MityCAM-C50000

CMV50000 EVK User's Manual

60-000034-1 RevA
1/11/2019
www.criticallink.com

Contents

Figures

Tables

1 Introduction

The purpose of this document is to detail features of the CMV50000 EVK, which includes a MityCAM-C50000 camera head.

1.1 Additional Documentation

In addition to this document, the following documents are also useful / pertinent to the use and operation of the MityCAM-C50000 cameras.

Table 1: Reference Documentation

Document #	Title	Description
DS000522	CMV50000 Datasheet	CMV50000 47.5MP CMOS Machine Vision Image Sensor Datasheet. See www.ams.com.
60-000030	MityCAM-C50000 datasheet	Complete specification for MityCAM-C50000.
	U3V Vision Standard 1.0.1	See https://www.visiononline.org/vision-standards-details.cfm?type=11
	GenTL Viewer User's Manual	Users guide for the Critical Link Supplied GenTL Viewer PC software.

1.2 Organization

This document is organized in sections covering a specific topic.

2 Interfaces

2.1 AIA USB 3 Vision

The MityCAM-C50000 includes a USB 3.0 interface that is complaint with the AIA USB 3.0 Vision standard (U3V). This is the main control and data interface to the camera system. A list of the GenICam registers available for control of the system included in Section 12 of this document.

Critical Link supplies a free PC application that may be used to control, capture and save images generated by the evaluation kit. However, this kit should also be compatible with any third-party software that is complaint with the U3V standard, such as the National Instruments Vision Acquisition Software, HALCON, etc. Figures in this document are captured using the Critical Link provided software.

2.2 HDMI

The MityCAM-C50000 includes an HDMI output interface port. This port will support 1080P 24 bit-per-pixel RGB output as well as UHD 4K (30 Hz) output for sensor preview. Configuration of the HDMI output mode is controlled

through the GenICAM HdmiOutputResolution register. The interface port must use an HDMI 1.4 compliant interface cable and suitable monitor.

2.3 Power Interface

The MityCAM-C50000 kit requires a +12 V input voltage supply. A minimum of 2 amps is required. See the datasheet for details on the connector.

2.4 USB 2.0 RNDIS Debug

The USB 2.0 port on the MityCAM-C50000 kit provides an RNDIS (ethernet) connection to an attached HOST PC. The port is configured to run a DHCP server and present an Ethernet IP address of 10.45.45.1/8 for the camera and assign an address of 10.45.45.10/8 to the attached HOST PC. The camera supports accessing the embedded Linux shell on the device using the ssh protocol. Using this protocol it is also possible to transfer files onto the camera subsystem. There is also a simple web-server running on the camera to support firmware upgrades.

3 Frame Interval and Exposure Time

Control of the Frame Interval and Exposure Time can be performed both internally and externally on the kit using the GenICam control registers and (for the case of external control) the GPIO IO pins on J201. The block diagram shows how the kit interfaces with the CMV50000 sensor.

