632
		7	14400	0.16%	14423
		8	19200	0.33%	19264
		9	31250	0.00%	31250
		10	38400	0.33%	38527
		11	56000	0.45%	56250
		12	57600	1.73%	58594
		13	115200	1.73%	117188
		14	128000	4.63%	133929
		15	256000	9.86%	281250
		16	300000	4.17%	312500
		17	375000	7.14%	401786
		18	500000	12.50%	562500
		19	600000	17.19%	703125
Response	**acknowledge** (byte)				
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.			
Description	The **Set Baud Rate** command is used to set the required baud rate. To set the default baud rate, please refer to the instructions in Chapter 2.				
Example	**Byte Stream:** cmd(MSB), cmd(LSB), index(MSB), index(LSB) **0x00, 0x26, 0x00, 0x0D** This will set the baud rate to be 115200, which is Index 13 (0x00, 0x0D) The response will be **0x06** at the new baud rate set, 100ms after the command is sent				
Library Function	**setbaudWait**				

5.5. Timer Commands

The following is a summary of the commands available to be used for the Timers:

- Sleep

5.5.1. Sleep

Serial Command	**cmd** (word), **units** (word)	
	cmd	0xFF3B
	units	When in sleep mode, timing is controlled by an RC oscillator, therefore, timing is not totally accurate and should not be relied on for timing purposes. Sleep timer units may vary, however 1 unit is approximately 1 second.
Response	**acknowledge** (byte) , **units** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	units	Remaining time units when touch screen is touched, else returns zero.
Description	The **Sleep** command puts the display and processor into low power mode for a period of time. If "units" is zero, the display goes into sleep mode forever and needs power cycling to re-initialize. If "units" is 1 to 65535, the display will sleep for that period of time, or will be woken when touch screen is touched. The function returns the count of "units" that are remaining when the screen was touched. When returning from sleep mode, the display and processor are restored from low power mode. **Note:** Prior to PmmC R33, the Sleep command units were not approximately a second in length. This was fixed in R33.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), units(MSB), units(LSB) **0xFF, 0x3B, 0x00, 0x0A** This will put the display to sleep for 10 (0x00, 0x0A) 'units', or approximately 10 seconds. If the display is touched in this time, it will return the number of 'units' remaining in the timer. The response is **0x06, 0x00, 0x00** assuming the display was not touched during this period.	
Library Function	**sys_Sleep**	

5.6. FAT16 File Commands

The following is a summary of the commands available to be used for FAT16:

- File Error
- File Count
- List Filenames
- Find First File
- Find First File and Report
- Find Next File
- Find Next File and Report
- Find Exists
- File Open
- File Close
- File Read
- File Seek
- File Index
- File Tell
- File Write
- File Size
- Display Image (FAT)
- Screen Capture
- Write Character to the File
- Read Character from the File
- Write Word to the File
- Read Word from the File
- Write String to the File
- Read String from the File
- File Erase
- File Rewind
- File Load Function
- File Call Function
- File Run
- File Execute
- Load Image Control
- File Mount
- File Unmount
- Play WAV File
- Load String for 4XE/4FN File
- Read String for 4XE/4FN File

5.6.1. File Error

Serial Command	**cmd** (word)		
	cmd	0xFF1F	
Response	**acknowledge** (byte) , **ErrorNumber** (word)		
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.	
	ErrorNumber	Returns Error Number.	
		ErrorNumber	**Description**
		1	IDE command execution error
		2	CARD not present
		3	WRONG partition type, not FAT16
		4	MBR sector invalid signature
		5	Boot Record invalid signature
		6	Media not mounted
		7	File not found in open for read
		8	File not open
		9	Fat attempt to read beyond EOF
		10	Reached the end of file
		11	Invalid cluster value > maxcls
		12	All root dir entry are taken
		13	All clusters in partition are taken
		14	A file with same name exist already
		15	Cannot init the CARD
		16	Cannot read the MBR
		17	Malloc could not allocate the FILE struct
		18	Mode was not r.w.
		19	Failure during FILE search
		20	Invalid Filename
		21	bad media
		22	Sector Read fail
		23	Sector write fail
Description	Returns the most recent error code or 0 if there were no errors.		
Example	**Byte Stream:** cmd(MSB), cmd(LSB), line(MSB), line(LSB), column(MSB), column(LSB) **0xFF, 0x1F** This will request the most recent error code from the display. The response will be **0x06, 0x00, 0x02** assuming the most recent error was 2 (0x00, 0x02) Card not Present.		
Library Function	**file_Error**		

5.6.2. File Count

Serial Command	**cmd** (word), **filename** (string)	
	cmd	0x0001
	filename	Name of the file(s) for the search (passed as a string). Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte)**, count** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	count	Number of files that match the criteria.
Description	Returns number of files found that match the criteria. The wild card character '*****'matches up with any combination of allowable characters and '**?**' matches up with any single allowable character.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, NULL **0x00, 0x01, 0x2A, 0x2E, 0x2A, 0x00** This will request the display to return the number of files on the disk, by sending the string "*.*" (0x2A, 0x2E, 0x2A) followed by a NULL. The response will be **0x06, 0x00, 0x23** assuming there are 35 (0x00, 0x23) files located on the root of the micro SD card.	
Library Function	**file_Count**	
See Also	The "**File Mount**" command, to initially mount the file system.	

5.6.3. List Filenames

Serial Command	**cmd** (word), **filename** (string)	
	cmd	0x0002
	filename	Name of the file(s) for the search (passed as a string). Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte)**, count** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	count	Number of files that match the criteria.
Description	Lists the stream of file names that agree with the search key on the Display Screen. Returns number of files found that match the criteria. The wild card character '*****' matches up with any combination of allowable characters and '**?**' matches up with any single allowable character. **Note**: "**Find First File and Report**" and "**Find Next File and Report**" are recommended alternatives in order to return the responses.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, NULL **0x00, 0x02, 0x2A, 0x2E, 0x34, 0x58, 0x45, 0x00** This will list on the display all the files on the root of the uSD card that fall in the category of "*.4XE" (0x2A, 0x2E, 0x34, 0x58, 0x45) followed by a NULL. The response will be **0x06, 0x00, 0x03** assuming there are 3 (0x00, 0x03) files located on the root of the micro SD card with the extension *.4XE The listing of these 3 files will also be displayed on the screen.	
Library Function	**file_Dir**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Find First File and Report**" and "**Find Next File and Report**" commands as alternatives which return the responses.	

5.6.4. Find First File

Serial Command	**cmd** (word), **filename** (string)	
	cmd	0x0006
	filename	Name of the file(s) for the search (passed as a string). Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If at least one file exists that satisfies the criteria. **0**: If no file satisfies the criteria.
Description	Returns true if at least 1 file exists that satisfies the file argument. Wildcards are usually used so if the "**Find First File"** command returns true, further tests can be made using the "**Find Next File"** command to find all the files that match the wildcard class. Note that the filename is printed on the screen. **Note:** "**Find First File and Report**" and "**Find Next File and Report**" are recommended alternatives in order to return the responses.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, NULL **0x00, 0x06, 0x2E, 0x2A, 0x47, 0x43, 0x49, 0x00** This will list on the display the first file on the root of the uSD card that falls in the category of "*.GCI" (0x2E, 0x2A, 0x47, 0x43, 0x49) followed by a NULL. The response will be **0x06, 0x00, 0x01** assuming there was at least 1 (0x00, 0x01) file located on the root of the micro SD card that satisfied this search. The listing of this file will also be displayed on the screen.	
Library Function	**file_FindFirst**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Find Next File**" command, to find the next file which meets the criteria. "**Find First File and Report**" and "**Find Next File and Report**" commands as alternatives which return the responses.	

5.6.5. Find First File and Report

Serial Command	**cmd** (word), **filename** (string)	
	cmd	0x0024
	filename	Name of the file(s) for the search (passed as a string). Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte)**, stringlength** (word), **filename** (string)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	stringlength	Length of the File-name string.
	filename	Filename if it exists. Filename string is not NULL terminated.
Description	The **Find First File and Report** command returns the length of the filename and the filename if at least 1 file exists that matches the criteria. Wildcards are usually used so if **Find First File and Report** command returns the stringlength and filename, further tests can be made using "**Find Next File**" or "**Find Next File and Report**" commands to find all the files that match the wildcard class.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, NULL **0x00, 0x24, 0x2E, 0x2A, 0x47, 0x43, 0x49, 0x00** This will list on the display the first file on the root of the uSD card that falls in the category of "*.GCI" (0x2A, 0x2E, 0x47, 0x43, 0x49) followed by a NULL. The response will be **0x06, 0x00, 0x07, 0x42, 0x6F, 0x62, 0x2A, 0x47, 0x43, 0x49** assuming there was a file in the root of the uSD card called "Bob.GCI", where the reported length of the filename was 7 (0x00, 0x07), and the filename was reported "Bob.GCI" (0x42, 0x6F, 0x62, 0x2E, 0x47, 0x43, 0x49).	
Library Function	**file_FindFirstRet**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Find Next File and Report**" and "**Find Next File**" commands to find the next file which meets the criteria.	

5.6.6. Find Next File

Serial Command	**cmd** (word)	
	cmd	0xFF1B
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If at least one file exists that satisfies the criteria. **0**: If no file satisfies the criteria.
Description	The **Find Next File** command returns true if more file exists that satisfies the file argument that was given for the "**Find First File**" or "**Find First File and Report**" commands. Wildcards must be used for the "**Find First File**" or "**Find First File and Report**" commands else this function will always return zero as the only occurrence will have already been found. Note that the filename is printed on the screen.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x2B** This will find the next file that meets the criteria specified in the **Find First File** or **Find First File and Report** commands used previously. The response will be **0x06, 0x00, 0x01** assuming there is another file found that matches the criteria.	
Library Function	**file_FindNext**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Find First File**" command, to find the first file which meets the criteria. "**Find First File and Report**" and "**Find Next File and Report**" commands as alternatives which return the responses.	

5.6.7. Find Next File and Report

Serial Command	**cmd** (word)	
	cmd	0x0025
Response	**acknowledge** (byte)**, stringlength** (word), **filename** (string)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	stringlength	Length of the File-name string.
	filename	Filename if it exists. Filename string is not NULL terminated.
Description	Returns length of the filename and the filename if at least 1 file exists that matches the criteria given for the "**Find First File**" or "**Find First File and Report**" commands. Wildcards must be used for the "**Find First File**" or "**Find First File and Report**" commands else this function will always return zero as the only occurrence will have already been found. Wildcards are usually used, so if the "**Find First File**" or "**Find First File and Report**" commands return the stringlength and filename, further tests can be made using **Find Next File and Report** command to find all the files that match the wildcard class.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0x00, 0x25** This will find the next file that meets the criteria specified in the **Find First File** or **Find First File and Report** commands used previously. The response will be **0x06, 0x00, 0x07, 0x42, 0x6F, 0x62, 0x2E, 0x47, 0x43, 0x49** assuming there was a file in the root of the uSD card that matched the wild card search criteria used in the "**Find First File"** or **"Find First File and Report"** commands, where the reported length of the filename was 7 (0x00, 0x07), and the filename was reported "Bob.GCI" (0x42, 0x6F, 0x62, 0x2E, 0x47, 0x43, 0x49).	
Library Function	**file_FindNextRet**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Find First File and Report**" and "**Find First File**" commands to find the next file which meets the criteria.	

5.6.8. File Exists

Serial Command	**cmd** (word), **filename** (string)	
	cmd	0x0005
	filename	Name of the file(s) for the search (passed as a string). Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: File found **0:** File not found
Description	Tests for the existence of the file provided with the search key. Returns TRUE if found.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, NULL **0x00, 0x05, 0x54, 0x45, 0x53, 0x54, 0x2E, 0x34, 0x58, 0x45, 0x00** This will search for the file “TEST.4XE” (0x54, 0x45, 0x53, 0x54, 0x2E, 0x34, 0x58, 0x45) on the uSD card, the string is ended with a NULL (0x00). The response will be **0x06, 0x00, 0x01** assuming the file was found.	
Library Function	**file_Exists**	
See Also	The “**File Mount**” command, to initially mount the file system.	

