



Camera User's Manual

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Contact

Emergent Vision Technologies Canada (Headquarters)

3135-580 Nicola Ave

Port Coquitlam, BC

V3B 0P2

Canada

info@emergentvisiontec.com

www.emergentvisiontec.com

Technical Support

info@emergentvisiontec.com

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Overview

This document is the User's Manual for Emergent Vision Technologies cameras. It serves as a ground-up reference for getting started and working with our cameras.

The Hardware Installation chapter includes all required to install the PCIe NIC, cables, camera and camera power supply. It also covers the interfaces associated with the camera such as LEDs, and the SFP+ 10G, RJ45 or SFP28 25G interfaces- GPIO is postponed until a later chapter.

The Software Installation chapter includes all required to install the Emergent Vision Technologies software which includes eCapture and eSDK as well as all necessary drivers and dependencies. Configuration of the NIC is also covered. All are covered on both Windows and Linux.

The eCapture chapter allows the user to get imaging quickly with the camera powered up and configured as described in previous chapters. eCapture is Emergent's GenICam based viewer software which also provides built-in functionality such as IP configuration and remote firmware upgrades which are described in later chapters.

The IP Configurator chapter describes the IP configuration functionality within eCapture which allows the user to set volatile and non-volatile IP address and associated subnet mask and default gateway for the selected camera.

The Firmware Upgrades chapter describes the firmware upgrade functionality within eCapture which allows the user to perform remote upgrades on the camera with Emergent provided firmware to take advantage of feature adds and other updates.

The eSDK chapter includes all required for the programmer to get up and running using the eSDK and this involves compiling and running the provided examples.

The camera interfaces chapter describes all interfaces of the camera and goes into detail for the GPIO interface for those connecting custom hardware to the GPIO connector.

Hardware Installation

Installing Mellanox 25G NICs or Myricom 10G NICs

As with the installation of any PCIe card, the PC must be powered down and the necessary ESD precautions must be observed. Both the dual port 25G NIC and dual/single port 10G NICs take a x8 PCIe slot (they will fit into a x16 slot also) but the chosen slot **MUST** be wired for at least x8. Some PCIe slots may be x16 or x8 in mechanical size but wired as x4. Please check your motherboard specifications.

Installation of the drivers for these PCIe cards is performed during the Emergent software installation and the user should not go to the manufacturers website to try to find drivers as this can lead to compatibility issues.

Installing 10GBaseT CAT/RJ45 Cables

CAT and RJ45 are cable and connector standards and the connector is keyed to prevent incorrect insertion. These are one-piece cables that plug into both the camera and NIC to complete the link.

Simply insert each end of the CAT/RJ45 cable into both the NIC RJ45 port and the camera RJ45 port. With the cable completely inserted there should be a clicking sound to indicate it is latched.

Removing the cables is accomplished by lifting the provided tab which releases the latching mechanism on the underside of the connector.



Installing SFP+ Direct Attach Cables

SFP+ is a 10G connector standard and is keyed to prevent incorrect insertion. Direct Attach cables are one-piece cables that plug into both the camera and NIC to complete the link.

Simply insert each end of the SFP+ cable into both the NIC SFP+ port and the camera SFP+ port. With the cable completely inserted there should be a clicking sound to indicate it is latched.

Removing the cables is accomplished by pulling on the provided tab which releases the latching mechanism on the underside of the connector. But note that some cable vendors have a different latching mechanism with a different process to remove.



Installing SFP+ and SFP28 Fiber Transceivers and Cables

Insert the LC fiber into the optical transceiver and then install the completed SFP+/SFP28 assembly into the NIC and camera as shown in the previous section. Fiber cables thus consist of three parts: 2 x Fiber Transceivers and 1x LC-LC fiber cable.

Removing the assembly from either end is accomplished by first removing the LC-LC fiber by pushing down on the release latch on the top side of the assembly. Then the optical transceiver can be removed by pulling the latch at the top of the transceiver outward and down- the whole SFP+/SFP28 transceiver module then simply slides out of the SFP+/SFP28 cage.

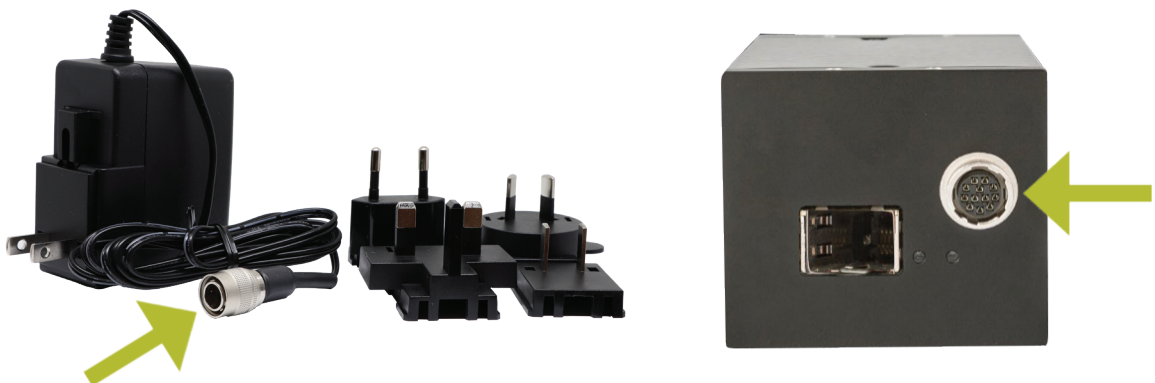


Connecting Power

Only use Emergent approved power supplies with Emergent cameras. Note that while other cameras use the same connector they do not necessarily use the same pinout. Also, FCC/CE testing was performed using the Emergent provided supplies and some power supplies are better at reducing power line transients than other poorly designed supplies.

