

I2MAP Camera System Design and Programming Notes

10021117DOC-1-F

Rev. E – 15JAN16 mrc Updated I/O and log list and minor revisions.

Rev. F – 21JUL16 mrc Added recorder and camera configuration.

1. Introduction.

This document describes the electrical design and is a programming reference for the i2MAP controller and electrical switching printed circuit board. The function of the board is to provide local control of the camera and light system while interfacing with the Dorado AUV using a 10/100 Base-T Ethernet connection. A commercial module based on a PIC processor provides the communications and processor input/output functions for the board. The LOCA board is installed in the camera housing and provides the following functions:

- a. Electrical switching and dimming control for four DeepSea Power & Light LED lights.
- b. Electrical power control for the camera system, which includes the camera, the video recorder and the camera lens iris drive circuit.
- c. Electrical power control for the SBE 25 CTD and the associated sensors.
- d. Serial communications (EIA 232) to the SBE 25.
- e. Serial communications (EIA 485) to the iris motor controller.
- f. Logic power control for the AJA KiProQuad video recorder.
- g. Local environmental monitoring for water alarms, internal housing temperature and humidity.
- h. Camera video signal mean and peak signal levels (for iris control algorithm).
- i. Power conversion from the AUV 18-36 Volt bus to local 12 and 5 VDC.

2. Detailed Circuit Description.

- a. **Embedded processor:** Communications and input output functions (I/O) are provided by a commercial processor module from the **Modtronix Corporation, PN SBC65EC (MODULE)**. This module has the advantage of having a TCP/IP stack and embedded firmware that allows configuration and control through a simple HTML interface available at IP address: 134.89.32.55, user: admin, password: pw. (this may change in the future). The functions of the host micro-processor, the PIC18F6627 CPU are all accessible through this interface, including 32 channels of analog and digital I/O. The details of setting up the Modtronix embedded processor are in section 3 below.
- b. **Electrical power switching: THIS NEEDS TO BE UPDATED!** The electrical switches for each of the individual lights, the camera system and the CTD loads are on digital output

Ports B0-B5. These ports should be configured as outputs. Check the port list table below to see if the switch active (ON) state for each output is high or low. A low level active signal /FAULT from each switch is routed to the analog input ports T0-T2. If an over-current or over-temperature is detected by the individual switch, it will set the /FAULT line low. The analog input reading for that port will drop from 4.5-5V to 0.1-0.4V and the switch will shut off the load. To restore the switch, the cause of the fault must be removed, and the power switch cycled through the off state.

- c. **AJA KiProQuad video recorder power control (RECORDER):** The video recorder is on the AUV Ethernet network and can be reached with an HTML GUI interface at IP address: 134.89.32.54 (this may change in the future). The electrical power for the RECORDER is switched ON or OFF using the circuit described in section B above. The RECORDER also requires a logic signal to mimic the action of the user pressed “power” button on the front panel. A 3.3V logic level circuit using MODULE Port B6 has been hacked into the recorder to provide this function. Control of the RECORDER logic power switch on/off function with Port B6 has the following properties:
 - i. Turn on with momentary pulse (~1 sec.).
 - ii. Turn off with pulse > 2 seconds.
 - iii. All override off and restore factory default with pulse > 6 seconds.
- d. **Dimming control:** The dimming function uses pulse width modulation and an integrating circuit to provide a 0-5V output from the RC1 output pin which provides dimming control to all 4 lights simultaneously. **This pin must be configured as a PWM output with a base frequency of 9.766 kHz and 8 bits** (important for proper calibration of light output vs PWM setting). Full scale (100% brightness) is a PWM setting of 255.