5.6.9. File Open

Serial Command	**cmd** (word), **filename** (string), **mode** (byte)	
	cmd	0x000A
	filename	Name of the file(s) to be opened (passed as a string). Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
	mode	'r' or 0x72 for File Read 'w' or 0x77 for File Write 'a' or 0x61 for File Append
Response	**acknowledge** (byte)**, handle** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	handle	Returns handle if file exists. Sets internal file error number accordingly (0 if no errors).
Description	Returns handle if file exists. The file **'**handle**'** that is created is now used as reference for 'filename' for further file commands such as "**File Close**", etc. For **File Write** and **File Append** modes ('w' and 'a') the file is created if it does not exist. If the file is opened for append and it already exists, the file pointer is set to the end of the file ready for appending, else the file pointer will be set to the start of the newly created file. If the file was opened successfully, the internal error number is set to 0 (i.e. no errors) and can be read with the "**File Error**" command. For **File Read** mode ('r') the file must exist else a null handle (0x00, 0x00) is returned and the 'file not found' error number is set which can be read with the "**File Error**" command. **Note:** If a file is opened for **File Write** mode 'w', and the file already exists, the operation will fail. Unlike C and some other languages where the file will be erased ready for re-writing when opened for writing, 4DGL offers a simple level of protection that ensures that a file must be purposely erased before being re-written. **Note:** Beginning with the v4.0 PmmC a file opened with FILE_APPEND may be randomly read and or written. Also any altered file will have the Archive bit set in the directory entry.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), line(MSB), line(LSB), column(MSB), column(LSB) **0x00, 0x0A, 0x54, 0x45, 0x53, 0x54, 0x2E, 0x54, 0x58, 0x54, 0x00, 0x72** This will attempt to read (0x72) a file called "TEST.TXT" (0x54, 0x45, 0x53, 0x54, 0x2E, 0x54, 0x58, 0x54) followed by a NULL (0x00) from the uSD Card The response will be **0x06, 0x14, 0x65** assuming the command was a success and the handle that was created had the value of DEC 5221 (0x14, 0x65).	
Library Function	**file_Open**	
See Also	The "**File Mount**" command, to initially mount the file system. The "**File Close**" command, to close the file once opened with this command.	

5.6.10. File Close

Serial Command	**cmd** (word), **handle** (word)	
	cmd	0xFF18
	handle	The file handle that was created by the "**File Open**" command which is now used as reference 'handle' for the filename, for further file functions such as in this function to close the file.
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: File Closed. **0:** File not closed.
Description	The **File Close** command will close the previously opened file.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0xFF, 0x18, 0x14, 0x65** This will close the file with the handle value of 5221 (0x14, 0x65) which was opened previously The response will be **0x06, 0x00, 0x01** assuming the command was a success and the file was successfully closed.	
Library Function	**file_Close**	
See Also	The "**File Mount**" command, to initially mount the file system. The "**File Open**" command, to initially open the file.	

5.6.11. File Read

Serial Command	**cmd** (word), **size** (word), **handle** (word)	
	cmd	0x000C
	size	Number of bytes to be read.
	handle	The handle that references the file to be read.
Response	**acknowledge** (byte)**, count** (word), **data** (string)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	count	Returns the number of bytes read.
	data	Data read from the file
Description	Returns the number of bytes specified by '**size**' from the file referenced by '**handle**'.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0x00, 0x0C, 0x00, 0x14, 0x14, 0x65** This will read 20 bytes (0x00, 0x14) from the file with handle 5221 (0x14, 0x65) The response will be **0x06, 0x00, 0x14, 0x31, 0x32, 0x33, 0x34, 0x35, 0x36, 0x37, 0x38, 0x39, 0x30, 0x61, 0x62, 0x63, 0x64, 0x65, 0x66, 0x67, 0x68, 0x69, 0x6A** assuming the command was a success, and 20 bytes (0x00, 0x14) were read. The File contained the following data: 1234567890abcdefghij	
Library Function	**file_Read**	
See Also	The "**File Mount**" command, to initially mount the file system.	

5.6.12. File Seek

Serial Command	**cmd** (word), **handle** (word), **HiWord** (word), **LoWord** (word)	
	cmd	0xFF16
	handle	The handle that references the file
	HiWord	Contains the upper 16bits of the memory pointer into the file.
	LoWord	Contains the lower 16bits of the memory pointer into the file.
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If Seek successful. **0:** if attempt failed.
Description	The **File Seek** command places the file pointer at the required position in a file that has been opened in '**r**' (read) or '**a**' (append) mode. In append mode, **File Seek** does not expand a filesize, instead, the file pointer (handle) is set to the end position of the file, e.g. assuming the file size is 10000 bytes, the **File Seek** command with HiWord = 0x00 and LoWord = 0x1234 will set the file position to 0x00001234 (byte position 4660) for the file handle, so subsequent data may be read from that position onwards with "**Read Character from the File",** "**Read Word from the File**", "**Read String from the File**" commands, or an image can be displayed with the "**Display Image (FAT)**" command. Conversely, "**Write Character to the File",** "**Write Word to the File**", "**Write String to the File**" commands can write to the file at the position. A **FE_EOF** (end of file error) will occur if you try to write or read past the end of the file, visible from the "**File Error**" command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), HiWord(MSB), HiWord(LSB), LoWord(MSB), LoWord(LSB) **0xFF, 0x16, 0x10, 0xD5, 0x00, 0x00, 0x12, 0x34** This will place a file pointer at the byte position 4660 (HiWord = 0x00, 0x00, LoWord = 0x12, 0x34) on the file with handle 4309 (0x10, 0xD5) The response will be **0x06, 0x00, 0x01** if the command was successful and the Seek was successful.	
Library Function	**file_Seek**	
See Also	The "**File Mount**" command, to initially mount the file system. The "**Read Character from the File**", "**Read Word from the File**", "**Read String from the File**", "**Write Character to the File**", "**Write Word to the File**", and "**Write String to the File**" commands. "**Display Image (FAT)**" command for displaying the image from File. "**File Error**" command for retrieving any error which may have occurred.	

5.6.13. File Index

Serial Command	**cmd** (word), **handle** (word), **HiSize** (word), **LoSize** (word), **recordnum** (word)	
	cmd	0xFF15
	handle	The handle that references the file
	HiSize	Contains the upper 16bits of the size of the file records.
	LoSize	Contains the lower 16bits of the size of the file records.
	recordnum	The index of the required record
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the index found successfully. **0:** if the attempt failed.
Description	Places the file pointer at the position in a file that has been opened in '**r**' (read) or '**a**' (append) mode. In append mode, **File Index** does not expand a filesize, instead, the file pointer (handle) is set to the end position of the file, e.g. assuming the record size is 100 bytes, the **File Index** command with HiSize = 0, LoSize = 100 and recordnum = 22 will set the file position to 2200 for the file handle, so subsequent data may be read from that position onwards with "**Read Character from the File",** "**Read Word from the File**", "**Read String from the File**" commands or an image can be displayed with the "**Display Image (FAT)**" command. Conversely, the "**Write Character to the File",** "**Write Word to the File**", "**Write String to the File**" commands can write to the file at the position. A **FE_EOF** (end of file error) will occur if you try to write or read past the end of the file, visible from the "**File Error**" command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), HiSize(MSB), HiSize(LSB), LoSize(MSB), LoSize(LSB), recordnum(MSB), recordnum(LSB) **0xFF, 0x15, 0x10, 0xD5, 0x00, 0x00, 0x00, 0x64, 0x00, 0x16** This will place a file pointer at the end of the file records specified, 22 records where each record is of size 100, (HiSize = 0x00, 0x00, LoSize = 0x00, 0x64, recordnum = 0x00, 0x16) on the file with handle 4309 (0x10, 0xD5) The response will be **0x06, 0x00, 0x01** if the command was successful and the Index was successful.	
Library Function	**file_Index**	
See Also	The "**File Mount**" command, to initially mount the file system. The "**Read Character from the File**", "**Read Word from the File**", "**Read String from the File**", "**Write Character to the File**", "**Write Word to the File**", and "**Write String to the File**" commands. "**Display Image (FAT)**" command for displaying the image from File. "**File Error**" command for retrieving any error which may have occurred.	

5.6.14. File Tell

Serial Command	**cmd** (word), **handle** (word)	
	cmd	0x000F
	handle	The handle that references the file
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
	HiWord	Contains the upper 16bits of the value of the pointer
	LoWord	Contains the lower 16bits of the value of the pointer
Description	The **File Tell** command returns the current value of the file pointer.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0x00, 0x0F, 0x10, 0xD5** This will return the current value of the file pointer 4309 (0x10, 0xD5) The response will be **0x06, 0x00, 0x01, 0x00, 0x00, 0x08, 0x98** assuming the command was successful (0x06), the operation was successful (0x00, 0x01), and the file pointer had the value of 2200 (0x00, 0x00, 0x08, 0x98)	
Library Function	**file_Tell**	
See Also	The "**File Mount**" command, to initially mount the file system.	

5.6.15. File Write

Serial Command	**cmd** (word), **size** (word), **source** (string) **handle** (word),	
	cmd	0x0010
	size	Number of bytes to be written. Maximum that can be written at one time is 512 bytes.
	source	String of Data without Null terminator.
	handle	The handle that references the file to write.
Response	**acknowledge** (byte)**, count** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	count	**Returns the number of bytes written.**
Description	The **File Write** command returns the current value of the file pointer.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), size(MSB), size(LSB), source(MSB), source(LSB), handle(MSB), handle(LSB) **0x00, 0x10, 0x00, 0x05, 0x48, 0x65, 0x6C, 0x6C, 0x6F, 0x0F, 0xB8** This will write 5 bytes (0x00, 0x05) where the string of data is “Hello” (0x48, 0x65, 0x6C, 0x6C, 0x6F) to the file with the handle of 4024 (0x0F, 0xB8) The response will be **0x06, 0x00, 0x05** assuming the command was successful and 5 bytes (0x00, 0x05) were successfully written	
Library Function	**file_Write**	
See Also	The “**File Mount**” command, to initially mount the file system.	

5.6.16. File Size

Serial Command	**cmd** (word), **handle** (word)	
	cmd	0x000E
	handle	The handle that references the file to write.
Response	**acknowledge** (byte), **status** (word), **HiWord** (word), **LoWord** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
	HiWord	Contains the upper 16bits of the file size.
	LoWord	Contains the lower 16bits of the file size.
Description	The **File Size** command reads the 32 bit file size.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0x00, 0x0E, 0x0F, 0xB8** This will request the size of the file with the handle 4024 (0x0F, 0xB8) The response will be **0x06, 0x00, 0x01, 0x00, 0x00, 0x00, 0xA7** assuming the command was successful (0x06), the operation was successful (0x00, 0x01), and the file size was 167 (0x00, 0x00, 0x00, 0xA7)	
Library Function	**file_Size**	
See Also	The "**File Mount**" command, to initially mount the file system.	

5.6.17. Display Image (FAT)

Serial Command	**cmd** (word), **x** (word) , **y** (word) , **handle** (word)	
	cmd	0xFF11
	x	X-position of the image to be displayed
	y	Y-position of the image to be displayed
	handle	The handle that references the file containing the image(s).
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	error	Returns a copy of the File Error, see the "**File Error**" command
Description	Display an image from the file stream at screen location specified by x, y (top left corner). If there is more than 1 image in the file, it can be accessed with the "**File Seek**" command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), handle(MSB), handle(LSB) **0xFF, 0x11, 0x00, 0x05, 0x00, 0x05, 0x0E, 0x9B** This will display the image which has the file handle of 3739 (0x0E, 0x9B) at position X=5 (0x00, 0x05), Y=5 (0x00, 0x05) The response will be **0x06, 0x00, 0x00** if the command was successful and there was no error associated with this command.	
Library Function	**file_Image**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" command to access another image from the same file, if required. "**File Error**" command for retrieving any error which may have occurred.	

5.6.18. Screen Capture

Serial Command	**cmd** (word), **x** (word), **y** (word) **width** (word) **height** (word), **handle** (word),	
	cmd	0xFF10
	x	X-position of the image to be captured.
	y	Y-position of the image to be captured.
	width	Width of the area to be captured.
	height	Height of the area to be captured.
	handle	The handle that references the file to store the image(s)
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**0**: If the operation was successful
Description	The **Screen Capture** command saves an image of the screen shot to file at the current file position. The image can later be displayed with the "**Display Image (FAT)**" command. The file may be opened in append mode to accumulate multiple images. Later, the images can be displayed with the "**File Seek**" command. The image is saved from x, y (with respect to top left corner), and the capture area is determined by "width" and "height".	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), width(MSB), width(LSB), height(MSB), height(LSB), handle(MSB), handle(LSB) **0xFF, 0x10, 0x00, 0x00, 0x00, 0x00, 0x00, 0x64, 0x00, 0x64, 0x0C, 0x4E** This will capture from X=0 (0x00, 0x00), Y=0 (0x00, 0x00) across 100 pixels (0x00, 0x64) and down 100 pixels (0x00, 0x64), and save the image inside that region to the file with handle 3150 (0x0C, 0x4E) The response will be **0x06, 0x00, 0x00** if the command was successful (0x06) and the operation was successful (0x00, 0x00)	
Library Function	**file_ScreenCapture**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Display Image (FAT)**" command for displaying the image from File. "**File Seek**" command to access another image from the same file, if required.	

