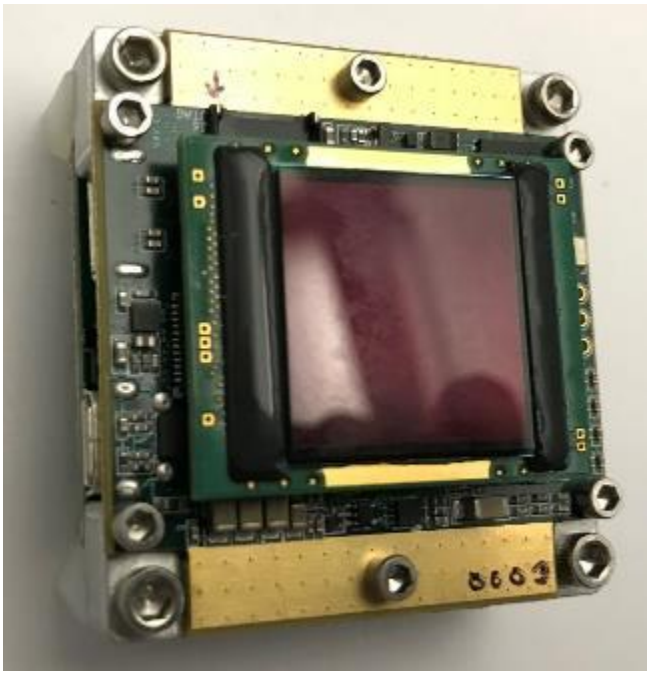
2K X 2K COMPACT INTERFACE

For Use with all eMagin 2K x 2K OLED Microdisplays



USER MANUAL
REV B

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Revision Level	ECN	Date	Scope
1		June 2018	Draft Release
2		July 2018	Command List Update
3		November 2018	Microdisplay Handling Section (5.1)
4		March 2019	Updated Serial Port speed to 921.6 Kbaud
-	000815	September 2019	Updated Command list
A		July 2020	Corrected serial port speed p. 19
B	001162	August 2021	Added information on Data Cable Connection Adde information on LVDS Extension Cable

TABLE OF CONTENTS

List of Figures

INTRODUCTION

The 2K x 2K Compact Interface (2K_CI), part number EMA-200024, provides the user with a compact and portable means of operating an eMagin 2K x 2K OLED Microdisplay, using a DisplayPort 1.2a compliant data interface. The included resident firmware provides access to the microdisplay's on-board register settings from any Windows-based PC through a USB port and supports all different types of 2K x 2K OLED Microdisplays. A freeware terminal application for Windows (PuTTY) is included with the interface. A single 9V DC power input is required to operate the 2K x 2K Compact Interface

1. INTERFACE CONTENTS

- 2K x 2K Compact Interface Assembly (#1000550)
- 9V DC , 2.5A Power Supply
- Power supply cable
- USB-A to mini-USB Cable
- DisplayPort to USB-C custom cable assembly
- Copy of PuTTY, Telnet and SSH client, Windows freeware
- User's Manual, Specification documents

2. FEATURES

2.1. Hardware Features

- Compact form factor 43 x 46 x 18 mm
- DisplayPort 1.2a compatible input video data
- USB 2.0 interface allows access to interface and microdisplay registers
- Mounting holes at corners to facilitate system integration
- Built-in heat spreader can be used to connect external heatsink as needed

2.2. Software Features

- Automatic format configuration at power-on
- Automatic valid input data detection
- Read/write capabilities allow adjustments of interface register settings to fine-tune image characteristics
- Brightness and custom gamma adjustments
- Save feature stores custom register settings for convenience

3. SYSTEM REQUIREMENTS & SPECIFICATIONS

3.1. System Requirements

- A PC capable of producing a digital video output compliant with the DisplayPort 1.2a and up, standard
- A terminal emulation software capable of ASCII communication using the USB 2.0 serial port. A copy of the PuTTY freeware is provided with the 2K x 2K Compact Interface and will be used to illustrate how to communicate with the interface controls

4. INTERFACE SETUP & OPERATION

4.1. 2K x 2K Microdisplay Handling

The gray material at each side of the microdisplay assembly is relatively soft. It protects the wires connecting the microdisplay die to the carrier board.
DO NOT PRESS ON THESE GRAY AREAS to install or remove the microdisplay from the drive board. This will result in permanent and un-repairable damage to the microdisplay
Refer to the view below to correctly identify these areas and avoid applying any pressure to them