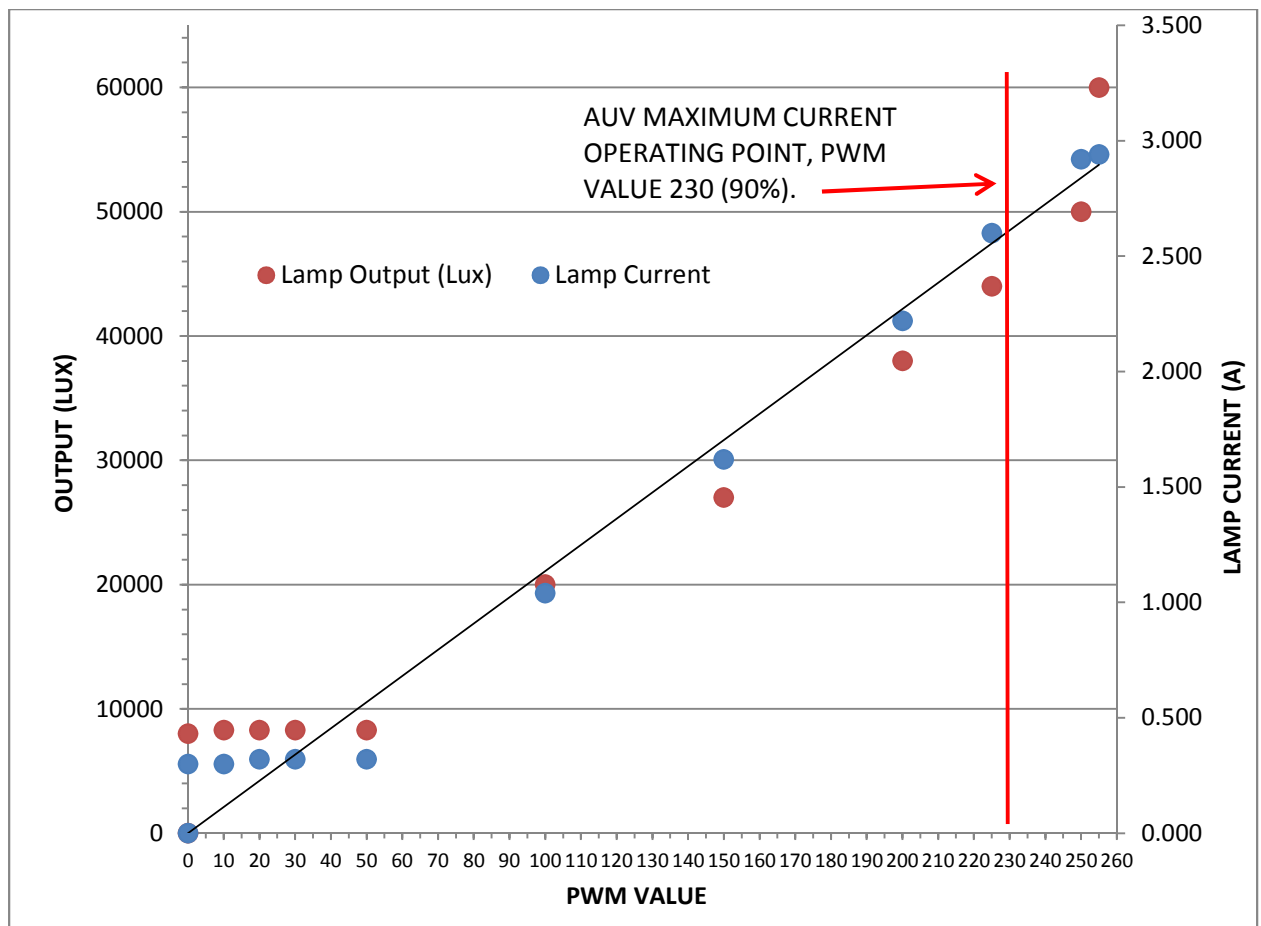


Figure 1. Plot showing relationship between PWM value and lamp current. Note that the lamp output in LUX was a very coarse measurement. It is safe to assume that the light output tracks the lamp input current.

- e. **SBE 25 CTD serial communications:** The communications with the SBE 25 use the processor MODULE internal USART, channel 1. The on-MODULE 232 transceiver is also used.
- f. **Camera lens iris position control:** The i2MAP system camera does not have any method of providing an internal auto-iris function. To allow for camera system operation under variable lighting conditions a lens iris drive system is implemented using a small stepper motor to drive the lens and an EZ Stepper model EZ17 motor controller. The communications between the MODULE and the EZ17 controller are EIA 485 serial protocol and the LOCA board provides a 485 transceiver and the required line turn-around circuit to arbitrate between the full duplex MODULE TTL communications and the half-duplex EIA 485 standard.

If the lens drive is disassembled, the intermediate gear and lens iris gear ring must be re-aligned using the index marks on the gears to provide the proper home position for the lens driver.