5.6.19. Write Character to the File

Serial Command	**cmd** (word), **char** (word), **handle** (word),	
	cmd	0x001F
	char	Data byte (in the LSB) about to be written.
	handle	The handle that references the file to be written to.
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	Returns the number of bytes written successfully
Description	This function writes the byte specified by "char" to the file, at the position indicated by the associated file-position pointer (set by the "**File Seek**" or "**File Index**" commands) and advances the pointer appropriately (incremented by 1). The file must be previously opened with 'w' (write) or 'a' (append) modes.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char(MSB), char(LSB), handle(MSB), handle(LSB) **0x00, 0x1F, 0x00, 0x58, 0x0B, 0x31** This will write the character 'X' (0x00, 0x58) to the file with handle 2865 (0x0B, 0x31) The response will be **0x06, 0x00, 0x01** if the command was successful (0x06) and the operation successfully wrote the 1 byte (0x00, 0x01)	
Library Function	**file_PutC**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" and "**File Index**" commands to access another image from the same file, if required.	

5.6.20. Read Character from the File

Serial Command	**cmd** (word), **handle** (word),	
	cmd	0xFF0E
	handle	The handle that references the file to be read from.
Response	**acknowledge** (byte)**, char** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	char	Returns the data byte read from the file in the LSB.
Description	The **Read Character from the File** command reads a byte from the file, at the position indicated by the associated file-position pointer (set by the "**File Seek**" or "**File Index**" commands) and advances the pointer appropriately (incremented by 1). The file must be previously opened with 'r' (read) mode.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0xFF, 0x0E, 0x0B, 0x31** This will read the character from the file with the point of 2865 (0x0B, 0x31) based on the position of the pointer determined previously by the "**File Seek**" or "**File Index**" commands. The response will be **0x06, 0x00, 0x74** assuming the command was successful and the pointer was pointing at the position of the file which contained the character 't' (0x00, 0x74)	
Library Function	**file_GetC**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" and "**File Index**" commands to access another image from the same file, if required.	

5.6.21. Write Word to the File

Serial Command	**cmd** (word), **word** (word), **handle** (word),	
	cmd	0xFF0D
	word	Word about to be written.
	handle	The handle that references the file to be written to.
Response	**acknowledge** (byte)**, status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	Returns the number of bytes written successfully
Description	This function writes word sized (2 bytes) data specified by 'word' to the file, at the position indicated by the associated file-position pointer (set by the "**File Seek**" or "**File Index**" commands) and advances the pointer appropriately (incremented by 2). The file must be previously opened with 'w' (write) or 'a' (append) modes.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), word(MSB), word(LSB), handle(MSB), handle(LSB) **0xFF, 0x0D, 0x01, 0xBB, 0x0B, 0x31** This will write the word 443 (0x01, 0xBB) to the file with handle 2865 (0x0B, 0x31) The response will be **0x06, 0x00, 0x02** assuming the command was successful and the operation was successful at writing the 2 bytes (0x00, 0x02).	
Library Function	**file_PutW**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" and "**File Index**" commands to access another image from the same file, if required.	

5.6.22. Read Word from the File

Serial Command	**cmd** (word), **handle** (word),	
	cmd	0xFF0C
	handle	The handle that references the file to be read from.
Response	**acknowledge** (byte)**, word** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	word	Returns the word read from the file.
Description	This function reads a word (2 bytes) from the file, at the position indicated by the associated file-position pointer (set by the "**File Seek**" or "**File Index**" commands) and advances the pointer appropriately (incremented by 2). The file must be previously opened with 'r' (read) mode.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0xFF, 0x0E, 0x0B, 0x31** This will read the character from the file with the point of 2865 (0x0B, 0x31) based on the position of the pointer determined previously by the "**File Seek**" or "**File Index**" commands. The response will be **0x06, 0x00, 0x74** assuming the command was successful and the pointer was pointing at the position of the file which contained the word 25972 (0x65, 0x74)	
Library Function	**file_GetW**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" and "**File Index**" commands to access another image from the same file, if required.	

5.6.23. Write String to the File

Serial Command	**cmd** (word), **data** (string), **handle** (word),	
	cmd	0x0020
	data	A Null terminated string to be written to the file.
	handle	The handle that references the file to be written to.
Response	**acknowledge** (byte)**, count** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	count	Returns the number of characters written (excluding the null terminator).
Description	This function writes a null terminated string to the file, at the position indicated by the associated file-position pointer (set by the "**File Seek**" or "**File Index**" commands) and advances the pointer appropriately. The file must be previously opened with 'w' (write) or 'a' (append) modes.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, handle(MSB), handle(LSB) **0x00, 0x20, 0x34, 0x44, 0x20, 0x53, 0x79, 0x73, 0x74, 0x65, 0x6D, 0x73, 0x00, 0x0B, 0x31** This will write the string "4D Systems" (0x34, 0x44, 0x20, 0x53, 0x79, 0x73, 0x74, 0x65, 0x6D, 0x73) followed by a Null (0x00) to the file which has a handle of 2865 (0x0B, 0x31) The response will be **0x06, 0x00, 0x0A** assuming the command was successful and the 10 characters (0x00, 0x0A) were written	
Library Function	**file_PutS**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" and "**File Index**" commands to access another image from the same file, if required.	

5.6.24. Read String from the File

Serial Command	**cmd** (word), **size**(word), **handle** (word),	
	cmd	0x0007
	size	The maximum number of bytes to be read from the file.
	handle	The handle that references the file to be read from.
Response	**acknowledge** (byte), **word** (word), **data** (string)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	count	Returns the number of characters read from file (excluding the null teminator)
	data	Returns the string read from the file excluding the Null terminator.
Description	This function reads a line of text from a file at the current file position indicated by the associated file-position pointer (set by the "**File Seek**" or "**File Index**" commands) and advances the pointer appropriately. Characters are read until either a newline or an EOF is received or until the specified maximum "**size**" is reached. In all cases, the string is null terminated. The file must be previously opened with 'r' (read) mode.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), size(MSB), size(LSB), handle(MSB), handle(LSB) **0x00, 0x07, 0x00, 0x05, 0x0B, 0x31** This will read the string from the file with handle 2865 (0x0B, 0x31) up to the maximum of 5 characters (0x00, 0x05) in length. The response will be **0x06, 0x00, 0x04, 0x74, 0x65, 0x73, 0x74** assuming the command was successful and the file contained only 4 characters (0x00, 0x04) at the pointer location, and the string was "test" (0x74, 0x65, 0x73, 0x74)	
Library Function	**file_GetS**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" and "**File Index**" commands to access another image from the same file, if required.	

5.6.25. File Erase

Serial Command	**cmd** (word), **filename** (string)	
	cmd	0x0003
	filename	Name of the file to be erased (passed as a string). Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	This function erases a file on the disk. **Note:** If the function fails, the appropriate error number is set in the "**File Error**" command and will usually be error 19, "failure during FILE search".	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, NULL **0x00, 0x03, 0x74, 0x65, 0x73, 0x74, 0x2E, 0x74, 0x78, 0x74, 0x00** This will erase the file called "test.txt" (0x74, 0x65, 0x73, 0x74, 0x2E, 0x74, 0x78, 0x74) followed by NULL (0x00) The response will be **0x06, 0x00, 0x01** assuming the command was successful and the operation was successful	
Library Function	**file_Erase**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Error**" command for retrieving any error which may have occurred.	

5.6.26. File Rewind

Serial Command	**cmd** (word), **handle** (word),	
	cmd	0xFF08
	handle	The handle that references the file.
Response	**acknowledge** (byte), **word** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	The **File Rewind** command resets the file pointer to the beginning of a file that has been opened in '**r**' (read), '**w**', or '**a**' (append) mode.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0xFF, 0x08, 0x0B, 0x31** This will reset the file point to the beginning of the file with file pointer 2865 (0x0B, 0x31) The response will be **0x06, 0x00, 0x01** assuming the command was successful and the operation was successful	
Library Function	**file_Rewind**	
See Also	The "**File Mount**" command, to initially mount the file system.	

5.6.27. File Load Function

Serial Command	**cmd** (word), **filename** (string)	
	cmd	0x0008
	filename	Name of the 4DGL function (filename.4FN) or application program (filename.4XE) that is about to be loaded into RAM. Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte), **pointer** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	pointer	Returns a pointer to the memory allocation where the function has been loaded from file which can be then used as a function call.
Description	The **File Load Function** command allocates the RAM area to the 4FN or 4XE program, load it from the uSD card in to the RAM and return a function pointer to the allocation. The function can then be invoked just like any other function would be called via a function pointer using the "**File Call Function**" commands. The 4FN or 4XE program may be discarded at any time when no longer required, thus freeing its memory resources. The loaded function can be discarded with the "**Memory Free**" command. **Note:** A 4FN or a 4XE file is an executable file generated when a 4DGL file is compiled. 4DGL file refers to the program files developed under "Designer" or "ViSi" Environments in the 4D Workshop4 IDE. .4FN file is generated when the 4DGL program has 'main' with arguments. .4XE file is generated when the 4DGL program has a 'main', with no arguments.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, char11, NULL **0x00 0x08 0x34 0x46 0x4E 0x2D 0x50 0x52 0x4F 0x47 0x2E 0x34 0x46 0x4E 0x00** This will load the "4FN-Prog.4FN" (0x34 0x46 0x4E 0x2D 0x50 0x52 0x4F 0x47 0x2E 0x34 0x46 0x4E 0x00) file, followed by a NULL. The response will be **0x06, 0x0D, 0x8B** assuming the command was successful and the pointer in memory where the function call has been loaded is 3467 (0x0D, 0x8B)	
Library Function	**file_LoadFunction**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Call Function**" command to invoke a loaded function "**Memory Free**" command to discard a loaded function	

5.6.28. File Call Function

Serial Command	**cmd** (word), **handle**(word), **Argcount**(word), **Arg0**(word), **Arg1**(word), …, **ArgN**(word)	
	cmd	0x0019
	handle	The file handle that was created by the "**File Load Function**" command which is now used as reference 'handle' for the filename, for further file functions such as in this function to close the file.
	Argcount	Number of arguments to be passed to the File Run command. Maximum 6 arguments.
	Arg0	Argument 0 to be passed. (optional)
	Arg1	Argument 1 to be passed. (optional)
	ArgN	Argument N to be passed. (optional)
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns the value from main in the called function
Description	Call the function previously loaded through "**File Load Function**". Parameters may be passed to it in a conventional way except the strings which needs to be loaded in to memory location separately through "**Load String for 4XE/4FN File**" command and the string handle is given to the File Call Function. The 4FN function or 4XE application may be discarded at any time when no longer required, thus freeing its memory resources. The loaded function can be discarded with the "**Memory Free**" command. **Note:** A 4FN or a 4XE file is an executable file generated when a 4DGL file is compiled. .4FN file is generated when the 4DGL program has 'main' with arguments. .4XE file is generated when the 4DGL program has a 'main', with no arguments.	
Example	**4DGL Program:** This program **"4FN-Prog.4FN"** when compiled under the "Designer Environment" generates the .4FN file.	

```
#platform "uLCD-32PTU"
#inherit "4DGL_16bitColours.fnc"

/* A 4DGL program without 'main'. When compiled, a .4FN
extension file is generated at the root folder where the 4DGL
program resides. Copy the 4FN file to the Fat16 (aka FAT)
formatted uSD card.*/

func messagebox(var line, var col, var txt)
    var txts ;
    gfx_Cls();
    gfx_ScreenMode(PORTRAIT) ;          // Change Orientation
    print("I am the Child Program\n") ; // Print text on screen
    print("line=", line, "\n");       // Print the 1st parameter
    print("column=", col, "\n");      // Print the 2nd parameter

    txt_MoveCursor(line, col);       // Move cursor to line, col
    txts := txt ;               // because str_Printf changes txt
    str_Printf(&txt, "%s");          // Print the 3rd parameter

    pause(3000);                        // Pause for 3 sec.
```

	`str_Copy(txts,"I have returned");`
	`return;`
	`endfunc`
	
	Example to use the "File Call Function" command:
	
	File Mount command:
	cmd(MSB), cmd(LSB)
	0xFF, 0x03
	Response:
	0x06 0x15 0x43 (ACK, Status(MSB), Status(LSB))
	
	File Load command:
	cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, char11, NULL
	0x00 0x08 0x34 0x46 0x4E 0x2D 0x50 0x52 0x4F 0x47 0x2E 0x34 0x46 0x4E 0x00
	Response:
	0x06 0x95 0x52 (ACK, Pointer(MSB), Pointer(LSB))
	
	Load String command:
	Cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, NULL
	0x00 0x21 0x00 0x00 0x48 0x65 0x6C 0x6C 0x6F 0x20 0x57 0x6F 0x72 0x6C 0x64 0x00
	Response:
	0x06 0x01 0x0E (ACK, pointer(MSB), pointer(LSB))
	