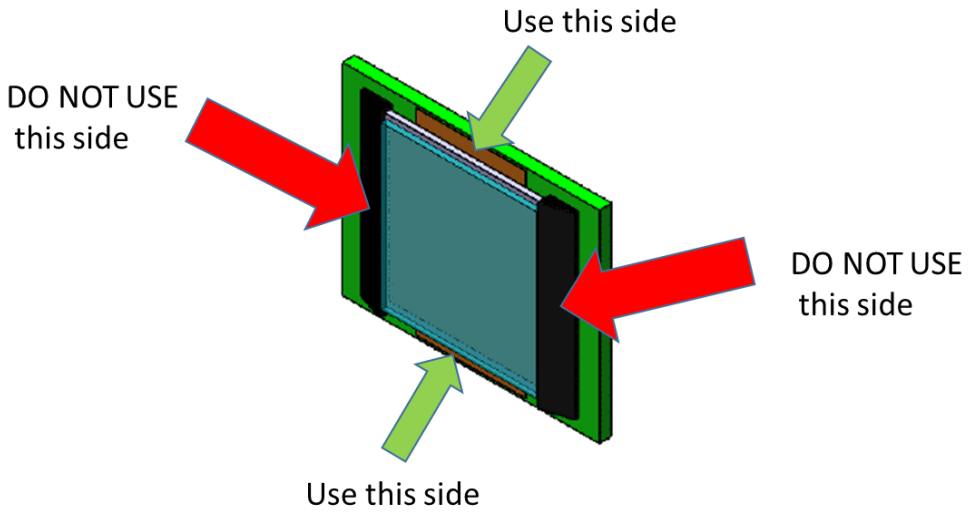

Figure 1: Microdisplay Handling

4.2. 2K x 2K Compact Interface Connections

The 2K x 2K Compact Interface is shown in Figure 2 below, with a 2K x 2K OLED microdisplay installed and all 3 cables connected. The major components are labeled for easier identification.
It is recommended to connect all cables to the interface, leaving the other end of the power cable open until ready to turn the power on.

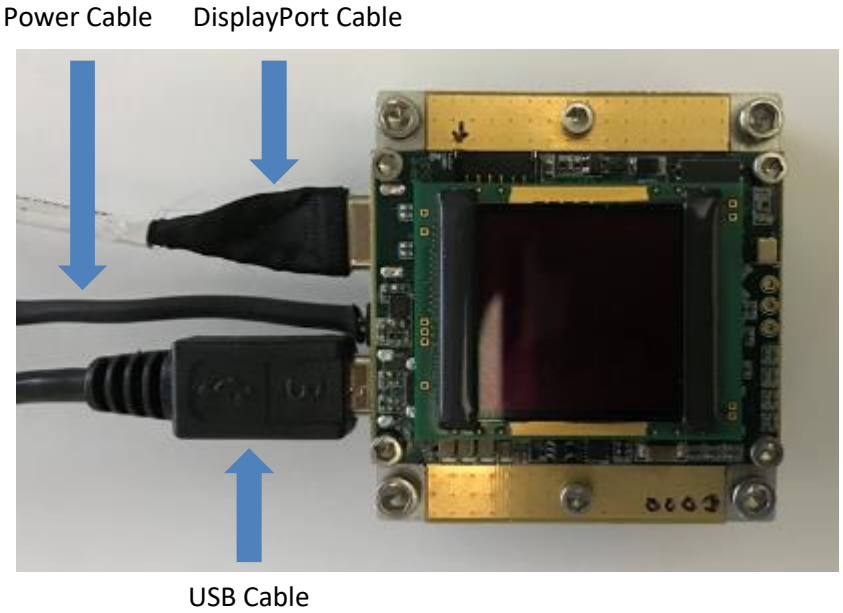

Figure 2: 2K Compact Interface cable connections

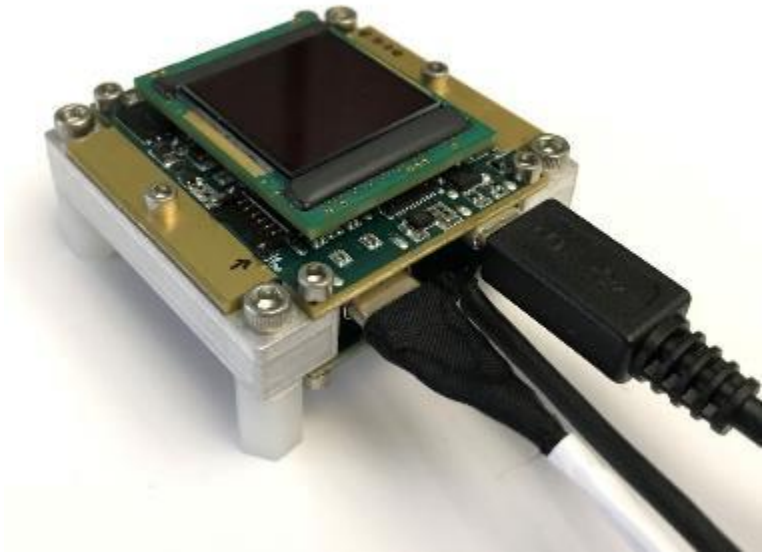

Figure 3: 2K Compact Interface – connected, with display

4.3. Data cable orientation

While the USB and input power connectors are keyed and can only be inserted one way, the USB-C connector is symmetrical and can be inserted two ways.