Under conditions of little ambient lighting, the iris is driven to and held in the $f5.6$ (note this value may change depending on testing results) position based on a lookup table of motor-steps to desired position from the mechanical stop at the minimum iris position . Under conditions of high ambient light levels (near the surface in daylight), two signals are provided to assist in setting the appropriate iris position. The first is the peak video signal level on the A/D converter input, Port A0. The peak video signal level should be about 0.9V. The second signal is the mean video signal level on the A/D converter input, Port A1. Depending on the type of scene, the mean level should be less than 0.5V. Using these two inputs, an adjustable algorithm weights each appropriately and compares the results to a set variable. Using the difference between the actual values and the set point, a look-up table is used to adjust the iris position before each recording when in environments of high ambient lighting.

- g. **Temperature sensing and over-temperature shutdown:** The housing ambient temperature is sensed with an analog module connected to the A/D converter input Port A3. The sensor outputs $500\text{mV} + (10\text{mV per degree Celsius})$, for example, $20^\circ\text{C} = 0.7\text{V}$. There is an over-temperature protection circuit in the electrical hardware that shuts down the 15 Volt power supply to the camera and recorder if the housing internal temperature reaches 40 degrees C. The circuit has 5 degrees of hysteresis and will not re-enable 15 Volt power until the temperature drops to 35 degrees C. The port map shows the /OVERTEMP FAULT signal routed to digital input port T6, but this has not been done in the current hardware revision. With the current revision, the only indications of an over-temperature fault would be a temperature above 40 degrees C in the system log file. If the system goes into over-temperature the camera and recorder will shut down immediately and if the system is recording then data may be lost. For this reason the software application should perform an orderly camera and recorder shutdown when the housing temperature reaches 35 degrees C.
- h. **Humidity sensing:** To sense humidity, an analog sensor is connected to A/D converter input Port A2. The output of 0.5 to 2.5V corresponds to 0-100% humidity.
- i. **Water alarms:** A water alarm contact is installed in the fore and aft ends of the camera pressure housing. The fore sensor is connected to A/D converter input Port A5 and the aft sensor connected to Port A4. A voltage of greater than 0.5V on these inputs signifies a water alarm.

3. Programming Notes.

- a. A **Modtronix Engineering** single board PIC computer model SBC65EC is used for network communications and all input and output functions. The i2MAP I/O board J1 & J2 connector pin description and Modtronix module configuration is shown below. Note that the configuration of the ports to digital or analog input only allows for sequential

analog assignments. The incorrectly mapped digital inputs shown on RF0, 1, 2, and 6 below will be re-assigned on the next hardware revision.

NAME	I2MAP PCB PIN	SIGNAL	PIN CONFIGURATION	POWER UP STATE	FUNCTION	Active State
A0	J1-10	PIC pin RA0	Analog INPUT	NA	Analog input peak video level 0-5V	0-5V
A1	J1-9	PIC pin RA1	Analog INPUT	NA	Analog input mean video level 0-5V	0-5V
A2	J1-12	PIC pin RA2	Analog INPUT	NA	Analog input for humidity sensor 0-5V	0-5V
A3	J1-11	PIC pin RA3	Analog INPUT	NA	Analog input for temp sensor 0-5V	0-5V
A4	J1-14	PIC pin RA4	Analog INPUT	NA	Not used - PIN functions not accessible.	
A5	J1-13	PIC pin RA5	Analog INPUT	NA	Analog input AFT water alarm	voltage > 0.5 V = water
B0	J2-13	PIC pin RB0	Digital OUTPUT	LOW	Output Switch 0 (CTD PWR)	High
B1	J2-14	PIC pin RB1	Digital OUTPUT	LOW	Output Switch 1 (CAM&REC PWR)	High
B2	J2-11	PIC pin RB2	Digital OUTPUT	HIGH	Output Switch 2 (Light 0)	Driven Low for ON
B3	J2-12	PIC pin RB3	Digital OUTPUT	HIGH	Output Switch 3 (Light 1)	Driven Low for ON
B4	J2-9	PIC pin RB4	Digital OUTPUT	HIGH	Output Switch 4 (Light 2)	Driven Low for ON
B5	J2-10	PIC pin RB5	Digital OUTPUT	HIGH	Output Switch 5 (Light 3)	Driven Low for ON
B6	J2-7	PIC pin RB6 – also used for ICP			Not used, digital I/O	
B7	J2-8	PIC pin RB7 – also used for ICP	Digital OUTPUT	HIGH	Output for power control of the AJA KiProQuad recorder. ECO #4,	Pulsed Low to activate recorder
C0	J1-16	PIC pin RC0			Not used, digital I/O	
C1	J1-15	PIC pin RC1	PWM OUTPUT	NA	PWM output for all light dimming. ECO #1.	Not Driven or Driven High = 100% = full pwr
C2	J1-18	PIC pin RC2			Not used, can be digital I/O or PWM output.	
C3	J1-17	PIC pin RC3 – port pin assigned for I2C			Not used - PIN functions not accessible.	
C4	J2-17	PIC pin RC4 – port pin assigned for I2C			Not used - PIN functions not accessible.	
C5	J2-18	PIC pin RC5			Not used, digital I/O	
C6	J2-15	PIC pin RC6			Not used, Xmit output for USART 1 (TTL)	
C7	J2-16	PIC pin RC7			Not used, Rec input for USART 1 (TTL)	