	File Call command (Arg0 = 10, Arg1 = 10, Arg2 = String Pointer):
	cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), Argcount(MSB), Argcount(LSB), Arg0(MSB), Arg0(LSB), Arg1(MSB), Arg1(LSB), Arg2(MSB), Arg2(LSB)
	0x00 0x19 0x95 0x52 0x00 0x03 0x00 0x0A 0x00 0x0A 0x01 0x0E
	Response:
	0x06 0x00 0x00 (ACK, value(MSB), value(LSB))
	
	Read String command:
	cmd(MSB), cmd(LSB), handle(MSB), handle(LSB)
	0x00 0x22 0x01 0x0E
	Response:
	0x49 0x20 0x68 0x61 0x76 0x65 0x20 0x72 0x65 0x74 0x75 0x72 0x6E 0x65 0x64
	(ACK, char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, char11, char12, char13, char14, char15, char16)
	
	Response = "I have returned"

Library Function	**file_CallFunction**
See Also	The "**File Mount**" command, to initially mount the file system. "**File Load Function**" command to load a function "**Memory Free**" command to discard a loaded function "**Load String for 4XE/4FN File**" command to pass a string to the Function

5.6.29. File Run

Serial Command	**cmd** (word), **filename** (string), **Argcount** (word), **Arg0**(word), **Arg1**(word),…, **ArgN**(word)	
	cmd	0x000D
	filename	A 4FN or a 4XE file is an executable file generated when a 4DGL file is compiled. Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
	Argcount	Number of arguments to be passed to the File Run command.
	Arg0	Argument 0 to be passed. (optional)
	Arg1	Argument 1 to be passed. (optional)
	ArgN	Argument N to be passed. (optional)
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns the value from the called program.
Description	The **File Run** command will load the 4FN or 4XE program from the uSD card in to the RAM and execute it. Once the program is called, the Host must wait until the program finished execution. Any attempt to send further commands while the 4FN or 4XE file is executing can cause the module to reset or respond with erroneous data. The 4FN or 4XE program may be discarded at any time when no longer required, thus freeing its memory resources. Parameters may be passed to it in a conventional way except the strings which needs to be loaded in to memory location separately through "**Load String**" command and the string handle is given to the File Call Function. The 4FN function or 4XE application may be discarded at any time when no longer required, thus freeing its memory resources. The loaded function can be discarded with the "**Memory Free**" command. **Note:** A 4FN or a 4XE file is an executable file generated when a 4DGL file is compiled. .4FN file is generated when the 4DGL program has 'main' with arguments. .4XE file is generated when the 4DGL program has a 'main', with no arguments. Any memory allocations in the main FLASH program are released; however, the stack and globals are maintained. func 'main' in the called program accepts the arguments, if any. If Argcount is 0, no arguments are passed; else Arg0-ArgN contains argument 0 to argument N. The disk does not need to be mounted; File Run automatically mounts the drive.	
Example	**4DGL Program:** This program **"4FN-Prog.4FN"** when compiled under the "Designer Environment" generates the .4FN file.	

```
#platform "uLCD-32PTU"
#inherit "4DGL_16bitColours.fnc"

/* A 4DGL program without 'main'. When compiled, a .4FN
extension file is generated at the root folder where the 4DGL
program resides. Copy the 4FN file to the Fat16 (aka FAT)
formatted uSD card.*/

func messagebox(var line, var col, var txt)
    var txts ;
    gfx_Cls();
    gfx_ScreenMode(PORTRAIT) ;          // Change Orientation
    print("I am the Child Program\n") ; // Print text on screen
    print("line=", line, "\n");       // Print the 1st parameter
    print("column=", col, "\n");      // Print the 2nd parameter

    txt_MoveCursor(line, col);      // Move cursor to line, col
    txts := txt ;               // because str_Printf changes txt
    str_Printf(&txt, "%s");          // Print the 3rd parameter

    pause(3000);                        // Pause for 3 sec.
    str_Copy(txts,"I have returned");
    return;
endfunc
```

Example to use the "File Run" command:

File Mount command:
cmd(MSB), cmd(LSB)
0xFF, 0x03
Response:
0x06 0x15 0x43 (ACK, Status(MSB), Status(LSB))

Load String command:
Cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, NULL
0x00 0x21 0x00 0x00 0x48 0x65 0x6C 0x6C 0x6F 0x20 0x57 0x6F 0x72 0x6C 0x64 0x00
Response:
0x06 0x01 0x0E (ACK, pointer(MSB), pointer(LSB))

File Run command (Arg0 = 10, Arg1 = 10, Arg2 = String Pointer):
cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, char11, Argcount(MSB), Argcount(LSB), Arg0(MSB), Arg0(LSB), Arg1(MSB), Arg1(LSB), Arg2(MSB), Arg2(LSB)
0x00 0x0D 0x34 0x46 0x4E 0x2D 0x50 0x52 0x4F 0x47 0x2E 0x34 0x46 0x4E 0x00 0x00 0x03 0x00 0x0A 0x00 0x0A 0x01 0x0E
Response:
0x06 0x80 0x24

Read String command:
cmd(MSB), cmd(LSB), handle(MSB), handle(LSB)
0x00 0x22 0x01 0x0E
Response:
0x49 0x20 0x68 0x61 0x76 0x65 0x20 0x72 0x65 0x74 0x75 0x72 0x6E 0x65 0x64
(ACK, char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, char11, char12, char13, char14, char15, char16)

Response = "I have returned"

Library Function	**file_Run**

5.6.30. File Execute

Serial Command	**cmd** (word), **filename** (string), **Argcount** (word), **Arg0**(word), **Arg1**(word),…, **ArgN**(word)	
	cmd	0x0004
	filename	A 4FN or a 4XE file 4FN or a 4XE file is an executable file generated when a 4DGL file is compiled. Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
	Argcount	Number of arguments to be passed to the File Run command.
	Arg0	Argument 0 to be passed. (optional)
	Arg1	Argument 1 to be passed. (optional)
	ArgN	Argument N to be passed. (optional)
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns the value from the called program.
Description	The **File Execute** command will load the 4FN or 4XE program from the uSD card in to the RAM and execute it. Once the program is called, the Host must wait until the program finished execution. Any attempt to send further commands while the 4FN or 4XE file is executing can cause the module to reset or respond with erroneous data. The 4FN or 4XE program may be discarded at any time when no longer required, thus freeing its memory resources. Parameters may be passed to it in a conventional way except the strings which needs to be loaded in to memory location separately through "**Load String**" command and the string handle is given to the File Call Function. The 4FN function or 4XE application may be discarded at any time when no longer required, thus freeing its memory resources. The loaded function can be discarded with the "**Memory Free**" command. **Note:** A 4FN or a 4XE file is an executable file generated when a 4DGL file is compiled. .4FN file is generated when the 4DGL program has 'main' with arguments. .4XE file is generated when the 4DGL program has a 'main', with no arguments. This function is similar to **File Run,** however, the main program in FLASH retains all memory allocations (eg file buffers, memory allocated with mem_Alloc etc)	

Example	**4DGL Program:**
	This program **"4FN-Prog.4FN"** when compiled under the "Designer Environment" generates the .4FN file.
	
	4DGL Program:
	`#platform "uLCD-32PTU"`
	`#inherit "4DGL_16bitColours.fnc"`	

```
/* A 4DGL program without 'main'. When compiled, a .4FN
extension file is generated at the root folder where the 4DGL
program resides. Copy the 4FN file to the Fat16 (aka FAT)
formatted uSD card.*/

func messagebox(var line, var col, var txt)
    var txts ;
    gfx_Cls();
    gfx_ScreenMode(PORTRAIT) ;          // Change Orientation
    print("I am the Child Program\n") ; // Print text on screen
    print("line=", line, "\n");      // Print the 1st parameter
    print("column=", col, "\n");     // Print the 2nd parameter

    txt_MoveCursor(line, col);      // Move cursor to line, col
    txts := txt ;               // because str_Printf changes txt
    str_Printf(&txt, "%s");          // Print the 3rd parameter

    pause(3000);                        // Pause for 3 sec.
    str_Copy(txts,"I have returned");
    return;
endfunc
```

Example to use the "File Execute" command:

File Mount command:
cmd(MSB), cmd(LSB)
0xFF, 0x03
Response:
0x06 0x15 0x43 (ACK, Status(MSB), Status(LSB))

Load String command:
Cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, NULL
0x00 0x21 0x00 0x00 0x48 0x65 0x6C 0x6C 0x6F 0x20 0x57 0x6F 0x72 0x6C 0x64 0x00
Response:
0x06 0x01 0x0E (ACK, pointer(MSB), pointer(LSB))

File Execute command (Arg0 = 10, Arg1 = 10, Arg2 = String Pointer):
cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, char11, Argcount(MSB), Argcount(LSB), Arg0(MSB), Arg0(LSB), Arg1(MSB), Arg1(LSB), Arg2(MSB), Arg2(LSB)
0x00 0x04 0x34 0x46 0x4E 0x2D 0x50 0x52 0x4F 0x47 0x2E 0x34 0x46 0x4E 0x00 0x00 0x03 0x00 0x0A 0x00 0x0A 0x01 0x0E
Response:
0x06 0x80 0x24

Read String command:
cmd(MSB), cmd(LSB), handle(MSB), handle(LSB)
0x00 0x22 0x01 0x0E
Response:
0x49 0x20 0x68 0x61 0x76 0x65 0x20 0x72 0x65 0x74 0x75 0x72 0x6E 0x65 0x64
(ACK, char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10, char11, char12, char13, char14, char15, char16)

Response = "I have returned"

Library Function	**file_Exec**

5.6.31. Load Image Control

Serial Command	**cmd** (word), **filename1** (string), **filename**2(string), **mode**(word)	
	cmd	0x0009
	filename1	The control list filename "*.dat". Created from Graphics Composer. Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
	filename2	The image filename "*.gci". Created from Graphics Composer. Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
	mode	**mode 0 :** It is assumed that there is a graphics file with the file extension "fname2.gci". In this case, the images have been stored in a FAT16 file concurrently, and the offsets that are derived from the "fname1.dat" file are saved in the image control so that the **Load Image Control** command can open the file (*.gci) and use the "**File Seek**" command to get to the position of the image which can then automatically be displayed using the "**Display Image (FAT)**" command. Mode 0 builds the image control quickly as it only scans the *.dat file for the file offsets and saves them in the relevant entries in the image control. The penalty is that images take longer to find when displayed due to the "**File Seek**" command overheads. **mode 1 :** It is assumed that there is a graphics file with the file extension "fname2.gci". In this case, the images have been stored in a FAT16 file concurrently, and the offset of the images are saved in the image control so that image file (*.gci) can be mapped to directly. The absolute cluster/sector is mapped so file seek does not need to be called internally. This means that there is no seek time penalty, however, the image list takes a lot longer to build, as all the seeking is done at control build time. **mode 2 :** In this case, the images have been stored in a in a RAW partition of the uSD card, and the absolute address of the images are saved in the DAT file. This is the fastest operation of the image control as there is no seeking or other disk activity taking place.
Response	**acknowledge** (byte), **handle** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	handle	Returns a handle (pointer to the memory allocation) to the image control list that has been created. Returns NULL if function fails.
Description	Reads a control file to create an image list. The GCI file may contain images, videos or animations built through the Graphics Composer Software tool.	

	The GCI file is created by selecting the **GCI – FAT Selected Folder** option in the Built Option type. See the Graphics Composer User Guide for further details on the Graphics Composer.
Example	**Byte Stream:** cmd(MSB), cmd(LSB), charA0, charA1, charA2, ..., charA12, NULL, charB0, charB1, charB2, ..., char12, NULL, mode(MSB), mode(LSB) **0x00, 0x09, 0x47, 0x46, 0x58, 0x32, 0x44, 0x45, 0x4D, 0x4F, 0x2E, 0x44, 0x41, 0x54, 0x00, 0x47, 0x46, 0x58, 0x32, 0x44, 0x45, 0x4D, 0x4F, 0x2E, 0x47, 0x43, 0x49, 0x00, 0x00, 0x01** This will load the Image Control System using the 2 specified files (GFX2DEMO.DAT and GFX2DEMO.GCI) The response will be **0x06 0x0D 0x6A** assuming the command is successful and the handle that is returned is 3434 (0x0D, 0x6A)
Library Function	**file_LoadImageControl**
See Also	The "**File Mount**" command, to initially mount the file system. "**File Seek**" command to access another image from the same file, if required. "**Display Image (FAT)**" command for displaying the image from File.