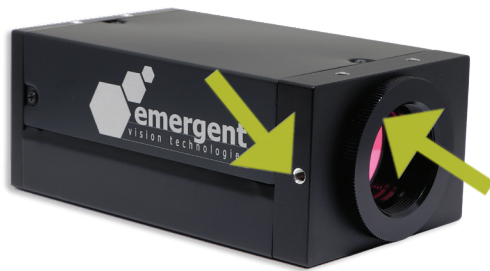
A poorly designed non-approved supply can, under the right influence, damage the camera and will not be covered by the warranty.

Simply insert the HR12 connector into the camera HR12 port. This is a latching connector and requires pulling back on the outer shell of the connector and rotating around and pushing in until seated. Emergent GPIO accessories are installed in the same manner.



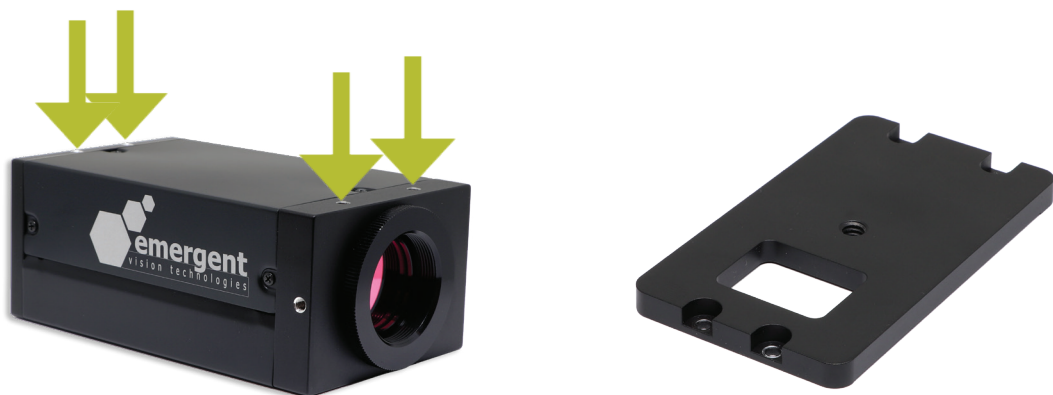
Adjusting Backflange Distance

Standard practices apply to adjusting back flange distance but Emergent cameras are equipped with user adjustable distance. As shown, there are entry points on the side of the front plate to a hex key screw which when loosened allows the camera lens barrel to screw in and out. With the barrel in the accepted position, simply gently tighten the hex screws to complete the operation. Standard C mount lenses then screw into the end of the barrel. The process is the same for the M42 and M52 F-Mount adapters for the larger format models.



Tripod Mount

A tripod mount and screws are available to order for all cameras and can easily be mounted on top or bottom of the camera using the screw locations shown. A cutout is made in the mount for easy viewing of the camera label.



GPIO

Please see the Camera Interfaces chapter in this manual.



Software Installation

Installing Software (Windows)

The software installation is quite straightforward. Simply run the provided installer (ie. EVT_SDK_Installer_2_23_01_20605.exe) and options will be provided to install the Mellanox and Myricom drivers, the Emergent eSDK and eCapture software, and any dependencies such as Visual Studio runtime libraries. It is easiest to say yes to all. Reboot may be required.



NOTE: When prompted to upgrade the NIC firmware during Mellanox install, uncheck the box to skip this part.
NOTE: if prompted to restart system during the install, do not do so until full software installation is complete.

The Myricom drivers are compatible with Windows 7,8, and 10. The Mellanox drivers are compatible with Windows 10 only.

The Mellanox drivers require to run applications as administrator.



NOTE: All drivers and dependencies are included in our installer so do not try to install these from other sources otherwise incompatibilities could arise.

Installing Software (Linux)

Copy the install .tgz file to a directory on the Linux machine and then run from that directory:

```
# tar xzf emergent_camera_2.22.10.20604-ubuntu18.04.01.x86_64.tgz  
(or provided .tgz file name)  
# ./install_eSDK
```

This installs the Mellanox and Myricom drivers, the Emergent eSDK and eCapture software, and any dependencies. It is easiest to say yes to all. Reboot may be required.

To uninstall:

```
# ./uninstall_eSDK
```

Software is installed to /opt/EVT directory.

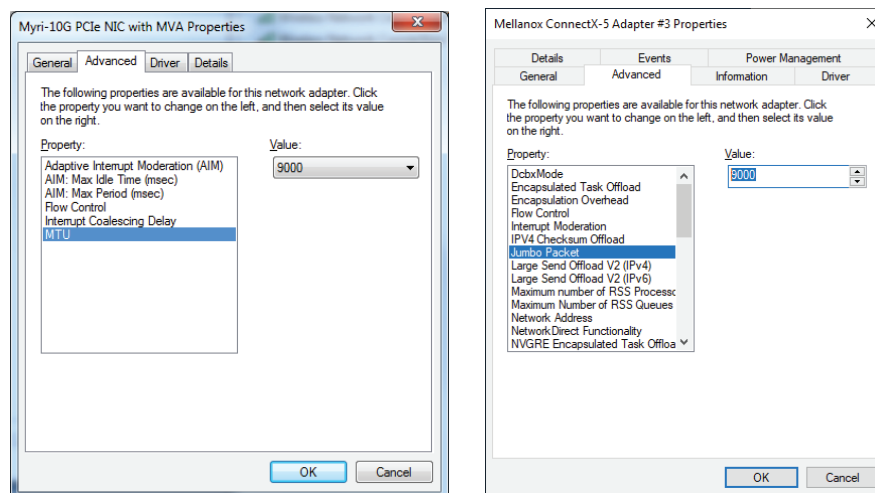


NOTE: Make note of the installer file name as this dictates the distribution and specific version of that distribution which is supported.