NAME	I2MAP PCB PIN	SIGNAL	PIN CONFIGURATION	POWER UP STATE	FUNCTION	Active State
D0	J1-20	RG0			Not used, can be digital I/O or PWM output.	
D1	J1-19	RG1 – USART2 Transmit			Camera Iris controller xmit (TTL)	Idle high active low
D6	J2-19	RG2 – USART2 Receive			Camera Iris controller receive (TTL)	Idle high active low
D7	J2-20	RG3			Not used, can be digital I/O or PWM output.	
SIG0	J2-6	USART 1 receive signal - RS232			SBE-25 comms receive (232)	
SIG1	J2-5	USART 1 transmit signal - RS232			SBE-25 comms xmit (232)	
T0	J2-2	PIC pin RF0	Analog INPUT (1)	NA	Power switch SW0 fault input	Low indicates fault
T1	J2-1	PIC pin RF1	Analog INPUT (1)	NA	Power switch SW1 fault input	Low indicates fault
T2	J2-4	PIC pin RF2	Analog INPUT (1)	NA	Power switch SW2 - SW5 fault input	Low indicates fault
T3	J2-3	PIC pin RF3			Not used, can be analog input or digital I/O	
T4	J1-2	PIC pin RF4	Analog INPUT	NA	Analog input FWD water alarm. ECO #2.	voltage > 0.5 V = water
T5	J1-1	PIC pin RF5			Not used, can be analog input or digital I/O	
T6	J1-4	PIC pin RF6	Digital INPUT	NA	Over temperature fault input	Low indicates fault
T7	J1-3	PIC pin RF7			Not used, digital I/O	
GND	J1-5	Ground			Power return	
+5V	J1-7	Regulated 0.5A 5V supply			5 V Power input if regulated supply available	
VIN	J1-8	Unregulated input voltage			7-35 V Power input	
CLR#	J1-6	PIC pin /MCLR			Not used	

Notes: (1) These ANALOG inputs will switch to DIGITAL inputs in the next hardware revision.

b. **Data logging.** The state of the following Modtronix/PIC register values shall be included in the log file for post-mission camera system performance analysis:

[illegible]

- c. **Modtronix configuration.** The following port and system configurations are set through the Modtronix web interface. Make sure that you are on the same subnet as the camera system (AUV subnet), and point your browser to the IP address 134.89.32.55.

i. **System settings.**

The screenshot shows the 'Modtronix SBC65EC Web Server Configuration' page. The left sidebar contains a navigation menu with the following items: 'Back to Main Page', 'System Settings', 'Analog Settings', 'Network Settings', 'Port Settings', 'PWM Settings', 'Expansion Board', 'Commands', and 'Web Server Settings'. The 'System Settings' section is active. The main content area is titled 'System Settings' and includes a description: 'This section is used to configure System Settings.' Below this is a table of parameters:

Parameters	
Modtronix TCP/IP Stack Version	V2.51
Modtronix SBC65EC Web Server Version	V3.10
Board has bootloader	Yes
Currently logged in as	admin
Blink System LED	☒ If checked, System LED is toggled every 500ms
Bootloader startup delay	3.2 In seconds, multiple of 0.8 seconds. Default is 3 seconds, maximum of 8 seconds
Serial Configuration startup delay	2 In seconds, Default is 3.2 seconds, maximum of 12 seconds