5.6.32. File Mount

Serial Command	**cmd** (word)	
	cmd	0xFF03
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**Non-zero**: If the operation successful. **0:** if the attempt failed.
Description	Starts up the FAT16 disk file services and allocates a small 32 byte control block for subsequent use. When you open a file using the "**File Open**" command a further 512 + 44 = 556 bytes are attached to the FAT16 file control block. When you close a file using the "**File Close**" command, the 556 byte allocation is released leaving the 32 byte file control block. The **File Mount** command must be called before any other FAT16 file related functions can be used. The control block and all FAT16 file resources are completely released with the "**File Unmount"** command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x03** This will mounts the file system The response will be **0x06** followed by a non-zero number (such as **0x00, 0x01**) if the command is successful, or zero (**0x00, 0x00**) if unsuccessful.	
Library Function	**file_Mount**	
See Also	The "**File Unmount**" command, to unmount the file system.	

5.6.33. File Unmount

Serial Command	**cmd** (word)	
	cmd	0xFF02
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The "**File Unmount"** command releases any buffers for FAT16 and unmount the Disk File System. This function is to be called to close the FAT16 file system.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x02** This will unmounts the file system The response will be **0x06** if the command is successful	
Library Function	**file_Unmount**	
See Also	The "**File Mount**" command, to initially mount the file system.	

5.6.34. Play WAV File

Serial Command	**cmd** (word), **filename.WAV** (string)	
	cmd	0x000B
	filename.4XE	Name of the wav file to be opened and played. Filename must be 8.3 format. char0, char1, char2, …, charN, NULL
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	If there are no errors, returns number of blocks to play (1 to 32767) If errors occurred, the following is returned 6 : can't play this rate 5 : no data chunk found in first sector 4 : no format data 3 : no wave chunk signature 2 : bad wave file format 1 : file not found
Description	Open the wav file, decode the header to set the appropriate wave player parameters and set off the playing of the file as a background process. See "Sound Control Commands" for additional play control functions. **Note:** Wave files should be mono to keep data bandwidth to a minimum, and should be 'canonic' format. Lots of windows formats will not work. Use something like 'Cool Edit' or similar to tailor the wav files to a suitable format. The ideal sample rate of the WAV file is 16Khz-Mono and the maximum should be 22Khz. Any higher sample rate will extremely slow down the system. Sample rates below 12Khz, the PWM will cause aliasing (filtering is a bare minimum). If you only hear noise or random snippets of sound remember, the Speed and Capacity of the memory card are important, most 2Gb cards should be fine, 64mb cards fail all but the most-simple sounds.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), char0, char1, char2, char3, char4, char5, char6, char7, char8, char9, char10 **0x00, 0x0B, 0x43, 0x48, 0x49, 0x4D, 0x45, 0x53, 0x2E, 0x57, 0x41, 0x56, 0x00** This will open the "CHIMES.WAV" file (0x43, 0x48, 0x49, 0x4D, 0x45, 0x53, 0x2E, 0x57, 0x41, 0x56) and play it, the string is appended with a Null (0x00) The response will be **0x06, 0x00, 0x1E** assuming the command was successful, and it returned there are 30 blocks (0x00, 0x1E) of the WAV file to play.	
Library Function	**file_PlayWAV**	
See Also	The "**File Mount**" command, to initially mount the file system. All 'Sound Control Commands', section 5.7	

5.6.35. To Load String for 4XE/4FN File

Serial Command	**cmd** (word), **handle**(word), **string** (string)	
	cmd	0x0021
	handle	A string pointer to the memory area where the string is to be loaded. The first string would start with handle = 0, next one would use the handle = string pointer returned from the execution of the Write string earlier.
	string	A Null terminated string which is to be passed to the Child (4XE or 4FN) program.
Response	**acknowledge** (byte), **pointer** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	pointer	Returns a pointer to the memory allocation where the string has been loaded.
Description	Load the Memory space with the string to be used by the "**File Call Function"**, "**File Run"** and "**File Execute"** commands as an argument. The Memory Space for the "**Read String for 4XE/4FN File**" command or "**Load String for 4XE/4FN File**" command is pre-allocated memory, 512 bytes in size. It doesn't need to be released.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), char0, char1, char2, char3, char4, NULL **0x00, 0x21, 0x11, 0xA9, 0x48, 0x65, 0x6C, 0x6C, 0x6F, 0x00** This will Load the String "Hello" (0x48, 0x65, 0x6C, 0x6C, 0x6F) which has been NULL terminated (0x00) into the designated string pointer location 4521 (0x11, 0xA9) The response will be **0x06, 0x01, 0x0E** assuming the command was successful and the pointer where the string was loaded was 4522 (0x11, 0xAA)	
Library Function	**writeString**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Call Function**", "**File Run**" and "**File Execute**" commands to invoke a loaded function "**Read String for 4XE/4FN File**" to read the string from the invoked function	

5.6.36. Read String for 4XE/4FN File

Serial Command	**cmd** (word), **handle**(word)	
	cmd	0x0022
	handle	A string pointer to the memory area where the string is returned from the child (4FN or 4XE) program. The first string would start with handle = 0, next one would use the handle = string pointer returned from the execution of the Write string earlier.
Response	**acknowledge** (byte), **string** (string)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	string	A string without NULL terminator.
Description	Allocate and read the string from the Memory space returned by **File Call Function**, **File Run** and **File Execute** functions as an argument. The Memory Space for the "**Read String for 4XE/4FN File"** and **"Load String for 4XE/4FN File"** commands is pre-allocated memory, 512 bytes in size. It doesn't need to be cleared. **Note:** You have to write to a string first using the "**Load String for 4XE/4FN File**" command to get a handle, you pass that to the program, the handle will be used by the child program to write to what it intends to return, then you use the same handle to read what is being returned by the child program. If you only have one string then you can write anything to it, if you have 2 and the first one is written to by the child program then the initial write must be longer than the maximum returned string. See the examples listed under the "**File Run**", "**File Execute**" and "**File Call Functions**" commands.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0x00, 0x22, 0x01, 0x0E** This will read the string from the memory space with the handle 270 (0x01, 0x0E), and return the string from that memory space, without the NULL terminator. The response will be **0x06, 0x49, 0x20, 0x68, 0x61, 0x76, 0x65, 0x20, 0x72, 0x65, 0x74, 0x75, 0x72, 0x6E, 0x65, 0x64** assuming the command was successful and the string that was returned was "I have returned" (0x49, 0x20, 0x68, 0x61, 0x76, 0x65, 0x20, 0x72, 0x65, 0x74, 0x75, 0x72, 0x6E, 0x65, 0x64**)**	
Library Function	**readString**	
See Also	The "**File Mount**" command, to initially mount the file system. "**File Call Function**", "**File Run**" and "**File Execute**" commands to invoke a loaded function "**Load String for 4XE/4FN File**" to load the string into the invoked function	

5.7. Sound Control Commands

The following is a summary of the commands available to be used for Sound Control:

- Sound Volume
- Sound Pitch
- Sound Buffer
- Sound Stop
- Sound Pause
- Sound Continue
- Sound Playing

Note: All these commands are used in conjunction with 'Play WAV file' command.

5.7.1. Sound Volume

Serial Command	**cmd** (word), **level** (word)	
	cmd	0xFF00
	level	Sound playback volume level. 0 - 127
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Set the sound playback volume. Var must be in the range from 8 (min volume) to 127 (max volume). If var is less than 8, volume is set to 8, and if var > 127 it is set to 127.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), level(MSB), level(LSB) **0xFF, 0x00, 0x00, 0x64** This will set the volume to be 100 (0x00, 0x64) out of the possible 127 The response will be **0x06** if the command was successful	
Library Function	**snd_Volume**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Play WAV File**" command, to open the WAV file to be played	

5.7.2. Sound Pitch

Serial Command	**cmd** (word), **pitch** (word)	
	cmd	0xFEFF
	pitch	Sample's playback rate. Minimum is 4KHz. Range is, 4000 – 65535.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns sample's original sample rate.
Description	Sets the samples playback rate to a different frequency. Setting pitch to zero restores the original sample rate.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), pitch(MSB), pitch(LSB) **0xFE, 0xFF, 0x50, 0x14** This will set the pitch to be 20500 (0x40, 0x14) out of the possible 65535 The response will be **0x06** if the command was successful	
Library Function	**snd_Pitch**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Play WAV File**" command, to open the WAV file to be played	

5.7.3. Sound Buffer

Serial Command	**cmd** (word), **buffersize** (word)	
	cmd	0xFEFE
	buffersize	Specifies the buffer size. 0 = 1024 bytes (default) 1 = 2048 bytes 2 = 4096 bytes
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Specify the memory chunk size for the wavefile buffer, default size 1024 bytes. Depending on the sample size, memory constraints, and the sample quality, it may be beneficial to change the buffer size from the default size of 1024 bytes. This command is for control of a wav buffer, see the "**Play WAV File"** command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), buffersize(MSB), buffersize(LSB) **0xFE, 0xFE, 0x00, 0x01** This will set the sound buffer size to be 2048 bytes (0x00, 0x01) The response will be **0x06** if the command was successful	
Library Function	**snd_BufSize**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Play WAV File**" command, to open the WAV file to be played	

5.7.4. Sound Stop

Serial Command	**cmd** (word)	
	cmd	0xFEFD
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Stop any sound that is currently playing, releasing buffers and closing any open WAV file. This command is for control of a wav buffer, see the "**Play WAV File"** command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFE, 0xFD** This will stop any currently playing sound The response will be **0x06** if the command was successful	
Library Function	**snd_Stop**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Play WAV File**" command, to open the WAV file to be played	

5.7.5. Sound Pause

Serial Command	**cmd** (word)	
	cmd	0xFEFC
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Pause any sound that is currently playing. This command is for control of a wav buffer, see the "**Play WAV File"** command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFE, 0xFC** This will pause any currently playing sound The response will be **0x06** if the command was successful	
Library Function	**snd_Pause**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Play WAV File**" command, to open the WAV file to be played	

5.7.6. Sound Continue

Serial Command	**cmd** (word)	
	cmd	0xFEFB
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Resume any sound that is currently paused by the "**Sound Pause**" command. This command is for control of a wav buffer, see the "**Play WAV File"** command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFE, 0xFB** This will continue any currently paused sound The response will be **0x06** if the command was successful	
Library Function	**snd_Continue**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Play WAV File**" command, to open the WAV file to be played	

5.7.7. Sound Playing

Serial Command	**cmd** (word)	
	cmd	0xFEFA
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Number of 512 byte blocks to go.
Description	Returns 0 if sound has finished playing, else return number of 512 byte blocks to go. This command is for control of a wav buffer, see the "**Play WAV File"** command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFE, 0xFA** This command will return the number of 512 byte blocks remaining on the currently playing sound file. The response will be **0x06, 0x26, 0x2A** assuming the command was successful and the currently playing WAV file had 9770 blocks (0x26, 0x2A) of 512 bytes remaining to play.	
Library Function	**snd_Playing**	
See Also	The "**File Mount**" command, to initially mount the file system. "**Play WAV File**" command, to open the WAV file to be played	

5.8. Touch Screen Commands

The following is a summary of the commands available to be used for Touch Screens:

- Touch Detect Region
- Touch Set
- Touch Get

Note: All these commands do not apply for the uVGA-II or uVGA-III

5.8.1. Touch Detect Region

Serial Command	**cmd** (word), **x1** (word) , **y1** (word) , **x2** (word) , **y2** (word)	
	cmd	0xFF39
	x1	Specifies the horizontal position of the top left corner of the region.
	y1	Specifies the vertical position of the top left corner of the region.
	x2	Specifies the horizontal position of the bottom right corner of the region.
	y2	Specifies the vertical position of the bottom right corner of the region.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Specifies a new touch detect region on the screen. This setting will filter out any touch activity outside the region and only touch activity within that region will be reported by the status poll "**Touch Get**" command	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), line(MSB), line(LSB), column(MSB), column(LSB) **0xFF, 0x39, 0x00, 0x00, 0x00, 0x00, 0x00, 0x64, 0x00, 0x64** This will set a touch region between X1=0 (0x00, 0x00), Y1=0 (0x00, 0x00) and X2=100 (0x00, 0x64), Y2=100 (0x00, 0x64) The response will be **0x06** if the command was successful	
Library Function	**touch_DetectRegion**	

5.8.2. Touch Set

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFF38
	mode	**mode = 0:** Enables and initialises Touch Screen hardware. **mode = 1:** Disables the Touch Screen. **Note:** Touch Screen task runs in the background and disabling it when not in use will free up extra resources for 4DGL CPU cycles. **mode = 2:** This will reset the current active region to default which is the full screen area
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Sets various Sets various Touch Screen related parameters.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0x38, 0x00, 0x00** This will enable and initialise the touch screen hardware, Mode = 0 (0x00, 0x00) The response will be **0x06** assuming the command was successful	
Library Function	**touch_Set**	

5.8.3. Touch Get

Serial Command	**cmd** (word), **mode** (word)	
	cmd	0xFF37
	mode	**mode = 0 :** Get Status **mode = 1 :** Get X coordinates **mode = 2 :** Get Y coordinates
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	mode = 0 Returns the various states of the touch screen 0 = INVALID/NOTOUCH 1 = PRESS 2 = RELEASE 3 = MOVING mode = 1 : Returns the X coordinates of the touch reported by mode 0 mode = 2 : Returns the Y coordinates of the touch reported by mode 0
Description	Returns various Touch Screen parameters to caller, based on the touch detect region on the screen set by the "**Touch Detect Region**" command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), mode(MSB), mode(LSB) **0xFF, 0x37, 0x00, 0x01** This will get the current X coordinate of where the users finger is on the touch screen, in the touch region, using Mode = 1 (0x00, 0x01) The response will be **0x06, 0x00, 0x47** assuming the command was successful and the users finger was located at X=71 (0x00, 0x47)	
Library Function	**touch_Get**	

5.9. Image Control Commands

The following is a summary of the commands available to be used for Image Control:

- Image Set Position
- Image Enable
- Image Disable
- Image Darken
- Image Lighten
- Set Image Parameters
- Get Image Parameters
- Show Image
- Set Image Attributes
- Clear Image Attributes
- Image Touched
- Blit Com to Display

Note: All these commands are used in conjunction with the file "**Load Image Control**" command.