Figure 4 shows the Data Connector orientation. Because the USB-C connector is symmetrical, care must be taken when connecting the data cable to the 2K CI interface. If the connector is inserted incorrectly (wrong orientation), no damage will occur but since the input data will not be decoded properly, the interface will force the display to show a solid blue screen, indicative of a lack of input signal.

The data cable provided with the 2K Compact Interface is a custom assembly. The USB-C end of the cable assembly has a mark on one side, which is the A side of the connector. When looking at the 2K Compact Interface from the microdisplay side, as shown in Figure 4, the A side of the Data Cable connector is facing away from the user.

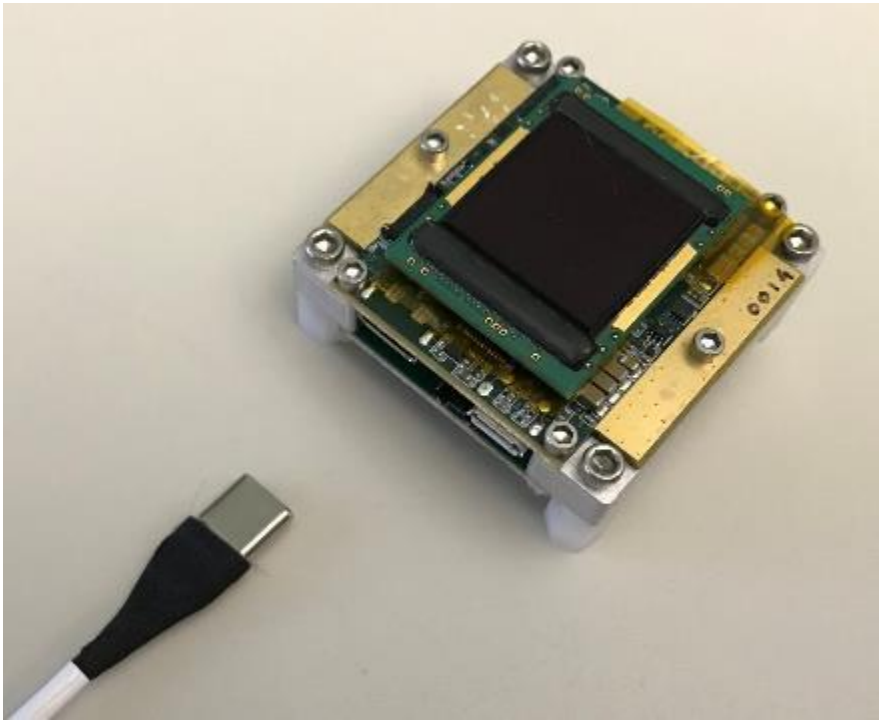

Figure 4: Data Connector - Correct Orientation

Figure 5 shows the incorrect Data Connector orientation

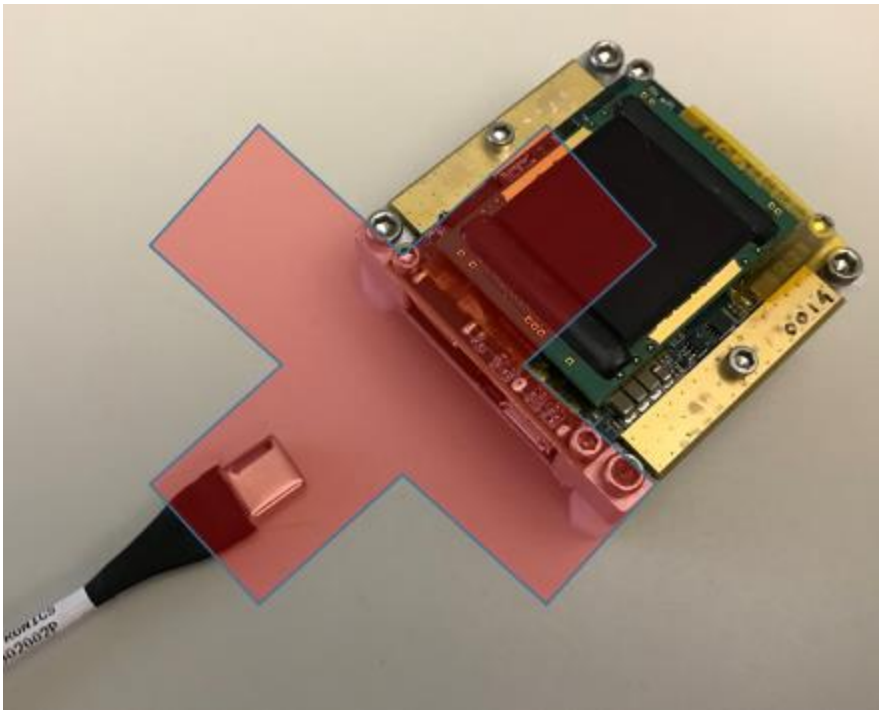

Figure 5: Data Connector - Wrong Orientation

Alternatively, some data cables have an A and a B mark on each side: in this case, the B mark must be facing up (towards the display) when connecting to the interface as shown in Figure 6 below