Below the table is an 'Update' button. At the bottom of the page, there is a link: 'To change the username and password, [click here!](#)' and a 'Reset Board III' button.

ii. **Network interface.**

The screenshot shows the 'Modtronix SBC65EC Web Server Configuration' page. The left sidebar contains a navigation menu with the following items: 'Back to Main Page', 'System Settings', 'Analog Settings', 'Network Settings', 'Port Settings', 'PWM Settings', 'Expansion Board', 'Commands', and 'Web Server Settings'. The 'Network Settings' section is active. The main content area is titled 'Current Network Value' and includes a description: 'This section shows the current network values.' Below this is a table of current network values:

Current Network Value	
IP Address:	134.89.32.55
Subnet Mask:	255.255.254.0
Gateway Address:	134.89.32.1
MAC Address:	0.4.163.0.0.34

Below this table is the 'Network Settings' section. It includes a description: 'The IP, Subnet and Gateway addresses are only used in the following situations:' followed by a list of conditions:

- When DHCP is disabled
- When DHCP is enabled, but there is no DHCP server available on the network
- For the network bootloader

Below the list is a note: 'If DHCP is enabled and available on the network, all these values will be obtained from the DHCP server.' Below this is a table of network settings:

Network Settings	
IP Address:	134 89 32 55
Subnet Mask:	255 255 254 0
Gateway Address:	134 89 32 1
MAC Address:	0 4 163 0 0 34

Below the table is the 'Parameters' section. It includes a checkbox for 'Enable DHCP' and a text input for 'NetBIOS name' (currently set to 'MXBOARD'). Below the parameters is an 'Update' button.

iii. **Web server configuration.**

The image displays two screenshots of the Modtronix SBC65EC Web Server Configuration interface, showing the 'Web Server Settings' and 'Command Settings' pages.

Top Screenshot: Web Server Settings

- Back to Main Page** (Left Sidebar): System Settings, Analog Settings, Network Settings, Port Settings, PWM Settings, Expansion Board, Commands, Web Server Settings.
- Web Server Settings** (Main Content):
 - Authentication**: This section is used to configure the HTTP Web Server.
 - Required for all pages: ☐ If checked, Authentication is required for all Web Pages.
 - Required for 'x' pages: ☒ If checked, Authentication is required for all Web Pages that start with a 'x' character.
 - Required for pages with CGI Commands: ☐ If checked, Authentication is required for all pages that issue CGI commands via the HTTP GET Methods. This is the case for any page that has a name-value command appended to the web address. For example, the following address issues the "c1=1" command: `http://mboard/c1=1`
 - Required for all Dynamic pages: ☐ If checked, Authentication is required for all Dynamic pages. All 'CGI' files are Dynamic pages. Additional files can also be configured to be Dynamic.
 - Required for 'CGI' Dynamic pages: ☒ If checked, Authentication is required for all 'CGI' files.
 - Dynamic Pages and Tags**: Dynamic Pages are web pages that are parsed for tags. If any tags are found in these files they are replaced by dynamic values. All 'CGI' files are parsed by default! All Tags fall in to one of two categories:
 - Standard Tags**: These tags are always parsed and displayed.
 - Secure Tags**: These tags require Authentication before they are parsed and displayed. If no Authentication has been done, they will be displayed as 0. All "Secure", and "Configuration Tags" are secure tags.Authentication required to display Secure Tags: ☒ If checked, Authentication is required to display any secure tags. If Checked, and no Authentication is provided, they will be displayed as 0.
 - Parameters**: Web Server Port: 80. Update button.

Bottom Screenshot: Command Settings

- Back to Main Page** (Left Sidebar): System Settings, Analog Settings, Network Settings, Port Settings, PWM Settings, Expansion Board, Commands, Web Server Settings.
- Command Settings** (Main Content):
 - UDP Commands**: This section is used to configure Command Settings.
 - Enable UDP Commands: ☒ If checked, UDP Commands are enabled.
 - Authentication required: ☐ If checked, each UDP Command message requires a username and password included with the message. For example, if username is "admin" and password is "pw", then "admin:pw c1=1" command will set Port C1.
 - UDP Command Port: 54123. Update button.

iv. Serial buses.