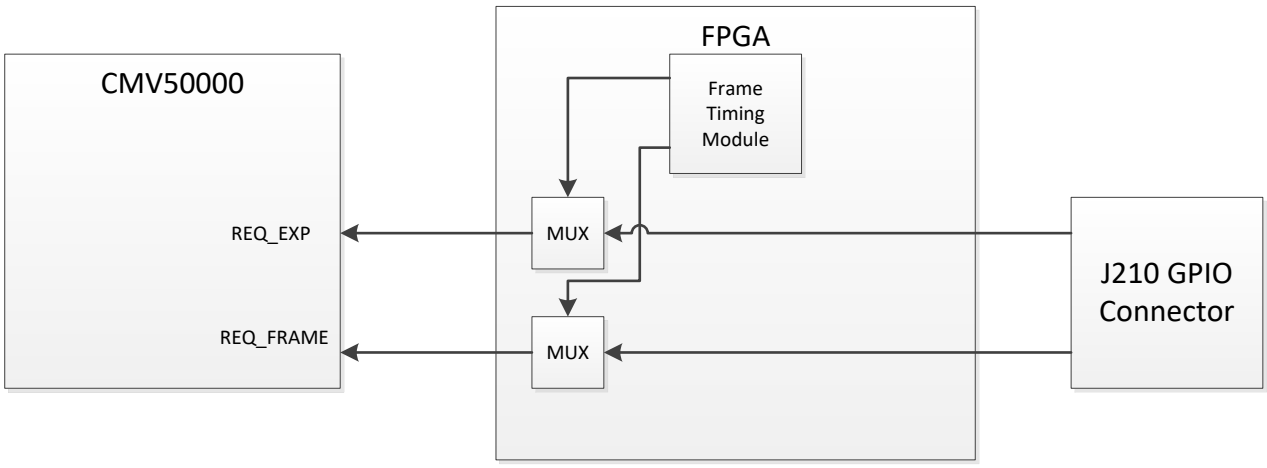

Figure 1 Sensor Connections Relating to Frame Exposure and Timing Control

3.1 External Exposure and External Frame Rate

This mode uses Control Mode 0 (Full External) mode of the CMV50000 as described by the CTRL_MODE register in the sensor datasheet. In this mode GPIO IO 0 (pin 1) and GPIO IO 1 (pin 2) of the P201 cable interface are used as

the REQ_EXP and REQ_FRAME signals, respectively. To configure this mode, the following GenICAM registers of the camera should be configured:

Register	Setting
LineMode[0]	Input
LineMode[1]	Input
TriggerMode	On
InternalExposureMode	False

Note, instead of the GPIO IO 0 and GPIO IO 1, the optical input pins may be used with the following GenICAM settings:

Register	Setting
LineMode[0]	OptoInput
LineMode[1]	OptoInput
TriggerMode	On
InternalExposureMode	False

The timing of the external exposure and frame rate must be consistent with the capabilities of the CMV50000 Sensor.

3.2 External Frame Rate and Internal Exposure

This mode uses Control Mode 1 (Programmed External) mode of the CMV50000 as described by the CTRL_MODE register in the sensor datasheet. In this mode GPIO IO 0 (pin 1) of the P201 cable interface is used as the REQ_EXP

signals, respectively. To configure this mode, the following GenICAM registers of the camera should be configured:

GenICam Register	Setting
LineMode[0]	Input
LineMode[1]	Input
TriggerMode	On
ExposureTime	User Required Exposure Time
InternalExposureMode	True

Note, instead of the GPIO IO 0, the optical input pins may be used with the following GenICAM settings:

GenICam Register	Setting
LineMode[0]	OptoInput
LineMode[1]	OptoInput
TriggerMode	On
ExposureTime	User Required Exposure Time
InternalExposureMode	True

3.3 Internal Frame Rate and Internal Exposure

This mode uses Control Mode 1 (Programmed External) mode of the CMV50000, but the FPGA drives the REQ_EXP signal using an internally generated timer based on the GenICAM frame time register. To configure this mode, the following GenICAM registers of the camera should be configured:

GenICam Register	Setting
TriggerMode	Off
ExposureTime	User Required Exposure Time
AcquisitionFrameRate or AcquisitionFramePeriod	User Required Sensor Frame Rate
InternalExposureMode	True

3.4 Notes on Frame Interval

The maximum frame interval time is defined in the CMV50000 datasheet. For a full ROI, up to 30 Hz may be achieved. For ROIs that are smaller in height, higher frame rates out of the sensor are possible. However, the USB 3.1 interface is limited to approximately 400 MB/sec. So, for a full ROI image at 12 bits per pixel, the maximum continuous framerate achievable is limited to approximately 6 Hz. For continuous operation, if the requested frame rate is higher than can be achieved, frames will be periodically dropped on the USB output interface.

4 Continuous Operation

4.1 USB Output

When the GenICam AcquisitionMode register is set to Continuous and acquisition is started, the camera will configure the sensor to operate at the requested Frame Rate and start transmitting data to the USB 3.0 interface.