5.9.1. Image Set Position

Serial Command	**cmd** (word), **handle** (word), **index** (word), **xpos**(word), **ypos**(word)	
	cmd	0xFF4E
	handle	Pointer to the Image List.
	index	Index of the images in the list.
	xpos	Top left horizontal screen position where image is to be displayed.
	ypos	Top left vertical screen position where image is to be displayed.
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	This function requires that an image control has been created with the "**Load Image Control"** command. Sets the position where the image will next be displayed. Returns TRUE if index was ok and function was successful. (The return value is usually ignored). You may turn off an image so when the "**Show Image**" command is called, the image will not be shown.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB), xpos(MSB), xpos(LSB), ypos(MSB), ypos(LSB) **0xFF, 0x4E, 0x11, 0xB3, 0x00, 0x01, 0x00, 0x19, 0x00, 0x0A** This will set the position of the top left corner of the image to be displayed at X=25 (0x00, 0x19), Y=10 (0x00, 0x0A), where the image has a file handle of 4531 (0x11, 0xB3) and the index of the required image in that file is 1 (0x00, 0x01). The response will be **0x06, 0x00, 0x01** assuming the command was successful (0x06) and the operation was successful (0x00, 0x01)	
Library Function	**img_SetPosition**	

5.9.2. Image Enable

Serial Command	**cmd** (word), **handle** (word), **index** (word)	
	cmd	0xFF4D
	handle	Pointer to the Image List.
	index	Index of the images in the list.
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	This command requires that an image control has been created with the "**Load Image Control**" command. Enables a selected image in the image list. Returns TRUE if index was ok and function was successful. This is the default state so when the "**Show Image"** command is called, all the images in the list will be shown. To enable all of the images in the list at the same time set index to -1. To enable a selected image, use the image index number.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB) **0xFF, 0x4D, 0x11, 0xB3, 0x00, 0x01** This will enable the image with index = 1 from the image which has a handle of 4531 (0x11, 0xB3) The response will be **0x06, 0x00, 0x01** assuming the command was successful (0x06) and the operation was successful (0x00, 0x01)	
Library Function	**img_Enable**	

5.9.3. Image Disable

Serial Command	**cmd** (word), **handle** (word), **index** (word)	
	cmd	0xFF4C
	handle	Pointer to the Image List.
	index	Index of the images in the list.
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successfull. **0:** if the attempt failed.
Description	This function requires that an image control has been created with the "**Load Image Control**" command. Disables an image in the image list. Returns TRUE if index was ok and function was successful. Use this function to turn off an image so that when the "**Show Image"** command is called the selected image in the list will not be shown. To disable all of the images in the list at the same time set index to -1.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB) **0xFF, 0x4C, 0x11, 0xB3, 0x00, 0x02** This will disable the image with index = 2 from the image which has a handle of 4531 (0x11, 0xB3) The response will be **0x06, 0x00, 0x01** assuming the command was successful (0x06) and the operation was successful (0x00, 0x01)	
Library Function	**img_Disable**	

5.9.4. Image Darken

Serial Command	**cmd** (word), **handle** (word), **index** (word)	
	cmd	0xFF4B
	handle	Pointer to the Image List.
	index	Index of the images in the list.
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	This function requires that an image control has been created with the "**Load Image Control**" command. Darken an image in the image list. Returns TRUE if index was ok and function was successful. Use this function to darken an image so that when the "**Show Image"** command is called the control will take effect. To darken all of the images in the list at the same time set index to -1. **Note:** This feature will take effect one time only and when the "**Show Image"** command is called again the darkened image will revert back to normal.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB) **0xFF, 0x4B, 0x11, 0xB3, 0xFF, 0xFF** This will darken all of the images in the list that will next be shown by using the index = -1 (0xFF, 0xFF), using the image file which has a handle of 4531 (0x11, 0xB3) The response will be **0x06, 0x00, 0x01** assuming the command was successful (0x06) and the operation was successful (0x00, 0x01)	
Library Function	**img_Darken**	

5.9.5. Image Lighten

Serial Command	**cmd** (word), **handle** (word), **index** (word)	
	cmd	0xFF4A
	handle	Pointer to the Image List.
	index	Index of the images in the list.
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	This function requires that an image control has been created with the "**Load Image Control**" command. Lighten an image in the image list. Returns TRUE if index was ok and function was successful. Use this function to lighten an image so that when the "**Show Image"** command is called the control will take effect. To lighten all of the images in the list at the same time set index to -1. **Note:** This feature will take effect one time only and when the "**Show Image"** command is called again the lightened image will revert back to normal.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB) **0xFF, 0x4A, 0x11, 0xB3, 0x00, 0x01** This will lighten the images in the list that has the index = 1 (0x00, 0x01), using the image file which has a handle of 4531 (0x11, 0xB3) The response will be **0x06, 0x00, 0x01** assuming the command was successful (0x06) and the operation was successful (0x00, 0x01)	
Library Function	**img_Lighten**	

5.9.6. Set Image Parameters

Serial Command	**cmd** (word), **handle** (word), **index** (word), **offset** (word), **value** (word)	
	cmd	0xFF49
	handle	Pointer to the Image List.
	index	Index of the images in the list.
	offset	Offset of the required word in the image entry. 2 IMAGE_XPOS // WORD image location X 3 IMAGE_YPOS // WORD image location Y 6 IMAGE_FLAGS // WORD image flags 7 IMAGE_DELAY // WORD inter frame delay 9 IMAGE_INDEX // WORD current frame **Note:** Not all Constants are listed as some are Read Only.
	value	The word to be written to the entry.
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	This function requires that an image control has been created with the "**Load Image Control**" command. Set image parameters in an image entry. **Note:** The "**Show Image"** command will now show an error box for out of range video frames. Also, if frame is set to -1, just a rectangle will be drawn in background colour to blank an image. It applies to PmmC R29 or above.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB), offset(MSB), offset(LSB), value(MSB), value(LSB) **0xFF, 0x49, 0x0D, 0xE4, 0x00, 0x01, 0x00, 0x04, 0x00, 0x64** This will set the IMAGE_WIDTH parameter (0x00, 0x04) of the image with a handle of 3556 (0x0D, 0xE4) and image index of 1 (0x00, 0x01) to have the value of 100 (0x00, 0x64) The response will be **0x06, 0x00, 0x01** assuming the command was successful (0x06) and the operation was successful (0x00, 0x01)	
Library Function	**img_SetWord**	

5.9.7. Get Image Parameters

Serial Command	**cmd** (word), **handle** (word), **index** (word), **offset** (word)	
	cmd	0xFF48
	handle	Pointer to the Image List.
	index	Index of the images in the list.
	offset	Offset of the required word in the image entry. 2 IMAGE_XPOS // WORD image location X 3 IMAGE_YPOS // WORD image location Y 4 IMAGE_WIDTH // WORD image width 5 IMAGE_HEIGHT // WORD image height 6 IMAGE_FLAGS // WORD image flags 7 IMAGE_DELAY // WORD inter frame delay 8 IMAGE_FRAMES // WORD number of frames 9 IMAGE_INDEX // WORD current frame
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	The word to be written to the entry.
Description	This function requires that an image control has been created with the "**Load Image Control**" command. Returns the image parameters in an image entry.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB), offset(MSB), offset(LSB) **0xFF, 0x48, 0x0D, 0xE4, 0x00, 0x06, 0x00, 0x05** This will get the current IMAGE_HEIGHT (0x00, 0x05) value from the image, which has a handle of 3556 (0x0D, 0xE4), and index of 6 (0x00, 0x05) The response will be **0x06, 0x00, 0x49** assuming the command was successful and the Image Height was reported to be 73 (0x00, 0x49).	
Library Function	**img_GetWord**	

5.9.8. Show Image

Serial Command	**cmd** (word), **handle** (word), **index** (word)	
	cmd	0xFF47
	handle	Pointer to the Image List.
	index	Index of the images in the list.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**0:** if the attempt failed. **Non 0**: If the operation was successful.
Description	This function requires that an image control has been created with the "**Load Image Control**" command. Enable the displaying of the image entry in the image control. Returns a non-zero value if successful but return value is usually ignored.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB) **0xFF, 0x47, 0x0D, 0xE4, 0x00, 0x01** This will show the image which has a handle of 3556 (0x0D, 0xE4) and image index of 1 (0x00, 0x01) The response will be **0x06, 0x00, 0x01** assuming the command was successful and the image show operation was successful (return may be any non-zero value) (0x00, 0x01)	
Library Function	**img_Show**	

5.9.9. Set Image Attributes

Serial Command	**cmd** (word), **handle** (word), **index** (word), **value** (word)	
	cmd	0xFF46
	handle	Pointer to the Image List.
	index	Index of the images in the list.
	value	Refer to the Image Attribute Flags in the description below.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	TRUE or FALSE
Description	This command SETS one or more bits in the IMAGE_FLAGS field of an image control entry. "value" refers to various bits in the image control entry (see image attribute flags above). A '1' bit in the "value" field SETS the respective bit in the IMAGE_FLAGS field of the image control entry. Image Attribute Flags I_ENABLED 0x8000 // bit 15, set for image enabled I_DARKEN 0x4000 // bit 14, display dimmed I_LIGHTEN 0x2000 // bit 13, display bright I_Y_LOCK 0x0800 // bit 11, stop Y movement I_X_LOCK 0x0400 // bit 10, stop X movement I_TOPMOST 0x0200 // bit 9, draw on top of other images next update I_STAYONTOP 0x0100 // bit 8, draw on top of other images always I_TOUCH_DISABLE 0x0020 // bit 5, set to disable touch for this image, default=1 for movie, default=0 for image	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB), value(MSB), value(LSB) **0xFF, 0x46, 0x11, 0xB3, 0x00, 0x01, 0x40, 0x00** This will set the image with handle=4531 (0x11, 0xB3) with index=1 (0x00, 0x01) that is next shown with the “Show Image” command to be Darker (0x40, 0x00), the same as using the “Image Darken” command. The response will be **0x00, 0x00, 0x01** assuming the command was successful and the image attribute was successfully set (0x00, 0x01)	
Library Function	**img_SetAttributes**	

5.9.10. Clear Image Attributes

Serial Command	**cmd** (word), **handle** (word), **index** (word), **value** (word)	
	cmd	0xFF45
	handle	Pointer to the Image List.
	index	Index of the images in the list.
	value	A '1' bit indicates that a bit should be set and a '0' bit indicates that a bit is not altered. **Note:** if index is set to -1, the attribute is altered in ALL of the entries in the image list. Refer to the Image Attribute Flags in the description below.
Response	**acknowledge** (byte), **status** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**1**: If the operation successful. **0:** if the attempt failed.
Description	Clear various Image Attribute Flags in an image control entry. (see image attribute flags below) Image Attribute Flags may be combined by adding the hex of two or more flags together, or with binary addition. This function requires that an image control has been created with the "**Load Image Control**" command. Returns TRUE if index was ok and function was successful. (the return value is usually ignored). Image Attribute Flags I_ENABLED 0x8000 // bit 15, set for image enabled I_DARKEN 0x4000 // bit 14, display dimmed I_LIGHTEN 0x2000 // bit 13, display bright I_Y_LOCK 0x0800 // bit 11, stop Y movement I_X_LOCK 0x0400 // bit 10, stop X movement I_TOPMOST 0x0200 // bit 9, draw on top of other images next update I_STAYONTOP 0x0100 // bit 8, draw on top of other images always I_TOUCH_DISABLE 0x0020 // bit 5, set to disable touch for this image, default=1 for movie, default=0 for image	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB), value(MSB), value(LSB) **0xFF, 0x45, 0x11, 0xB3, 0x00, 0x21, 0x80, 0x00** This will clear the I_ENABLED (0x80, 0x00) attribute from the image with handle = 4531 (0x11, 0xB3) and index = 33 (0x00, 0x21) The response will be **0x06, 0x00, 0x01** assuming the command was successful (0x06) and the attribute was successfully cleared (0x00, 0x01)	
Library Function	**img_ClearAttributes**	