The first screenshot shows the 'Serial Buses Configuration' page. It includes a sidebar with links: 'Back to Main Page', 'Buses Configuration', 'Serial Bus Settings', and 'UDP Bus Settings'. The main content area has a warning: 'Linking of Serial Buses is in Beta stage, and has not been fully tested yet! Please report any bugs on our forum.' Below this, it explains the purpose of the section and lists available serial buses. The 'Bus Linking' section allows linking UDP Buses to Serial Ports. The 'Buffer Sizes' section allows configuring Transmit and Receive buffers for Serial and I2C buses.

The second screenshot shows the 'UDP Port 1 Settings' and 'UDP Port 2 Settings' pages. Each section includes a warning to reset the board for changes to take effect. The 'Parameters' section for each port includes a checkbox to 'Enable UDP Port' and a text field for the 'UDP Port' number (54125).

The third screenshot shows the 'USART 1 Settings' and 'USART 2 Settings' pages. Each section includes a warning to reset the board for changes to take effect. The 'Parameters' section for each port includes a checkbox to 'Enable USART' and a dropdown for 'Baud Rate' (9600).

v. Analog input settings.

The screenshot shows the 'Analog Input Settings' page. The sidebar includes links: 'Introduction', 'Analog Inputs', 'Port Values', 'LCD Display', 'PWM Values', 'Expansion Board', 'Example 1', 'System Configuration', 'Serial Configuration', and 'Contact'. The main content area has a title 'Analog Input Settings' and a description: 'This section is used to configure the Analog to Digital converter.' The 'Parameters' section includes a dropdown for 'Port Configuration' (A0, A1, A2, A3, A5, F0, F1, F2, F3, F4), a dropdown for 'Voltage Reference Configuration' (Vref+ = AVdd, Vref- = AVss), and a dropdown for 'Acquisition Time' (32uS). An 'Update' button is at the bottom.

vi. Port settings.

Modtronix SBC65EC xGetting Started134.89.32.55/index.htm

Modtronix SBC65EC Web Server

Introduction

Analog Inputs

Port Values

LCD Display

PWM Values

Expansion Board

Example 1

System Configuration

Serial Configuration

Contact

Port Settings

This section is used to configure the ports.

Port Direction

This section is used to set the direction of the spare I/O pins on the CPU. When checked, the port is configured as an output pin. When not checked, it is configured as an input pin.

Port Pin	7	6	5	4	3	2	1	0
Port A:								
Port B:	☒	☒	☒	☒	☒	☒	☒	☒
Port C:							☒	
Port F:								
Port G:								

Default Port Values

This section is used to set the default port values on powerup. When checked, the port is set (5V). When not checked, the port is clear (0V).

Port Pin	7	6	5	4	3	2	1	0
Port A:								
Port B:	☒	☒	☒	☒	☒	☒	☒	☒
Port C:							☒	
Port F:								
Port G:								

Submit

vii. PWM settings. Important for proper calibration of light output vs PWM setting.

Modtronix SBC65EC xGetting Started134.89.32.55/xcfg.htm

Modtronix SBC65EC Web Server Configuration

Back to Main Page

System Settings

Analog Settings

Network Settings

Port Settings

PWM Settings

Expansion Board

Commands

Web Server Settings

PWM Settings

This section is used to configure the PWM channels.

Mode

The PWM can be configured for 8-bit or 10-bit mode. When in 8-bit mode, channel values are from 0 to 255. When in 10-bit mode, channel values are from 0 to 1023.

Mode

8-bit Mode

PWM Frequency

Select the frequency of all PWM channels. The frequency range for 8-bit mode is from 9.766 to 156.25 kHz. The frequency range for 10-bit mode is from 2.441 to 39.062 kHz.

Frequency

9.766 kHz

PWM Channels

Enable PWM Channels. All PWM Channels should also be configured as outputs via the Port Settings page.

Channel 1 (Port C1)	☐
Channel 2 (Port C2)	☒
Channel 3 (Port G0)	☐
Channel 4 (Port G3)	☐

Update

Remember Settings After Power Up

4. AJA KiPro Quad Recorder Configuration.

See: EngineeringDesignDocs\ReleasedPDFs\AJAConfigurationSettings_RevA.pdf

5. Sony PMW F5 Camera Configuration.

See: EngineeringDesignDocs\ReleasedPDFs\ SonyCameraConfigurationSettings_RevA.pdf