If the requested data rate exceeds the capability of the USB 3.0 link, the camera will periodically drop incoming frames prior to transmission to the host PC in order to reduce the latency of the data shown on a host PC display.

4.2 HDMI Output

The HDMI output supports operation at UHD 4K resolution at 30 Hz, or 1080P resolution at 60 Hz based on the HdmiOutputResolution GenICam parameter. Frames received by the sensor are clipped according to the HdmiOffsetX, HdmiOffsetY, HdmiWidth, and HdmiHeight GenICam parameters, converted to RGB color space based on the HdmiColor parameter, rate converted (via frame dropping or frame repeating), and transmitted to the HDMI display as the received from the sensor. The latency of the HDMI output is typically 1-2 frames (~66 ms at UHD 4K resolution).

The HDMI output is enabled and disabled using GenICam HdmiStart and HdmiStop commands.

4.3 Simultaneous Output

The MityCAM-C50000 EVK supports both running both the USB output and the HDMI output at the same time.

5 Changing LVDS Clock Rate

The camera supports operating the LVDS serializer rates of the CMV50000 at different frequencies up to the maximum 830 MHz. The data rate of the lanes is configurable using the SensorClockSpeed GenICam parameter. Lowering the maximum clock rate will reduce power consumed by the sensor and processor, but will reduce the

maximum possible framerate for a given resolution. For a full ROI, the maximum frame rate from the sensor will scale by approximately

$$FrameRateFrameRate_{Max} \approx \frac{30\ F_{LVDS-MHZ}}{830}$$

6 Burst Mode Operation

6.1 USB 3 Output

The camera has a section of RAM dedicated as a circular image buffer. When the AcquisitionMode GenICam register is set to Single or Multi-Frame, data will be streamed at the configured rate into the image buffer and streamed out at the maximum achievable rate on the USB 3.0 interface, which is approximately 400 MB/sec.

6.2 HDMI

When the HDMI output is enabled, the maximum frame rate generated by the sensor must be less than or equal to 30 Hz for 4K operation, or 60 Hz for 1080P operation, otherwise undefined behavior may occur.

7 Configurable Region of Interest

While the CMV50000 supports multiple ROI, the MityCAM-C50000 supports a single ROI.

7.1 U3V

The base ROI captured from the Sensor and transmitted via the U3V interfaces is configured using the GenICam defined Width, Height, OffsetX, and OffsetY registers while the camera is IDLE.

7.2 HDMI

The HDMI ROI is configured using the GenICam parameters in the HDMI control group: HdmiOffsetX, HdmiOffsetY, HdmiWidth, and HdmiHeight. These parameters are relative to the U3V Width, Height, OffsetX, and

OffsetY registers. So if the sensor ROI is configured to start at offset (1024,1024), then the HDMI display will be start at (1024+HdmiOffsetX, 1024+HdmiOffsetY).

8 Optical Black Data

The CMV50000 uses optical black data for offset bias correction on a row by row basis. The CMV50000 includes 68 optical black columns on both the left and right side of the array as is shown in the figure below (taken from the CMV50000 datasheet).