5.9.11. Image Touched

Serial Command	**cmd** (word), **handle** (word), **index** (word)	
	cmd	0xFF44
	handle	Pointer to the Image List.
	index	Index of the images in the list.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns image index if image touched. -1 if image not touched.
Description	This command requires that an image control has been created with the "**Load Image Control**" command. Returns index if image touched or returns -1 image not touched. If index is passed as -1 the command tests all images and returns -1 if image not touched or returns index.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB), index(MSB), index(LSB) **0xFF, 0x44, 0x0D, 0xE4, 0x00, 0x05** This will return if an image with handle 3556 (0x44, 0x0D) and index 5 (0x00, 0x05) has been touch. The response will be **0x06, 0x00, 0x05** assuming the command was successful and the image touched had the index of 5 (0x00, 0x05).	
Library Function	**img_Touched**	

5.9.12. Blit Com to Display

Serial Command	**cmd** (word), **x** (word), **y** (word), **width** (word), **height** (word), **data** (data)	
	cmd	0x0023
	x, y	Specifies the horizontal and vertical position of the top-left corner of the image to be displayed
	width	width of the image to be displayed
	height	height of the image to be displayed
	data	pixel1…pixeln 16 bit pixel data to be plotted on the Display screen. 16 bit = 5bit Red, 6bit Green, 5bit Blue
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	This command will BLIT (Block Image Transfer) 16 bit pixel data from the Com port on to the screen.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), x(MSB), x(LSB), y(MSB), y(LSB), width(MSB), width(LSB), height(MSB), height(LSB), pixel1, pixel2, …, pixelN **0x00, 0x23, 0x00, 0x00, 0x00, 0x00, 0x01, 0xE0, 0x00, 0xBC, 0x31, 0x81, 0x63**... etc This will displaying an image at X=0 (0x00, 0x00), Y=0 (0x00, 0x00) with Width = 480 (0x01, 0xE0) and height = 188 (0x00, 0xBC) The response will be **0x06** assuming the command was successful	
Library Function	**blitComtoDisplay**	

5.10. System Commands

The following is a summary of the commands available to be used for System:

- Memory Release
- Memory Status
- Get Display Model
- Get SPE Version
- Get PmmC Version
- Peek Memory
- Poke Memory

5.10.1. Memory Release

Serial Command	**cmd** (word), **handle** (word)	
	cmd	0xFF24
	handle	Pointer to the memory block.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	status	**0:** If the attempt failed. **Non-0**: If the operation successful.
Description	The 'memory release' command releases the memory space used by the the 'Load Image Control' and 'file Load Function' commands.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), handle(MSB), handle(LSB) **0xFF, 0x24, 0x11, 0xB3** This will release the memory utilized by the handle 4531 (0x11, 0xB3) The response will be **0x06, 0x00, 0x01** assuming the command was successful and the operation was successful.	
Library Function	**mem_Free**	

5.10.2. Memory Status

Serial Command	**cmd** (word)	
	cmd	0xFF23
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns the largest available memory chunk of the heap.
Description	Returns byte size of the largest chunk of memory available in the heap.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0x23** This will return the largest available chunk of memory in the heap The response will be **0x06, 0x26, 0x86** assuming the command was successful and the display reported back 9862 (0x26, 0x86) bytes of available memory in its largest chunk	
Library Function	**mem_Heap**	

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5.10.3. Get Display Model

Serial Command	**cmd** (word)	
	cmd	0x001A
Response	**acknowledge** (byte), **model** (string)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	count	Number of characters in the model name to return
	model	Display Module's model name. Without NULL terminator.
Description	Returns the Display Model in the form of a string without Null terminator.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0x00, 0x1A** This will request the display to return its model name as a string of characters without the NULL. The response will be **0x06, 0x00, 0x0A, 0x75, 0x4C, 0x43, 0x44, 0x2D, 0x33, 0x32, 0x50, 0x54, 0x55** assuming the command was successful and the display returned 10 characters (0x00, 0x0A) and the display model was "uLCD-32PTU" (0x75, 0x4C, 0x43, 0x44, 0x2D, 0x33, 0x32, 0x50, 0x54, 0x55)	
Library Function	**sys_GetModel**	

5.10.4. Get SPE Version

Serial Command	**cmd** (word)	
	cmd	0x001B
Response	**acknowledge** (byte), **version** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	version	SPE Version installed on the module.
Description	Returns the SPE Version installed on the module.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0x00, 0x1B** This will return the version of the SPE Application loaded into the display The response will be **0x06, 0x01, 0x00** assuming the command was successful and the version of the SPE Application was 256 (0x01, 0x00)	
Library Function	**sys_GetVersion**	

5.10.5. Get PmmC Version

Serial Command	**cmd** (word)	
	cmd	0x001C
Response	**acknowledge** (byte), **version** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	version	PmmC Version installed on the module.
Description	Returns the PmmC Version installed on the module.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0x00, 0x1C** This will return the version of the PmmC loaded into the display The response will be **0x06, 0x03, 0x03** assuming the command was successful and the PmmC loaded was version 771 (0x03, 0x03)	
Library Function	**sys_GetPmmC**	

5.10.6. Peek Memory

Serial Command	**cmd** (word)**, address**(word)	
	cmd	0x0027
	address	The address to be peeked.
Response	**acknowledge** (byte), **contents** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	contents	The contents of the specified memory address.
Description	Returns the word contents of a specified memory address. This command would normally be used to read the contents of File and/or ImageControl handles.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), address(MSB), address(LSB) **0x00, 0x27, 0x14, 0x3C** This example assumed a file had been opened and the handle returned was at 0x142A. Offset 18 from this (0x143C) is the FILE_ATTRIBUTES word. The response will be **0x06, 0x00, 0x20** assuming the command was successful and the file had the Archive bit set.	
Library Function	**peekM**	

5.10.7. Poke Memory

Serial Command	**cmd** (word)**, address**(word), **wordvalue**(word)	
	cmd	0x0028
	address	The address to be poked
	wordvalue	The data to be poked into the address
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Sets the word contents of a specified memory address. This command would normally be used to alter the contents of File and/or ImageControl handles.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), address(MSB), address(LSB) **0x00, 0x27, 0x14, 0x3C, 0x00, 0x00** This example assumed a file had been opened and the handle returned was at 0x142A. Offset 18 from this (0x143C) is the FILE_ATTRIBUTES word. The response will be **0x06** assuming the command was successful. This example would clear the Archive bit.	
Library Function	**pokeM**	

5.11. I/O Commands

The following is a summary of the commands available to be used for I/O Control:

- BUS In
- BUS out
- BUS Read
- BUS Set
- BUS Write
- Pin HI
- Pin LO
- Pin Read
- Pin Set

5.11.1. BUS In

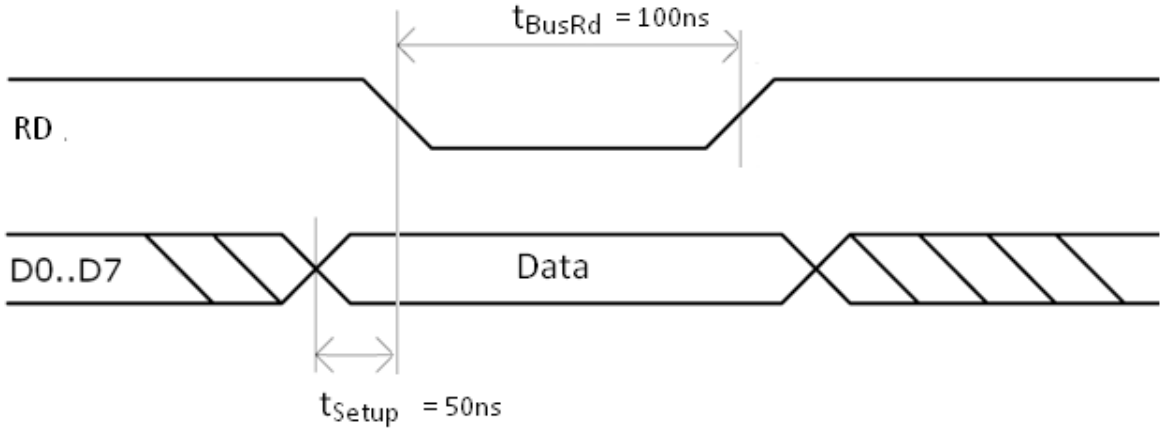
Serial Command	**cmd** (word)	
	cmd	0xFFD3
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns the state of the bus as an 8bit value.
Description	Returns the state of the bus as an 8bit value in to the lower byte of the assigned variable. Bus pins can be set as either INPUT or OUTPUT, using the BUS Set command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0xD3** This will return the value of the BUS pins The response could be **0x06, 0x00, 0x49** assuming the command was successful and the BUS has BUS0, BUS3 and BUS6 HI and the rest LO (0x00, 0x49) or (01001001 in Binary)	
Library Function	**bus_In**	
See Also	Bus Set command, to determine if the pin is an INPUT or an OUTPUT	

5.11.2. BUS Out

Serial Command	**cmd** (word)**, arg** (word)	
	cmd	0xFFD2
	arg	Argument specifying the pins on the bus to output. The lower byte of the argument is placed on the 8bit wide bus. The upper byte of the argument is ignored.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Sets the value of the BUS pins Bus pins should be set as OUTPUT first, using the BUS Set command.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), arg(MSB), arg(LSB) **0xFF, 0xD2, 0x00, 0x03** This will output HI on to BUS0 and BUS1 and LO on to the rest of the BUS pins (0x00, 0x03 is 00000011 in binary) The response could be **0x06** assuming the command was successful	
Library Function	**bus_Out**	
See Also	Bus Set command, to determine if the pin is an INPUT or an OUTPUT	

5.11.3. BUS Read

Serial Command	**cmd** (word)	
	cmd	0xFFCF
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns the state of the bus as an 8bit value.
Description	Returns the state of the bus as an 8bit value in to the lower byte of the assigned variable. Bus pins can be set as either INPUT or OUTPUT, using the BUS Set command. **Note:** The BUS_RD pin set to LO, then, after a settling delay of approx 50nsec, the BUS is read into the lower 8 bits of the assigned variable (the upper 8 bits being set to 0) the BUS_RD pin is then set back to a HI level. The BUS_RD pin is automatically pre-set to an output to ensure BUS write integrity. Please refer to the datasheet of the display module you are using, to determine which pin on your module is BUS_RD.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB) **0xFF, 0xCF** This will return the value of the BUS pins The response could be **0x06, 0x00, 0xEC** assuming the command was successful and the BUS has BUS2, BUS3, BUS5, BUS6 and BUS7 HI and the rest LO (0x00, 0xEC) or (11101100 in Binary)	
Library Function	**bus_Read**	
See Also	Bus Set command, to determine if the pin is an INPUT or an OUTPUT	

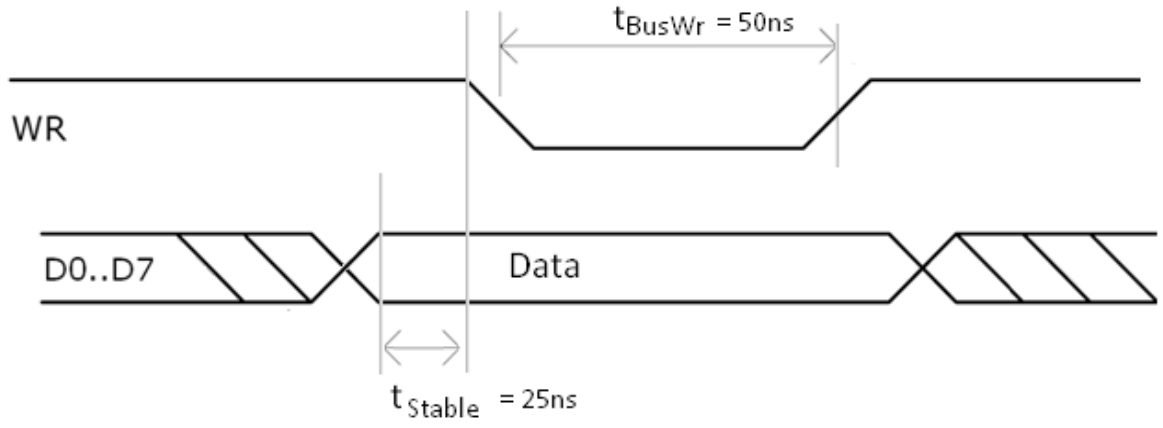


5.11.4. BUS Set

Serial Command	**cmd** (word), **arg** (word)	
	cmd	0xFFD1
	arg	Argument specifying the pins direction. The lower byte of the argument is placed on the 8bit wide bus. The upper byte of the argument is ignored.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	The lower 8 bits of arg are placed in the BUS direction register. A '1' sets a pin to be an input, a '0' sets a pin to be output. The upper 8 bits of arg are ignored. The BUS_RD and BUS_WR pins are not affected. **Note:** Bus Set is only valid for the BUS Pins, BUS0 to BUS7. It does not work on any of the other Pins.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), arg(MSB), arg(LSB) **0xFF, 0xD1, 0x00, 0xAA** This will set BUS1, BUS3, BUS5 and BUS7 to be INPUTs and the rest of the BUS pins will be OUTPUTs (0x00, 0xAA is 10101010 in binary) The response could be **0x06** assuming the command was successful	
Library Function	**bus_Set**	