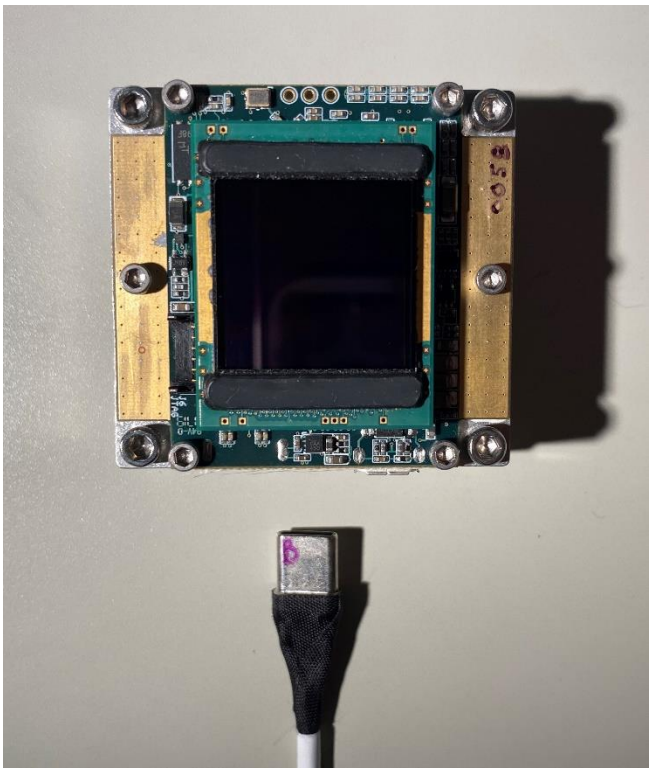

Figure 6 Data Connector - B side up

4.4. LVDS Cable Connection

An optional 24” LVDS extension cable is available to remote connect the microdisplay from the interface (Part number EMA-101305).
Figure 7 below shows how to connect the LVDS cable extension to the interface and 2K x 2K microdisplay. Because the display connectors are different, there is no ambiguity in selecting the correct orientation.

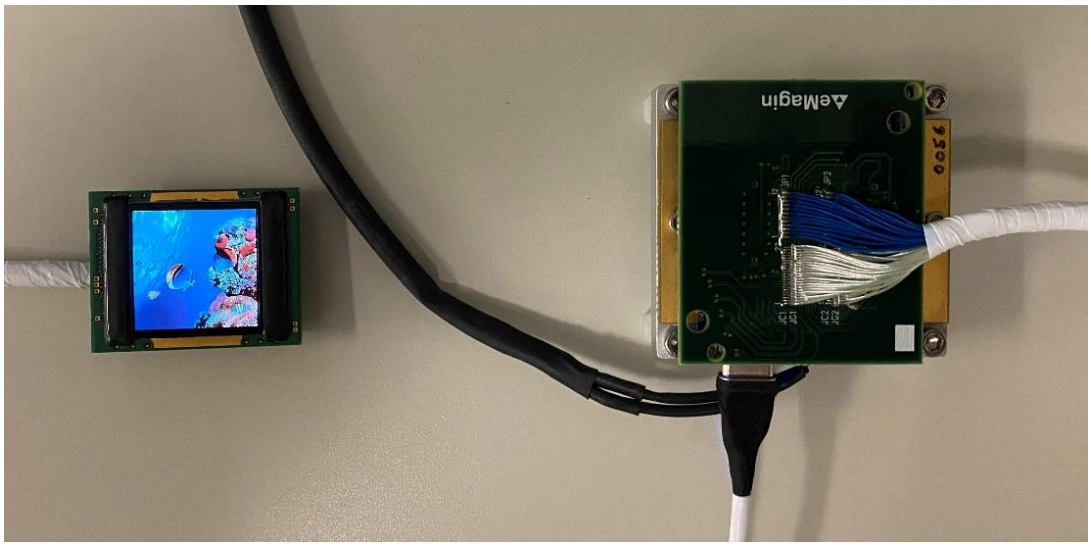

Figure 7 LVDS Cable Assembly Connection

4.5. Power Connection

The power connector is keyed and can only be fully inserted one way. Figure 8 below shows the correct orientation for the connector prior to insertion. The Pin #1 mark (small triangle) needs to be face-up with respect to the interface assembly to be set correctly.