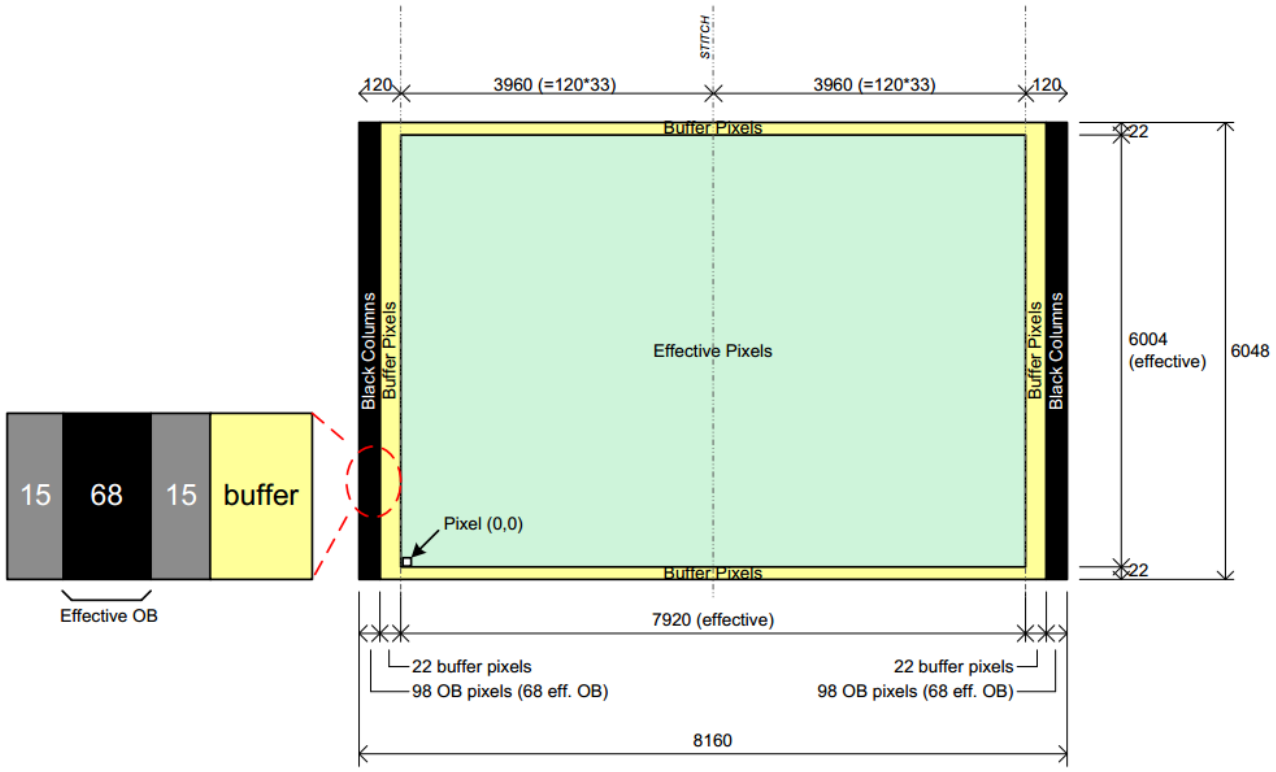

Figure 2 CMV50000 Pixel Array

The MityCAM-C50000 kit provides access to the top and bottom 22 buffer pixel rows and access to the left and right 68 OB column pixels by adjusting the request ROI of the camera. The camera presents the buffered pixel rows at the top and bottom positions in the ROI. The camera packs the 68 optical black pixels in 2 groups of 96 pixels (192 total) at the right side of the ROI. The right most 192 pixels, starting at pixel X offset of 7920, will consist of the 68 optical black pixels on the left side of the array followed by 28 padded pixels followed by 68 optical black pixels on the right side of the array followed by 28 padded pixels. The 28 padded pixels should be ignored.

The nominal ROI that will capture the Effective pixels should be specified as having a X offset of 0, a Y offset of 22, a width of 7920 and a height of 6004. To capture the black pixels on the column the ROI should have an X offset

of 0, a Y offset of 22, a width of 8112, and a height of 6004. To capture the black pixels and the buffer row pixels, the ROI should have an X offset = 0, a Y offset = 0, a width of 8112 and a height of 6048.

9 Color Processing

10 GPIO Interface

The EVK comes with a breakout cable for the GPIO interface harness. The pin connections are listed in Table 2. P1 is the 12-Pin GPIO connector interface. P2 is the USB Type A interface for Host PC insertion. P3 is the 9 Pin receptacle (female) cable end. P4 is the 9 pin plug (male) cable end.