NOTE: All drivers and dependencies are included in our installer so do not try to install these from other sources otherwise incompatibilities could arise.

Configuring NIC

The NIC should be correctly configured if the instructions in the section on Installing the NIC are followed. MTU 9000 should be set by default as below. The Mellanox driver install does not set MTU so this step will need to be done in this case.



We naturally must configure the IP address of the NIC and coordinate this with the camera and other devices with respect to subnets, IP address conflicts, etc. For simplicity, our example shows static IP address configuration. We thus might setup our camera with an IP address of 192.168.1.69 which would put the camera on the same subnet as the NIC which also avoids an IP address conflict with the host IP of 192.168.1.20 and subnet mask of 255.255.255.0. This is handled very much the same through the Network Connections dialogs when working under Linux.



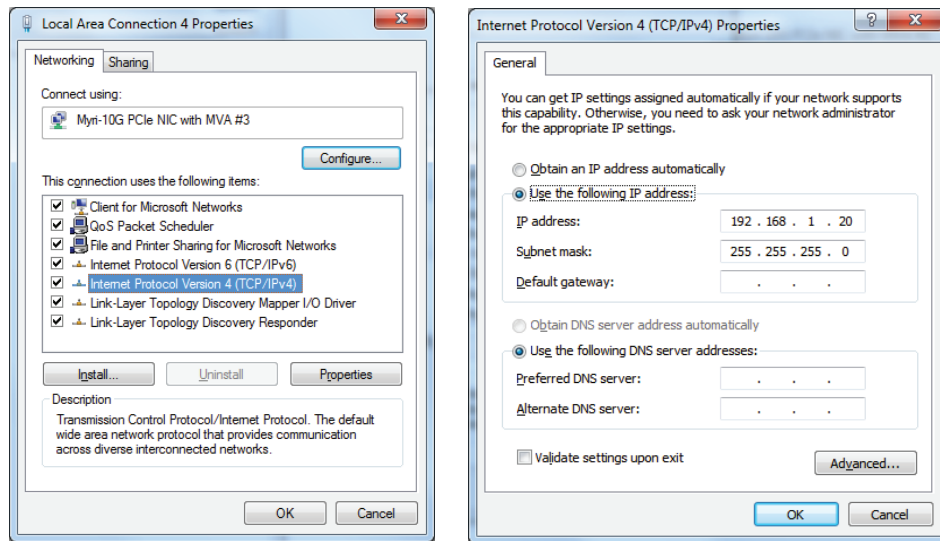
NOTE: A common mistake is not setting up the IP address and subnet mask correctly and in some cases this results in 0 cameras being found by the software. Other times 0 cameras are found as a result of a firewall which does not pass certain IP addresses.

An important point is that the default camera IP address is a static 192.168.1.69 so, provided no IP address conflicts with this or the host IP address, then a suitable host IP address and subnet mask would be:

IP:192.168.1.20

Subnet Mask: 255.255.255.0

with all being on the same 192.168.1.x subnet.

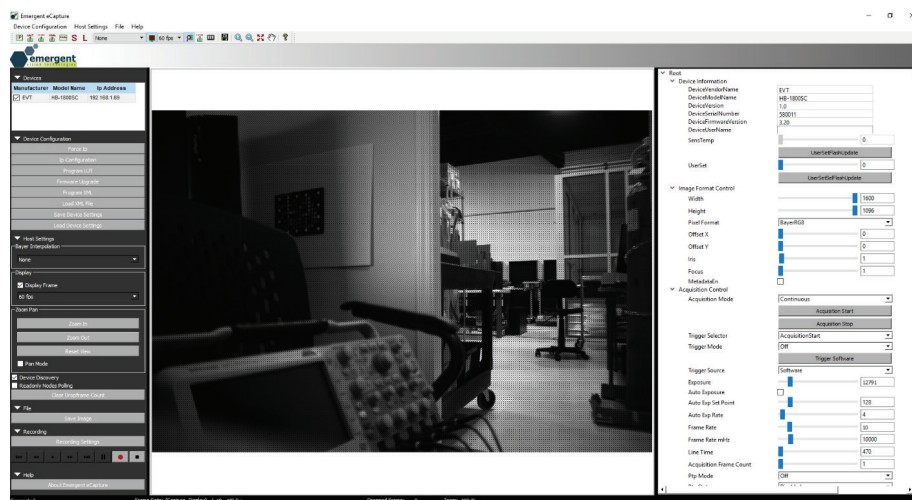


eCapture

Start eCapture

Plug in the camera and power up and configure as described in the previous chapters. Start the eCapture application. On the left-hand side of the main window the “Devices” view will show all Emergent cameras found during the discovery process. Clicking (single) on a camera in this list gains control of this camera which also involves retrieving the camera GenICam XML feature file and filling in the GenICam feature tree “Device Settings” view on the right side of the main window. Clicking on the same camera disconnects that camera. Clicking on another camera disconnects any other camera already connected and connects the new camera. eCapture only connects to one camera at a time. The eSDK can be used to connect and stream from multiple cameras.