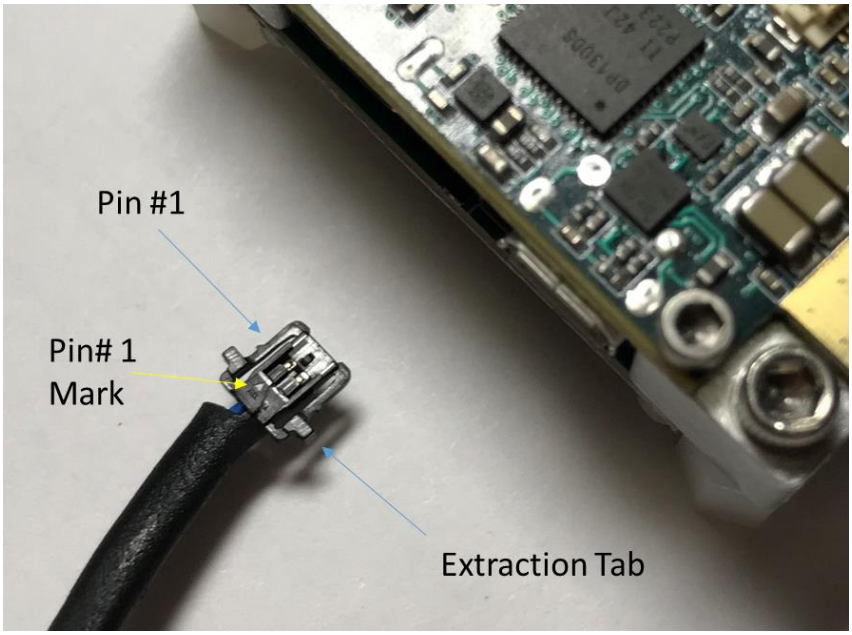

Figure 8: Power connector orientation

Caution: the connector uses crimped blades which may come away from the connector should there be too much force on the cable, pulling it away from the interface assembly. The connector has two tabs on each side, designed to facilitate disconnect.
Please do not pull on the cable to disconnect power, it will likely result in damaging the connector.

4.6. Setup PC for Proper Video Output

- The 2K_CI will detect the video format and automatically configure the interface to support this format. The following formats are programmed into the interface for automatic configuration
  - 2048 x 2048 @ 60Hz, 85Hz or 120Hz
  - 1920 x 1200 @ 60Hz, 85Hz or 120 Hz
  - 1920 x 1080 @ 60Hz, 85Hz or 120 Hz
  - 1280 x 1024 @ 60Hz, 85Hz or 120 Hz
- Ensure that the DisplayPort used to drive the interface is configured to any of the above format. Custom formats are supported by the interface and will require using the advanced options provided by the graphics adapter vendor software
- From a practical standpoint, first time use should be done with the second video output of the host PC, the primary monitor being used for system setup and control

4.7. Power Up

- There is no power switch provided with the interface. Power is turned on by plugging the 9 V DC adapter into an AC outlet and connecting its output to the power connector cable.
- Provided the host system video out has been correctly configured, right after power is connected, a brief white screen will flash, then the display screen will turn to blue, and after a few seconds, the image present on the host system desktop will show up on the microdisplay.
- If the data cable is not correctly inserted or the video source is either not present or configured with a different format than described above, the display screen will remain blue.
- A blue LED will turn on near the data cable connector. It will remain on during operation, and can be turned off via the control interface if need be.

4.8. Power Down

- Power down is achieved by either disconnecting the 9V DC adapter or separating the power cable from the adapter cable. Alternatively, the 9V DC adapter can be plugged into a switchable multiple outlet unit.

5. ACCESSING THE 2K X 2K COMPACT INTERFACE CONTROLS

5.1. Command Interface

The serial interface supports ASCII communication and operates as a virtual COM port running over USB
The COM port will instantiate at power-on and which port is allocated by the host system can be found, for Windows users, by launching the Device Manager and looking at the Ports list.
The port configuration is:

- 8 bits
- No parity
- 1 stop bit
- No flow control
- Speed: 921,600 bauds

5.2. Commands List

Command	Description	Argument			
		Type	Min	Default	Max
BLUESCRN	24-bit RGB color value for "blue" screen which is displayed when no input video is available - each value 0~0xff - bits [23:16] = red - bits [15:8] = green - bits [7:0] = blue - default value = 0x000055	UINT32	0	0x55	0xffffff
BRT	Set brightness (luminance)	UINT16	0	0x0A	BRTMOD
BRTDEC	Decrement BRT by 1	None	-	-	-
BRTDFLT	Command resets brightness to the original hardware default value	None	-	-	-
BRTINC	Increment BRT by 1	None	-	-	-
BRTLPC	Display Linear Perception Coeffecient - range 0.5 ~ 5.0 - default 2.5	float	0.5	2.5	5.0
BRTMOD	Set number of BRT adjustment steps (modulus)	UINT16	0	16	256
DCFG	Delete manually saved configuration data from Flash	None	-	-	-
DDYN	Delete dynamically saved configuration data from Flash	None	-	-	-
DIMCTL	Direct access to OLED DIMCTL register	BYTE	0	-	127
DP130D	Access to SN75DP130 DisplayPort Configuration Data (DPCD) registers, indexed as: 0: 0x00100 link bw set 1: 0x00101 lane count set 2: 0x00103 train lane0 set 3: 0x00104 train lane1 set 4: 0x00105 train lane2 set 5: 0x00106 train lane3 set 6: 0x0010F train lane0 1 set2 7: 0x0110F train lane2 3 set2 8: 0x00600 set power	BYTE	0	-	0xff
DP130R	Direct access to SN75DP130 I2C registers	BYTE	0	-	0xff
DPCD	Access to Bitec DPCD register set	BYTE	0	-	0xff
DPDC	Display Persistence Duty Cycle (1~100)	BYTE	1	100	100
DPEQ	Sets equalization value in DP130, for all lanes: 0 = 0 dB 1 = 3.5 dB 2 = 6 dB 3 = 8 dB 4 = 10 dB 5 = 13 dB (dflt) 6 = 15 dB 7 = 18 dB Change occurs immediately	BYTE	0	-	7

Command	Description	Argument			
		Type	Min	Default	Max
DPLQA	Enable/disable LQA 0=disable 1=enable Will be applied at the next DPRST or received video format change	BOOL8	0	1	1
DPREG	Access to Bitec internal register set	UINT32	0	-	0xffffffff
DPRST	Reset DisplayPort receiver 0=restart only (no DP130 initialization) 1=full reset	BYTE	0	-	1
DPSQLCH	Sets receiver squelch level: 0 = 40 mVpp 1 = 80 mVpp 2 = 160 mVpp 3 = 250 mVpp 4 = disabled (dflt) Change occurs immediately	BYTE	0	4	4
DPSTAT	Prints DisplayPort detailed receive status (debug)	None	-	-	-
EDID	Dumps the contents of the EDID image to the serial port	BYTE	0	-	4
EDIDCURR	Displays the number/index of the internal EDID file currently in use by the DisplayPort interface. This can be different to the EDIDSEL number if for any reason there was an error loading the file requested by the EDIDSEL command (for example, if the requested file had not been programmed). Please see the EDID command for more information.	BYTE	-	-	-
EDIDPROG	Invokes YMODEM to program EDID file to Flash	BYTE	1	-	4
EDIDSEL	Selects the EDID image to use. The DP interface is reset after a change so that the host will see the new data.	BYTE	0	0	4
F 0	Queries Flash Prom type	BYTE	0	-	1
FEDBG	Causes debug serial "printout" of 9 different debug counters attached to the video format detection algorithm	None	-	-	-
GAMMA	Gamma value for OLED - floating point - range 0.001 thru 9.999 accepted	float	0.001	1.8	9.999
HPOS	Set horizontal image position offset: 0 = default center neutral	NT16	-2047	0	+2047
HSCAN	Display horizontal scan direction (0=L->R; 1=R->L)	BYTE	0	0	1

Command	Description	Argument			
		Type	Min	Default	Max
I2CA	I2C Debug Address - to be set up prior to sending I2CC command - 32-bit word format: 76543210 (hex digits, not bits) ======== bbddssss | | |____ ssss = subaddr | |_____ dd = dev addr |_____ bb = busnum	UINT32	0	-	0xffffffff
I2CC	I2C Debug Command - bus activity takes place when this is written - 16-bit word format: 3210 (hex digits, not bits) ==== txcc || |__ cc = bytecount minus 1 ||____ x = command (0=wr, 1=rd, 3=rd w/stop) |_____ t = subaddr type (0=none, 1=8b, 2=16b, 3=test)	UINT16	0	-	0xffff
I2CD	I2C Debug Data - up to 16 bytes, indexed - for I2C writes: set up prior to sending I2CC command - for I2C reads: read back after sending I2CC command	BYTE	0	-	0xff
IDRF	Direct access to OLED IDRF register	BYTE	0	200	0xff
IVQ	Query input video returns lock status, vert & horiz resolution & frequencies	None	-	-	-
LEDEN	Set on-board LED enable: 0 = BLU, RED LEDs disabled 1 = BLU, RED LEDs enabled	BOOL8	0	1	1
LIST	Prints unsorted, unordered list of all available commands	None	-	-	-
LUTM	Gamma LUT control: 0=Off 1=Gamma Only 2=VGN Only 3=Gamma and VGN	BYTE	0	3	3
MAXLUM	Set maximum display luminance, 100% = display device upper limit - minimum value = 10	BYTE	10	100	100
MEAS	Causes debug serial "printout" of most recent measurements of input video format - includes H-Active, H-Total V-Active, V-Total, fV (Hz), fH (KHz), fP (MHz) - measurements in the H direction may appear to be incorrect due to the use of an intermediate clock which is not running at the usual pixel rate	None	-	-	-