Table 2 GPIO Break Out Cable Pin Assignments

GPIO Port (P1)	Break Out Cable Port-Pin	Description
1	P3-6	FPGA IO 0 – 1.8V CMOS Logic Level
2	P3-7	FPGA IO 1 – 1.8V CMOS Logic Level
3	P3-8	FPGA IO 2 – 1.8V CMOS Logic Level
4	P3-9	FPGA IO 3 – 1.8V CMOS Logic Level
5	P3-4	Camera shutdown, short to GND to turn off camera, otherwise leave unconnected.
6	P3-5	Ground
7	USB-A Connector, P2	1.8V Serial Console Output
8	USB-A Connector, P2	1.8V Serial Console Input
9	P4-5	Reference / Return for Isolated input currents.
10	P4-6	Opto-isolated Input 0
11	P4-7	Opto-isolated Input 1
12	P4-8	Opto-isolated Input 2

The available modes of operation for the 4 GPIO pins are listed in Table 3.

Table 3: GPIO Modes

#	Mode
1.	Input for reading
2.	Output driven low
3.	Output driven high
4.	Input for external trigger

The following sections will cover Modes 1, 2 and 3. Mode 4 is covered in separate sections.

The Opto-Isolated Input pins may be used as inputs for reading. Input 0 may be used as an optional trigger source in the same way as GPIO 0.

10.1 Input

In the input mode of operation, the pin can be queried for its current logical value (High or Low).

10.2 Output

In output mode, the pin can be driven high or low. This can be used to toggle a light source or some other operation.

11 Firmware Upgrade

Recent versions of the MityCAM-C50000 allow upgrading the firmware via the network interface. Details for acquiring the firmware and downloading the firmware to the camera are available on the Critical Link MityCAM Support Site.

12 MityCAMC50000 GenICam Features

This section presents a summary of the Generic Interface for Cameras (GenICam) available features provided by the camera. Many of the listed features, identified by the SFNC=Y field, are defined by the european machine vision association (emva) Standard Features Naming Convention.

12.1 Device Control Group

Feature	Type	SFNC?	Description
DeviceReset	Command	Y	This command is used to reset the device and to put it in its power up state.
DeviceVendorName	StringReg	Y	Name of camera vendor
DeviceModelName	StringReg	Y	Name of the camera model
DeviceManufacturerInfo	StringReg	Y	Manufacturer Info
DeviceVersion	StringReg	Y	Device Version
DeviceSerialNumber	StringReg	Y	Displays the factory set camera serial number.
DeviceFirmwareVersion	StringReg	Y	Firmware Version
DeviceSFNCVersionMajor	Integer	Y	Major version of the Standard Features Naming Convention that was used to create GenICam XML
DeviceSFNCVersionMinor	Integer	Y	Minor version of the Standard Features Naming Convention that was used to create GenICam XML
DeviceSFNCVersionSubMinor	Integer	Y	Sub-Minor version of the Standard Features Naming Convention that was used to create GenICam XML
SensorTemperature	Float	Y	Sensor temperature in degrees C. **Min Value:**-200.0 **Max Value:**200.0
CalibrationMode	Enumeration	Y	Calibration type to run when issuing calibration command. **Allowed Values :** • Dark • White
Calibration	Command	N	This command cause the camera to calibrate column level offset and gain correction Tables. Requires the sensor to covered (dark).

12.2 Image Format Control Group

Feature	Type	SFNC?	Description
OffsetX	Integer	Y	X offset of image, in pixels. **Min Value:**0 **Increment:**1
OffsetY	Integer	Y	Y offset of image, in pixels. **Min Value:**0 **Increment:**1
Width	Integer	Y	Width of image, in pixels. **Min Value:**16 **Increment:**16
Height	Integer	Y	Height of image, in pixels. **Min Value:**1 **Increment:**1
PixelFormat	Enumeration	Y	Pixel format **Allowed Values :** • Mono12p • Mono8 • BayerBG8 • BayerBG12P
TestPattern	Enumeration	Y	This control allows the user to select between normal Sensor Data and the CMV50000 sensor channel test gradient test data as described in 7.8.5 of the AMS CMV50000 datasheet. **Allowed Values :** • SensorData • SensorGradient
BadPixelReplacementEnable	Enumeration	N	This control allows the user to enable or disable the replacement of pixels marked as bad by the system. **Allowed Values :** • On • Off