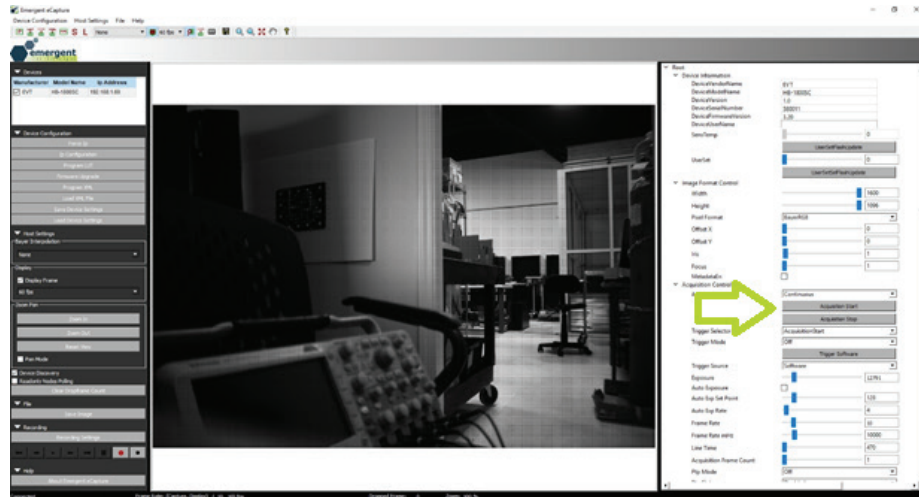
Under Linux we would simply launch eCapture by finding the application in the home search window and clicking on it to run.



Start Imaging

With above two steps completed, expand the GenICam feature tree in the “Device Settings” view and expand the “Acquisition Control” node. Then click the “Acquisition Start” button to start imaging.

In this same view, one can exercise the full functionality of the camera and make changes to camera parameters such as area of interest (AOI), exposure, gain, offset, pixel format and also to utilize special camera triggering modes as described in the EVT Camera Attributes manual. See also GPIO in the Camera Interfaces chapter of this manual for external triggering and other IO activities using GPIO.



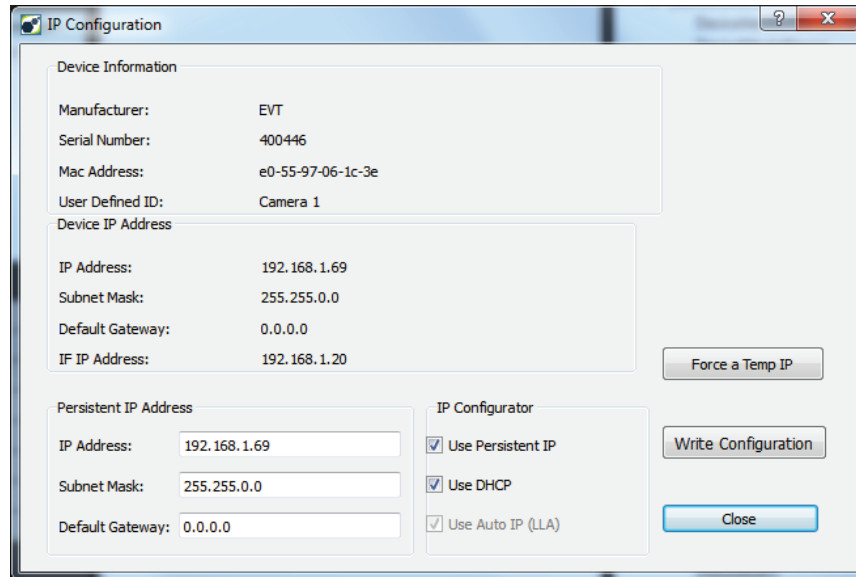
IP Configurator

Starting IP Configurator

Start the eCapture application as previously described and select a camera to control through the “Devices” view. Then navigate to “Device Configuration” and “IP Configurator.”



Note: This utility is only available when operating on a visible and “connected” camera. See ForceIP below for working with cameras not seen by the software.



Using IP Configurator

Selecting “IP Configurator” as detailed above presents a dialog with the following:

Device IP Settings (current settings):

IP Address
Subnet Mask
Default Gateway

Persistent IP Settings:

IP Address
Subnet Mask
Default Gateway
Configuration Method (Static/Fixed, DHCP, LLA/AutoIP)

Options available to the user are as follows:

- Write Configuration: to write new persistent IP settings to the camera.
- Force a Temp IP: to write/force temporary IP configuration data into the camera.
- For both the above, the new settings change will cause the camera to be disconnected, re-configured and then re-discovered. It will then show up again in the “Devices” view with the new IP configuration.

The user can enable and configure static IP, DHCP, or LLA as described above. Some firewalls prevent LLA so may need to turn off the firewall temporarily to perhaps set a static IP address that the firewall can be programmed to accept.

This dialog also presents other device information such as serial number, MAC address and the User Name assigned to this camera.

Starting Force IP

Start the eCapture application as previously described. Then navigate to “Device Configuration” and “Force IP”



Note: This utility is available when operating on an “un-connected” camera to handle all cases where the camera cannot even be seen by the software.

Using Force IP

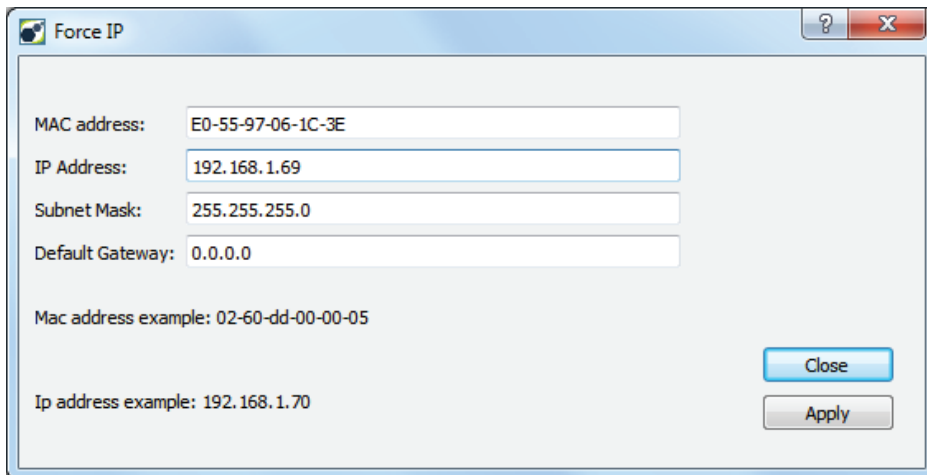
Selecting “Force IP” as detailed above presents a dialog with the following:

- MAC Address
- IP Address
- Subnet Mask
- Default Gateway

User should fill in items similar to that shown below and then click Apply.