5.11.5. BUS Write

Serial Command	**cmd** (word), **arg** (word)	
	cmd	0xFFD0
	arg	Argument specifying the pins on the bus to output. The lower byte of the argument is placed on the 8bit wide bus. The upper byte of the argument is ignored.
Response	**acknowledge** (byte)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
Description	Sets the value of the BUS pins Bus pins should be set as OUTPUT first, using the BUS Set command. The lower 8 bits of arg1 are placed on the BUS, then, after a settling delay of approx 50nsec, the BUS_WR pin is strobed LO for approx 50nsec then set back HI. The upper 8 bits of arg1 are ignored. **Note:** The BUS_WR pin is automatically pre-set to an output to ensure BUS write integrity. Please refer to the datasheet of the display module you are using, to determine which pin on your module is BUS_WR.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), arg(MSB), arg(LSB) **0xFF, 0xD0, 0x00, 0x02** This will output HI on to BUS1 and LO on to the rest of the BUS pins (0x00, 0x02 is 00000010 in binary) The response could be **0x06** assuming the command was successful	
Library Function	**bus_Write**	
See Also	Bus Set command, to determine if the pin is an INPUT or an OUTPUT	



5.11.6. Pin HI

Serial Command	**cmd** (word)**, pin** (word)	
	cmd	0xFFD6
	pin	A value specifying the pin number.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns 1 if the pin value was a legal number
Description	Outputs a "High" level (logic 1) on the appropriate pin that was previously selected as an Output. If the pin is not already set to an output, it is automatically made an output. I/O pins should be set as OUTPUT first, using the Pin Set/Bus Set commands. <u>Pin Constants able to be used with the Pin HI, Pin LO and Pin Read commands:</u> IO1_PIN 1 // Used for FMARK on the PTU Modules (See Datasheet) IO2_PIN 2 // Used for STAT on the PTU Modules (See Datasheet) IO3_PIN 3 // Used for PERF SUPPLY on the PTU Modules (See Datasheet) IO4_PIN 4 // Also used for BUS_RD IO5_PIN 5 // Also used for BUS_WR BUS_RD_PIN 4 // Alias IO4_PIN BUS_WR_PIN 5 // Alias IO5_PIN BACKLIGHT 6 // Backlight control pin AUDIO_ENABLE 7 // Amplifier chip control pin BUS_0 8 // Bus 0, also able to be set with Pin commands BUS_1 9 // Bus 1, also able to be set with Pin commands BUS_2 10 // Bus 2, also able to be set with Pin commands BUS_3 11 // Bus 3, also able to be set with Pin commands BUS_4 12 // Bus 4, also able to be set with Pin commands BUS_5 13 // Bus 5, also able to be set with Pin commands BUS_6 14 // Bus 6, also able to be set with Pin commands BUS_7 15 // Bus 7, also able to be set with Pin commands **Note:** Constant variables available for use when using a 4D Systems Serial library.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), pin(MSB), pin(LSB) **0xFF, 0xD6, 0x00, 0x04** This will set Pin 4 (IO4) to output HI The response could be **0x06, 0x00, 0x01** assuming the command was successful, and the pin number was legal (0x00, 0x01)	
Library Function	**pin_Hi**	
See Also	Pin Set command, to determine if the pin is an INPUT or an OUTPUT Bus Set command, to determine if the bus pin is an INPUT or an OUTPUT	

5.11.7. Pin LO

Serial Command	**cmd** (word)**, pin** (word)	
	cmd	0xFFD5
	pin	A value specifying the pin number.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns 1 if the pin value was a legal number
Description	Outputs a "Low" level (logic 0) on the appropriate pin that was previously selected as an Output. If the pin is not already set to an output, it is automatically made an output. I/O pins should be set as OUTPUT first, using the Pin Set/Bus Set commands. <u>Pin Constants able to be used with the Pin HI, Pin LO and Pin Read commands:</u> IO1_PIN 1 // Used for FMARK on the PTU Modules (See Datasheet) IO2_PIN 2 // Used for STAT on the PTU Modules (See Datasheet) IO3_PIN 3 // Used for PERF SUPPLY on the PTU Modules (See Datasheet) IO4_PIN 4 // Also used for BUS_RD IO5_PIN 5 // Also used for BUS_WR BUS_RD_PIN 4 // Alias IO4_PIN BUS_WR_PIN 5 // Alias IO5_PIN BACKLITE 6 // Backlight control pin AUDIO_ENABLE 7 // Amplifier chip control pin BUS_0 8 // Bus 0, also able to be set with Pin commands BUS_1 9 // Bus 1, also able to be set with Pin commands BUS_2 10 // Bus 2, also able to be set with Pin commands BUS_3 11 // Bus 3, also able to be set with Pin commands BUS_4 12 // Bus 4, also able to be set with Pin commands BUS_5 13 // Bus 5, also able to be set with Pin commands BUS_6 14 // Bus 6, also able to be set with Pin commands BUS_7 15 // Bus 7, also able to be set with Pin commands **Note:** Constant variables available for use when using a 4D Systems Serial library.
Example	**Byte Stream:** cmd(MSB), cmd(LSB), pin(MSB), pin(LSB) **0xFF, 0xD5, 0x00, 0x05** This will set Pin 5 (IO5) to output HI The response could be **0x06, 0x00, 0x01** assuming the command was successful, and the pin number was legal (0x00, 0x01)
Library Function	**pin_Lo**	
See Also	Pin Set command, to determine if the pin is an INPUT or an OUTPUT Bus Set command, to determine if the bus pin is an INPUT or an OUTPUT	

5.11.8. Pin Read

Serial Command	**cmd** (word)**, pin** (word)	
	cmd	0xFFD4
	pin	A value specifying the pin number.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns a 0 or 1 depending on the state of the pin
Description	Returns a "Low" level (logic 0) or a “High” level (logic 1) based on the value of the selected pin. I/O pins can be set as either INPUT or OUTPUT, using the Pin Set/Bus Set commands. <u>Pin Constants able to be used with the Pin HI, Pin LO and Pin Read commands:</u> IO1_PIN 1 // Used for FMARK on the PTU Modules (See Datasheet) IO2_PIN 2 // Used for STAT on the PTU Modules (See Datasheet) IO3_PIN 3 // Used for PERF SUPPLY on the PTU Modules (See Datasheet) IO4_PIN 4 // Also used for BUS_RD IO5_PIN 5 // Also used for BUS_WR BUS_RD_PIN 4 // Alias IO4_PIN BUS_WR_PIN 5 // Alias IO5_PIN BACKLITE 6 // Backlight control pin AUDIO_ENABLE 7 // Amplifier chip control pin BUS_0 8 // Bus 0, also able to be set with Pin commands BUS_1 9 // Bus 1, also able to be set with Pin commands BUS_2 10 // Bus 2, also able to be set with Pin commands BUS_3 11 // Bus 3, also able to be set with Pin commands BUS_4 12 // Bus 4, also able to be set with Pin commands BUS_5 13 // Bus 5, also able to be set with Pin commands BUS_6 14 // Bus 6, also able to be set with Pin commands BUS_7 15 // Bus 7, also able to be set with Pin commands **Note:** Constant variables available for use when using a 4D Systems Serial library.	
Example	**Byte Stream:** cmd(MSB), cmd(LSB), pin(MSB), pin(LSB) **0xFF, 0xD4, 0x00, 0x09** This will read the value of Pin 9 (BUS1) The response could be **0x06, 0x00, 0x01** assuming the command was successful, and the I/O pin was set HI (0x00, 0x01)	
Library Function	**pin_Read**	
See Also	Pin Set command, to determine if the pin is an INPUT or an OUTPUT Bus Set command, to determine if the bus pin is an INPUT or an OUTPUT	

5.11.9. Pin Set

Serial Command	**cmd** (word), **mode** (word), **pin** (word)	
	cmd	0xFFD7
	mode	A value specifying the pin mode.
	pin	A value specifying the pin number.
Response	**acknowledge** (byte), **value** (word)	
	acknowledge	0x06: ACK byte if successful Anything else implies mismatch between command and response.
	value	Returns 1 if the pin value was a legal number

Description

There are pre-defined constants for **mode** and **pin**:

Pin constants	Description	Remarks
IO1_PIN	I/O Pin 1 (IO1), **pin** = 1	FMARK on PTU modules
IO2_PIN	I/O Pin 2 (IO2), **pin** = 2	STAT on PTU modules
IO3_PIN	I/O Pin 3 (IO3), **pin** = 3	PERF SUPPLY on PTU modules
IO4_PIN	I/O Pin 4 (IO4), **pin** = 4	Also used for BUS_RD
IO5_PIN	I/O Pin 5 (IO5), **pin** = 5	Also used for BUS_WR
BACKLITE	Back-light control pin, **pin** = 6	Used internally. Permanently set as Output. **HIGH:** BACKLITE ON **LOW :** BACKLITE OFF
AUDIO_ENABLE	Amplifier Chip control pin, **pin** = 7	Used internally. Permanently set as Output **HIGH:** Amplifier OFF **LOW :** Amplifier ON

Mode Constants	Mode value	Description/meaning	IO1	IO2	IO3	IO4	IO5
OUTPUT	0	Pin is set to an output	YES	YES	YES	YES	YES
INPUT	1	Pin is set to an input	YES	YES	YES	YES	YES

Note: to set the mode of the Bus Pins, please see the BUS Set command.

Example

Byte Stream:
cmd(MSB), cmd(LSB), mode(MSB), mode(LSB), pin(MSB), pin(LSB)

0xFF, 0xD7, 0x00, 0x01, 0x00, 0x03

This will set Pin 3 (IO3) as an Input

The response could be **0x06, 0x00, 0x01** assuming the command was successful, and the I/O pin specified was a valid pin number (0x00, 0x01)

Library Function	**pin_Set**

6. Revision History

Revision History		
Revision	**Revision Content**	**Revision Date**
1.0	First Release	17/12/2012
1.1	Added additional description for Move Origin, explaining it can be used for both Text and Graphics, and adding See Also links for some text commands. Fixed a few typo mistakes in the File Commands sections, where incorrect byte values were written	12/01/2013
1.2	Making location of libraries more apparent	14/01/2013
1.3	File_Mount return fixed, as it can be a non-zero number for successful, not just 0x00 0x01	29/01/2013
1.4	Write Word command number missing, and updated example	10/02/2013
1.5	Correction to the gfx_Contrast command, plus addition of additional information	13/02/2013
1.6	Touch Get explanation of Mode 1 and Mode 2 extended	17/02/2013
1.7	Added character limit information to Put String command	22/02/2013
1.8	Added Pin and Bus I/O Control commands – NEW FEATURE	26/02/2013
1.9	Added missing Command Words for File Execute and Load Image Control	27/02/2013
1.10	2s changed to 3s on the Power Up after Reset section	28/02/2013
1.11	Updated Set and Get Image Parameters offset constants	07/03/2013
1.12	Updated Set and Clear Image Attributes tables, and correction in File Mount return	23/04/2013
1.13	Screen Mode command updated, removing uVGA-II/III statement which was incorrect	05/07/2013
1.14	Corrected return of File Call Function which was incorrect, Fixed a missing word in the response title for File Size command. Added txt_Wrap command.	30/01/2014
1.15	Documented v4.0 PmmC's changes to files opened in append mode. Added peekM and pokeM commands for SPE 1.2	21/03/2014
1.16	Updated image in section 2.2	07/05/2014
1.17	Fixed typo in putstr function (was shown as putStr incorrectly)	01/10/2014
1.18	Added information for file_LoadImageControl. Updated control block size in file_Mount. Added information relating to Set Font and uSD based fonts. Added note about restriction of clipping command. Added information about the use of TRANSPARENCY.	22/12/2014
1.19	Added max write size to "File Write" command	29/06/2015
1.20	Added Arduino specific library functions	10/11/2015

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For Technical Support: www.4dsystems.com.au/support

For Sales Support: sales@4dsystems.com.au

Website: www.4dsystems.com.au

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