BadPixelReplacementMap	Enumeration	N	When on, marked bad pixels are set to 0 and non-marked pixels are set to maximum value during image transmission. **Allowed Values :** • On • Off
SensorClockSpeed	Integer	N	This control allows the user to configure the LVDS data rate (in Mbps) transmitted from the sensor to the evaluation camera FPGA. By default the system sets this to the maximum rate. Reducing the LVDS data rate will impact the maximum frame rate achievable by the sensor. **Min Value:**200 **Max Value:**830

12.3 Acquisition Control Group

Feature	Type	SFNC?	Description
AcquisitionMode	Enumeration	Y	Acquisition mode **Allowed Values :** • Continuous • SingleFrame • MultiFrame
AcquisitionStart	Command	Y	Start acquisition.
AcquisitionStop	Command	Y	Stop acquisition.
ExposureTime	Float	Y	Exposure duration, in microseconds. **Min Value:**10.0 **Max Value:**10000000.0
AcquisitionFrameRate	Converter	Y	Frame rate, in frames per second.
AcquisitionFramePeriod	Integer	Y	Frame rate, in microseconds. **Min Value:**1000 **Max Value:**5000000 **Increment:**1
AcquisitionFrameCount	Integer	Y	Number of frames to acquire in MultiFrame Acquisition mode. **Min Value:**1 **Max Value:**1000 **Increment:**1
TriggerSelector	Enumeration	Y	TriggerSelector **Allowed Values :** • FrameStart
TriggerMode	Enumeration	N	TriggerMode **Allowed Values :** • Off • On

TriggerActivation	Enumeration	N	TriggerActivation **Allowed Values :** • RisingEdge

12.4 Sensor Peek/Poke Group

Feature	Type	SFNC?	Description
RegAddress	Integer	N	Register address of the Peek/Poke **Min Value:**0 **Max Value:**255 **Increment:**1
RegValue	Integer	N	Value of the address peeked or to be written when poked **Min Value:**0 **Max Value:**255 **Increment:**1
ExecRead	Command	N	Command reads and invalidates/replaces the RegValue register with the setting read back from the sensor.
ExecWrite	Command	N	Command writes the value stored in the RegValue register to the sensor at the specified RegAddress location.

12.5 Sensor Specific Group

Feature	Type	SFNC?	Description
DMUX1_SEL	Enumeration	N	This control allows routing various sensor timing signals to the TDIG test point on the sensor board. See section 8.2.62 of the datasheet. **Allowed Values :** • None • PLL_1_LOCK • PLL_2_LOCK • CLK_PIX • INT_REQ_FRAME • INT_REQ_EXP_L • GLOB_Start • CTR_EXP_L
GANA	Enumeration	N	Sensor Analog Gain Selection **Allowed Values :** • Gain_1x • Gain_2x • Gain_4x
GDIG_RE_CE	Integer	N	Digital Gain for Even Rows, Even Columns. See section 7.7.2 of the CMV50000 datasheet. **Min Value:**0 **Max Value:**255 **Increment:**1
GDIG_RE_CO	Integer	N	Digital Gain for Even Rows, Odd Columns. See section 7.7.2 of the CMV50000 datasheet. **Min Value:**0 **Max Value:**255 **Increment:**1
GDIG_RO_CE	Integer	N	Digital Gain for Odd Rows, Even Columns. See section 7.7.2 of the CMV50000 datasheet. **Min Value:**0 **Max Value:**255 **Increment:**1