The new settings change will cause the camera to be re-configured and then re-discovered. Assuming the IP address is on the same subnet as the programmed NIC IP address then It will now show up in the “Devices” view with the new IP configuration. At this point, we note that the MAC address of an Emergent camera takes this format: E0:55:97: SERIAL_NUMBER.

Thus, in the following example, the serial number is 06:1C:3E which is hexadecimal for 400446.

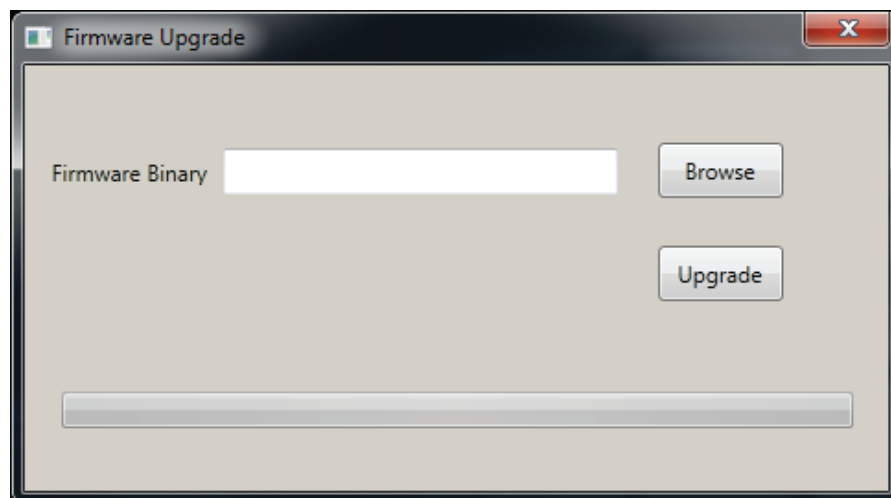


A screenshot of a Windows-style dialog box titled "Force IP". It contains four text input fields: "MAC address:" with the value "E0-55-97-06-1C-3E", "IP Address:" with "192.168.1.69", "Subnet Mask:" with "255.255.255.0", and "Default Gateway:" with "0.0.0.0". Below these fields, there is a line of text "Mac address example: 02-60-dd-00-00-05" and another line "Ip address example: 192.168.1.70". At the bottom right, there are two buttons: "Close" and "Apply".

Firmware Upgrades

Starting Firmware Upgrade

Start the eCapture application as previously described and select a camera to control through the "Devices" view. Then navigate to "Device Configuration" and "Firmware Upgrade."



A screenshot of a Windows-style dialog box titled "Firmware Upgrade". It features a "Firmware Binary" label followed by a text input field. To the right of the input field is a "Browse" button. Below the input field and "Browse" button is an "Upgrade" button. At the bottom of the dialog, there is a long, empty progress bar.



Using Firmware Upgrade

For updated firmware please contact technical support.

Assuming a compatible firmware upgrade file is available, simply select the file for upgrading through the “Firmware Upgrade” dialog and then click the Upgrade button to begin the short upgrade process. Once complete, the camera will reboot itself with the new firmware. Close and reopen the software to re-connect.



NOTE: Do not rename the provided files as the software provides validity checks with this information. Precautions should be taken to not power down the camera, overload the network, or otherwise while the short upgrade is in progress.

Depending on the nature of the firmware upgrade it may also be necessary to obtain an updated XML feature file to be used as previously described.

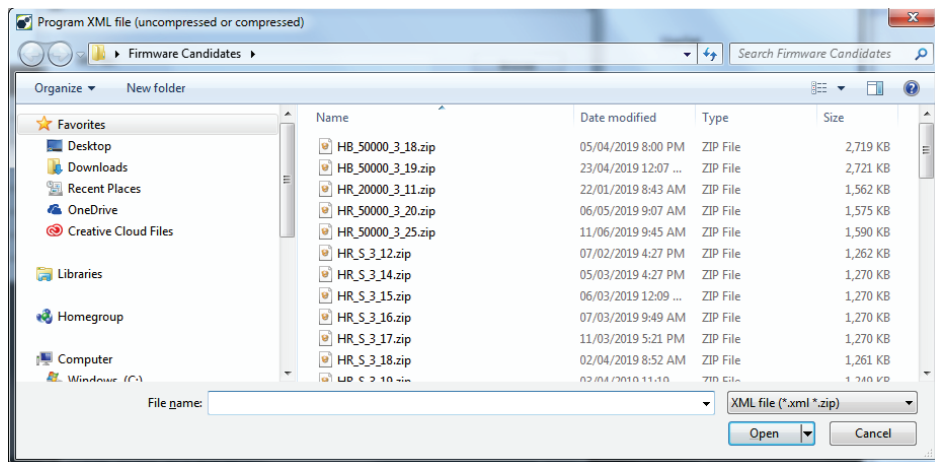
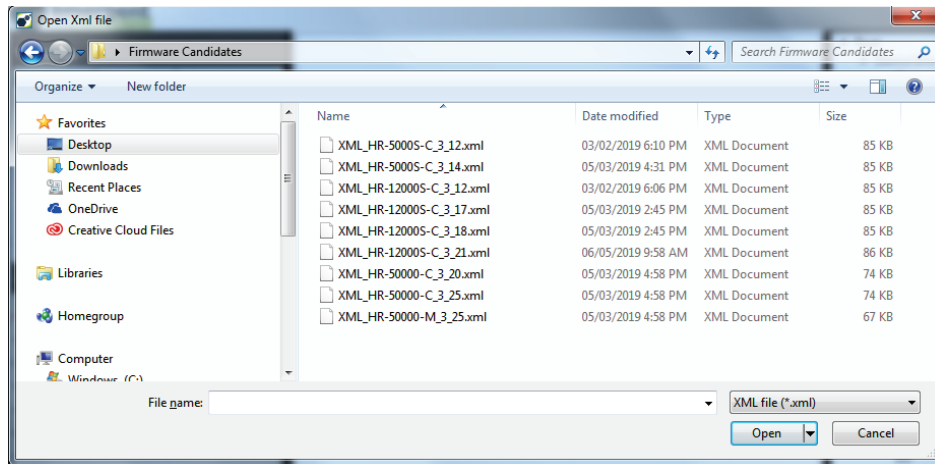
The ability to update the firmware is also exposed through the eSDK – please contact support for guidance. Emergent cameras always ship with the latest well tested firmware and XML in camera memory so updates are not usually required unless new features are added or custom work performed.