Command	Description	Argument			
		Type	Min	Default	Max
MINLUM	Set minimum display luminance, 0% = display device lower limit	BYTE	0	0	99
NOPIXDBL	Option to inhibit automatic OLED pixel doubling when the received input video format is small enough to allow doubling (i.e. less than or equal to 1/2 of the OLED image size in each direction) 0 = doubling permitted 1 = doubling inhibited	BOOL8	0	0	1
OGAMTBL	OLED returns register values which have been transferred to interpolator . .	UINT16	-	-	-
OGSPFRM	Global shutter on-time expressed as a percentage of the frame period - only this on-time value is saved - if not changed by user it remains constant across video format changes - shutter on-time is always centered at the center point of vertical blanking	float	0.006	5	99.994
OGSPVBL	Global shutter on-time expressed as a percentage of the vertical blanking period - this value will be converted to/from the OGSPFRM value - note that such conversions are dependent on the current video format - a readback of OGSPVBL will (most likely) change when the video format changes	float	Must satisfy OGSPFRM "arg min" after conversion	-	Must satisfy OGSPFRM "arg max" after conversion
OGSUSEC	Global shutter on-time expressed as microseconds - this value will be converted to/from the OGSPFRM value - note that such conversions are dependent on the current video format - a readback of OGSUSEC will (most likely) change when the video format changes	UINT32	Must satisfy OGSPFRM "arg min" after conversion	-	Must satisfy OGSPFRM "arg max" after conversion
OGSEN	Global shutter enable/disable 0 = disable (dflt) 1 = enable	BOOL8	0	0	1
OHACTMIN	Adjusts or reads back the minimum number of pixels in the horizontal active period to be used by the OLED.	UINT16	-	-	-
OLED	Direct access to OLED I2C registers	BYTE	0	-	0xff
OLEDBI	Enable/disable internal OLED test pattern: 0: Burn-in (all white) 1: Color Bar 2: 16 level gray scale 3: Checker Board 4: Vertical Line 5: Horizontal Line 6: Grid Pattern 7: Off	BYTE	0	0	7

Command	Description	Argument			
		Type	Min	Default	Max
OLEDRESET	Command sequences OLED shutdown followed by re-startup	None	-	-	-
ORUNST	Current running status of OLED softeware (debug) 0 = Idle 1 = Power On Pending 2 = Startup Delay 3 = Run 4 = Reset Delay 5 = Power Off Pending Note: In this design only the "Idle" and "Run" states are likely to be seen.	BYTE	-	-	-
OSLEEP	Directly controls OLED "All System Power Down" bit	BOOL8	0	0	1
OTEMP	Query OLED Temperature	float	-	-	-
OVACTMIN	Adjusts or reads back the minimum number of lines in the vertical active period to be used by the OLED.	UINT16	-	-	-
PATT	Set OLED Driver Test Pattern: 0 = No pattern 1 = Lines (W on B) 2 = Color Bars 100% 3 = Color Bars 75% 4 = Gray scale (L => R: B => W) 5 = Gray scale (L => R: W => B) 6 = Gray ramp (L => R: B => W)	BYTE	0	0	7
PATTLO	Optionally splits the pattern display into two parts - the upper 2/3 is set up by the PATT command - the lower 1/3 is set up by this PATTLO command - uses the same values as the PATT command - setting this to zero (no pattern) disables the split - only effective when PATT is non-zero	BYTE	0	0	7
POWER	Power control: 0 = Off 1 = On 2 = Auto: power down after timeout (see TIMEOUTSEC)	BYTE [3:0]	0	2	2

Command	Description	Argument			
		Type	Min	Default	Max
QPOS	Specially timed command, combining HPOS and VPOS values - the resulting OLED LFTPOS, RGTPOS, TOPPOS and BOTPOS register values are combined and transmitted to the OLED in a single message - the message is timed so as not to straddle the leading edge of vertical sync, which is where the OLED internally transfers the "POS" register values to working registers - in other words, if the QPOS command is received too late in a frame to meet this requirement, then software will wait until the following frame starts before transmitting the message to the OLED - syntax of the data is unusual, in that it is a 32-bit word which consists if two signed 6-bit words, with the HPOS value in the upper 16 bits, and the VPOS value in the lower 16 bits - for example, if HPOS=VPOS=34 (decimal), the command is "QPOS 0x00220022" - signed values are trickier - for example, if HPOS=VPOS=-64, send "QPOS 0xFFC0FFC0"	UINT32	Each 16-bit value: -2047	-	Each 16-bit value: +2047
RCFG	Recall manually saved configuration data from Flash	None	-	-	-
RDYN	Recall dynamically saved configuration data from Flash	None	-	-	-
SCFG	Save configuration data to Flash	None	-	-	-
TIMEOUTSEC	In the absence of a video signal at the input, the OLED will be powered down after this timeout period, expressed in seconds - this behavior must be enabled by the POWER command being set to Auto	UINT16	0	0x12C	0xffff
UPDATE	Invokes YMODEM to progrram FPGA boot-image to Fpash	None	-	-	-
VER	Causes serial "printout" of the current FPGA and software versions - for example: FW+SW C008-1300-01 FW C008-1200-01 Ver 110 SW C008-1000-01 Ver C008 2Kx2K RGB Driver v0.11, 06/22/2018	None	-	-	-
VGNDLY	Minimum delay between VGN updates - unit = milliseconds - default = 5000	UINT16	0	0x1388	0xffff
VGNGCT	Readback calculated gamma table coefficients ("GC" values)	float	-	-	-
VGNT	Most recent VGN voltages	float	-	-	-