GDIG_RO_CO	Integer	N	Digital Gain for Odd Rows, Odd Columns. See section 7.7.2 of the CMV50000 datasheet. **Min Value:**0 **Max Value:**255 **Increment:**1
EOB_DISABLE	Boolean	N	This register will disable (bypass) the Optical Black Correction logic on the sensor. See section 8.2.59 of the CMV50000 datasheet.
EOB_VALUE	Integer	N	This register will disable (bypass) the Optical Black Correction logic on the sensor. See section 8.2.59 of the CMV50000 datasheet. **Min Value:**0 **Max Value:**16384 **Increment:**1
EOB_TARGET	Integer	N	Target black level, in counts, that sensor normalizes to when optical black correction is enabled. See section 8.2.36 of the sensor datasheet. **Min Value:**0 **Max Value:**16384 **Increment:**1

12.6 Digital IO Control Group

Feature	Type	SFNC?	Description
LineSelector	Enumeration	Y	Selects the physical line (or pin) of the external device connector or the virtual line of the Transport Layer to configure. When a Line is selected, all the other Line features will be applied to its associated I/O control block and will condition the resulting input or output signal. For this case, Line0-3 correspond to High Speed FPGA IO numbers 1-4 on the GPIO connector interface. **Allowed Values :** • Line0 • Line1 • Line2 • Line3
LineMode	Enumeration	Y	LineMode **Allowed Values :** • Input • Output • OptoInput
LineSource	Enumeration	Y	LineSource **Allowed Values :** • Off • ExposureActive • UserOutput0 • UserOutput1
UserOutputSelector	Enumeration	Y	UserOutputSelector **Allowed Values :** • UserOutput0 • UserOutput1
UserOutputValue	Boolean	Y	Selecting high and low for the user output.

12.7 HDMI Control Group

Feature	Type	SFNC?	Description
HdmiStart	Command	N	This command will cause the evaluation kit to configure the Sensor to capture images, scale and output them to the HDMI port according to the settings in the HDMI Control group.
HdmiStop	Command	N	This command will cause the evaluation kit to configure the Sensor to stop sending data to the HDMI output port.
HdmiColor	Boolean	N	Setting this parameter to true will cause the RAW input to be assumed as a Bayer Pattern color image. It will be converted RGB using a nearest neighbor conversion algorithm for transmission to the HDMI output display. Setting this parameter to false will cause the image to be converted to grayscale RGB.
HdmiOffsetX	Integer	Y	X pixel offset of the clipping region of the captured sensor image that will be routed to the HDMI display. Note: This offset is with respect to the effective region transmitted to the USB 3 interface port as defined by the OffsetX parameter. **Min Value:**0 **Increment:**1
HdmiOffsetY	Integer	Y	Y pixel offset of the clipping region of the captured sensor image that will be routed to the HDMI display. Note: This offset is with respect to the effective region transmitted to the USB 3 interface port as defined by the OffsetY parameter. **Min Value:**0 **Increment:**1
HdmiHeight	Integer	Y	Pixel Height of the image sent to the HDMI output interface. Note: the image sent to the HDMI output interface will be scaled (up or down depending on the scenario) to match the configured HdmiOutputResolution parameter. Aspect ratio is not preserved. **Min Value:**1 **Increment:**1
HdmiWidth	Integer	Y	Pixel Width of the image sent to the HDMI output interface. Note: the image sent to the HDMI output interface will be scaled (up or down depending on the scenario) to match the configured HdmiOutputResolution parameter. Aspect ratio is not preserved. **Min Value:**16 **Increment:**16

HdmiOutputResolution	Enumeration	N	Selects the transmitted output resolution on the HDMI interface. Currently, 1080P60 and UHD 4K at 30 Hz are supported. **Allowed Values :** • Res_1080p • Res_4K
HdmiGamma	Float	N	The evaluation system will perform a gamma gain conversion of the HDMI output data using this parameter.

12.8 Transport Layer Control Group

Feature	Type	SFNC?	Description
PayloadSize	Integer	Y	Size of payload, in bytes **Min Value:**16 **Max Value:**95103360 **Increment:**1

13 Revision History

Revision	Date	Author	Description
-	05/22/2018	Mike Williamson	Outline / Draft.
A	01/11/2019	Mike Williamson	Initial Release.