XML Updates

This step should not be performed without consulting support first.

If there is an updated XML file for your camera then use the “Device Configuration” view “Load XML File” feature to locate and use this updated .xml file. Note that this is a volatile operation and the updated XML file is not programmed to the camera non-volatile memory so after power cycling this procedure will need to be repeated. Writing the XML file to the camera persistently is supported using the “Program XML” feature and this uses a .zip file which is simply a zipped version of the .xml file. When using “Program XML,” the camera will reboot itself with the new XML file- close and re-open the software to reconnect. The ability to update the XML is also exposed through the eSDK – please contact support for guidance.

Emergent cameras always ship with the latest well tested firmware and XML file in camera memory so updates are not usually required unless new features are added or custom firmware provided.



eSDK

Introduction

Included as part of the eSDK installation are many examples for exercising the camera functionality. Under Windows, these examples have been created, built and run with Microsoft Visual Studio Express 2017 and the examples are pre-configured projects for this build environment. Under Linux, the same applies but source files and makefiles comprise the projects.



Building Examples

Within VS Express, use Open Solution and navigate to the Examples directory within the install directory of the eSDK installation and then into the desired example directory (ie. EVT_DeviceInformation) and select the VS solution file (ie. EVT_DeviceInformation.sln).

The project may ask to upgrade to retarget project for latest Windows SDK and Platform Toolset which is fine to do so.

With the project now open select Build to build the project. The short process should output 0 Errors to the build console.

Under Linux a fresh install of Ubuntu 18.04 LTS would require the g++ tools. We install these if necessary with one terminal command (internet connection required):

```
#sudo apt-get install build-essential
```

Under Linux we would build an example in a terminal as follows:

```
# cd /opt/EVT/eSDK/Examples/EVT_DeviceInformation/  
# make
```

Running Examples

Open a DOS window and cd to the project Release/Debug directory and then run the newly built program by simply typing: EVT_DeviceInformation
The output will look similar to the following:

```
C:\.....\Debug>EVT_DeviceInformation
-----
DeviceInformation : Example program
-----
Open Camera:           Camera Opened

DeviceVendorName:      EVT
DeviceModelName:       HR12000S-C
DeviceVersion:         1.0
DeviceSerialNumber:    02100234
DeviceFirmwareVersion: 3.25

Close Camera:          Camera Closed
```

Or under Linux, the output will look similar to the following:

```
# cd /opt/EVT/eSDK/Examples/EVT_DeviceInformation/
# ./out/EVT_DeviceInformation
-----
DeviceInformation : Example program
-----
Open Camera:           Camera Opened

DeviceVendorName:      EVT
DeviceModelName:       HR12000S-C
DeviceVersion:         1.0
DeviceSerialNumber:    02100234
DeviceFirmwareVersion: 3.25

Close Camera:          Camera Closed
```

Camera Interfaces

10GBaseT/RJ45

The 10GBaseT/RJ45 port is a standard port for 10Gb Ethernet applications. Power is not provided over these cables and instead enters through the GPIO connector.



SFP+

The SFP+ port is a standard port for 10Gb Ethernet applications. SFP+ stands for “Enhanced small form-factor pluggable.”

SFP+ has some significant advantages over other Ethernet cabling options including a variety of cabling options including “Direct Attach” which is a copper base solution for reliable transmission up to 10m and Fiber Based Transceiver solutions for significantly longer transmission distances only limited by the available fiber transceiver technologies.

Power is not provided over these cables and instead enters through the GPIO connector.



SFP28

The SFP28 port is a standard port for 25Gb Ethernet applications. SFP28 stands for “Small form-factor pluggable 28”.

SFP28 has some significant advantages over other Ethernet cabling options including a variety of cabling options including “Direct Attach” which is a copper base solution for reliable transmission up to 10m and Fiber Based Transceiver solutions for significantly longer transmission distances only limited by the available fiber transceiver technologies.

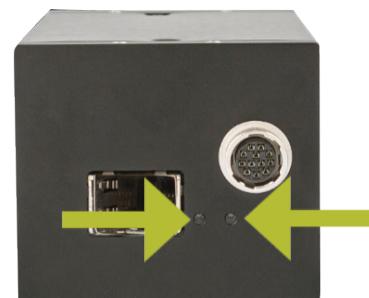
Power is not provided over these cables and instead enters through the GPIO connector.