Command	Description	Argument			
		Type	Min	Default	Max
VGNV	Direct and immediate read of VGN voltage	float	-	-	-
VIDINFO	Video format values in current use (input side), indexed: 0: H Total 1: H Active 2: H Begin 3: V Total 4: V Active 5: V Begin 6: valid (internal flag)	UINT16	0	-	Format values: 4095
VIDINV	Set video inversion mode: 0 = normal 1 = video inverted (B <=> W)	BYTE	0	0	1
VPOS	Set vertical image position offset: 0 = default center neutral	INT16	-2047	0	+2047
VSCAN	Display vertical scan direction (0=T->B; 1=B->T)	BYTE	0	0	1

5.3. Using PuTTY to control the 2K x 2K Compact Interface

Before using the command line interface, PuTTY must be configured to use the serial port. The port to which the USB cable is attached can be found by accessing the Windows' Device Manager
Enter the relevant COM port in the box below the Serial line and make sure to enter the 921,600 number in the Speed text box
Figure 9 below shows a screen shot of a configuration using the COM3 port

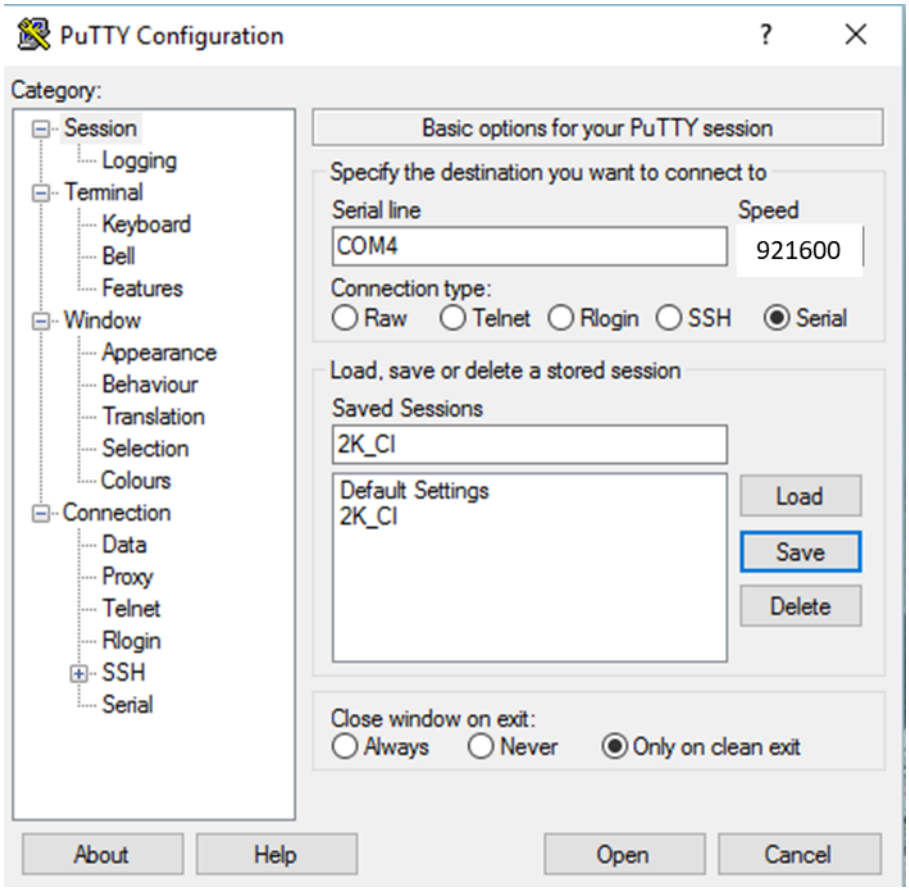

Figure 9: PuTTY Configuration Screen

Click the Open button when done, the user interface window will appear. Type in a command at the cursor prompt and hit the Enter key to send it to the interface

Figure 10 below shows the command to set the display gamma to 1.8

Figure 10: PuTTY command line interface