LEDs

Two LEDs are present on the back of the camera and their functionality is as follows:

- Green LED: Simply indicates that the camera is powered and active.
This LED will always be steady on while the camera is powered.
- Yellow LED: Indicates Ethernet Rx and Tx activity.





GPIO

This port is used for carrying the GPIO signals as well as 12V power and ground signals from the Emergent supplied power supply. Only use Emergent supplied or approved power supply for connecting to the camera otherwise permanent damage could occur.

There are currently three variations of the IO but all of them are compatible with the Emergent power and IO accessories.

1. Area Scan IO (firmware 3.xx) (open camera in eCapture to see firmware version)
2. Area Scan IO (firmware 2.xx)
3. Line Scan IO



1. Area Scan IO (firmware 3.xx)

The pin-out of this port is as follows:

1	VEXT	External 12V Power (pins 1 and 2 are connected internally)
2	VEXT	External 12V Power (pins 1 and 2 are connected internally)
3	GPO_3	General Purpose Opto-Isolated Output
4	GPI_2	General Purpose Opto-Isolated Input
5	ISO_GND	Isolated Ground (reference ground for Opto-Isolated IO)
6	GPO_1	General Purpose Opto-Isolated Output
7	GPO_0	General Purpose TTL (0-5V) Output. Use GND as reference.
8	GND	Ground (pins 8 and 9 are connected internally)
9	GND	Ground (pins 8 and 9 are connected internally)
10	DNC	Do not Connect.
11	GPI_5	General Purpose Opto-Isolated Input
12	GPI_4	General Purpose TTL (0-5V) Input. Use GND as reference.

Looking into the back of the camera has the pins numbered and colored as follows:



2. Area Scan IO (firmware 2.xx)

The pin-out of this port is as follows:

1	VEXT	External 12VPower (pins 1 and 2 are connected internally)
2	VEXT	External 12VPower (pins 1 and 2 are connected internally)
3	GPO_3	General Purpose Opto-Isolated Output
4	GPO_2	General Purpose Opto-Isolated Output
5	ISO_GND	Isolated Ground (reference ground for Opto-Isolated IO)
6	GPO_1	General Purpose Opto-Isolated Output
7	GPO_0	General Purpose Opto-Isolated Output
8	GND	Ground (pins 8 and 9 are connected internally)
9	GND	Ground (pins 8 and 9 are connected internally)
10	NC	No Connect – not connected internally.
11	GPI_5	General Purpose Opto-Isolated Input
12	GPI_4	General Purpose Opto-Isolated Input

Looking into the back of the camera has the pins numbered and colored as follows:



3. Line Scan IO

The pin-out of this port is as follows:

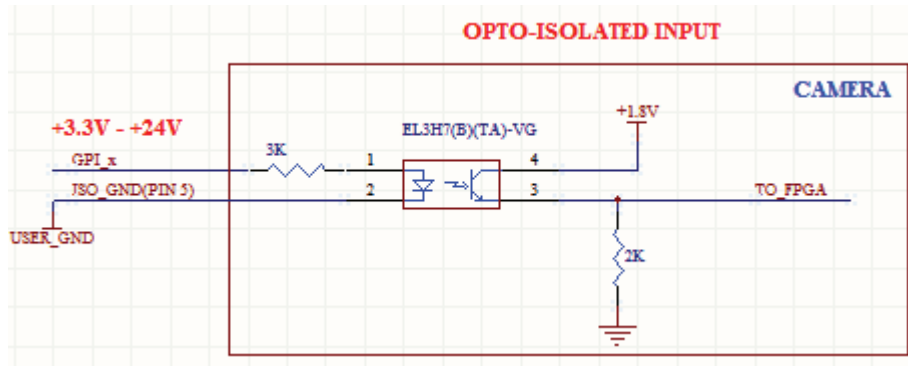
1	VEXT	External 12V Power (pins 1 and 2 are connected internally)
2	VEXT	External 12V Power (pins 1 and 2 are connected internally)
3	GPO_0	General Purpose Opto-Isolated Output
4	ENC_A_P	Encoder Ch A: RS422 Positive (LTC2855 Pin 11)
5	ISO_GND	Isolated Ground (reference ground for Opto-Isolated IO)
6	ENC_A_N	Encoder Ch A: RS422 Negative (LTC2855 Pin 10)
7	GPI_1	General Purpose Opto-Isolated Input
8	GND	Ground (pins 8 and 9 are connected internally)
9	GND	Ground (pins 8 and 9 are connected internally)
10	ENC_B_P	Encoder Ch B: RS422 Positive (LTC2855 Pin 11)
11	GPI_2	General Purpose Opto-Isolated Input
12	ENC_B_N	Encoder Ch B: RS422 Negative (LTC2855 Pin 10)

Looking into the back of the camera has the pins numbered and colored as follows:

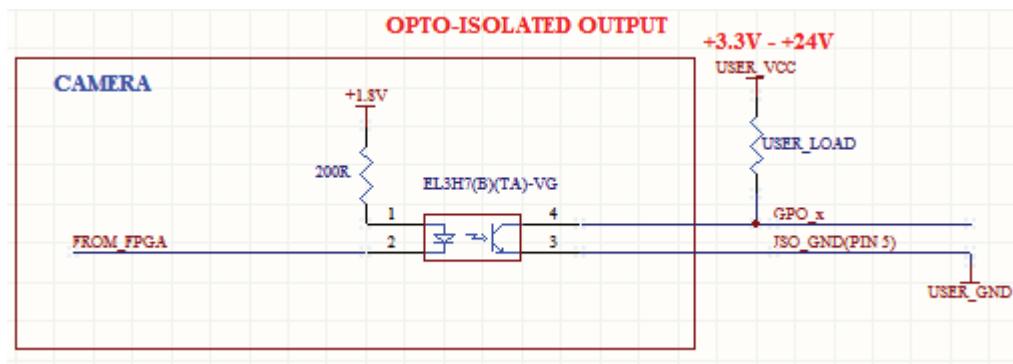


The simplified schematic of the Camera Opto-Isolated IO ports is as follows:

The input ports GPI_x are as follows:



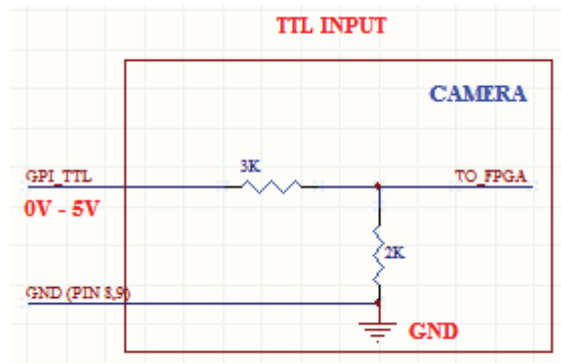
The output ports GPO_x are as follows:



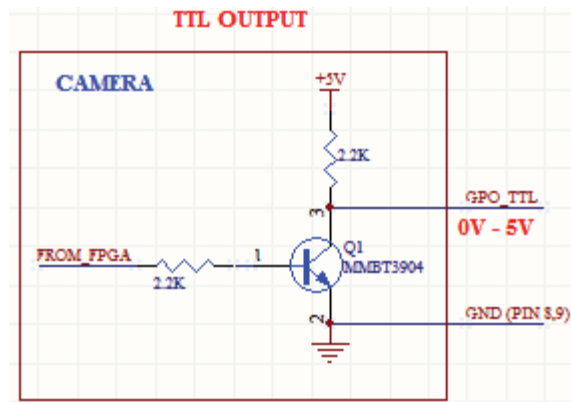
$R(\text{USER_LOAD})$ is chosen depending on USER_VCC with the desired output current. So, for a 24V USER_VCC and 10mA I_{out} , $R(\text{USER_LOAD}) = 24\text{V}/10\text{mA} = 2.4\text{K}$ (240mW package).

The simplified schematic of the Camera TTL IO ports is as follows:

The input ports GPI_x are as follows:

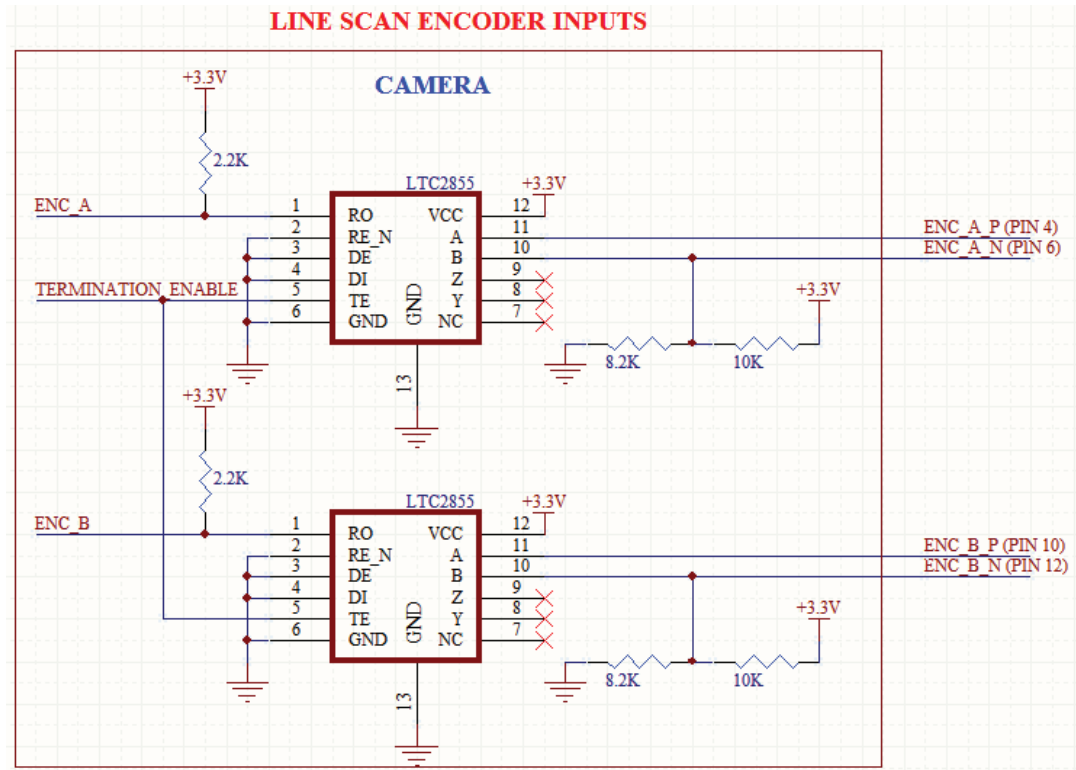


The output ports GPO_x are as follows:



For the TTL IO, it is important not to exceed +5.5V else IO damage could occur. These TTL options are provided for those needing a higher performance IO with low delay and jitter.

The schematic of the Line Scan Camera Encoder ports is as follows:



Power Adapter

This accessory is used when no GPIO is needed and thus simply powers the camera. Plug the 12-pin Hirose power connector into the camera 12-pin Hirose port.

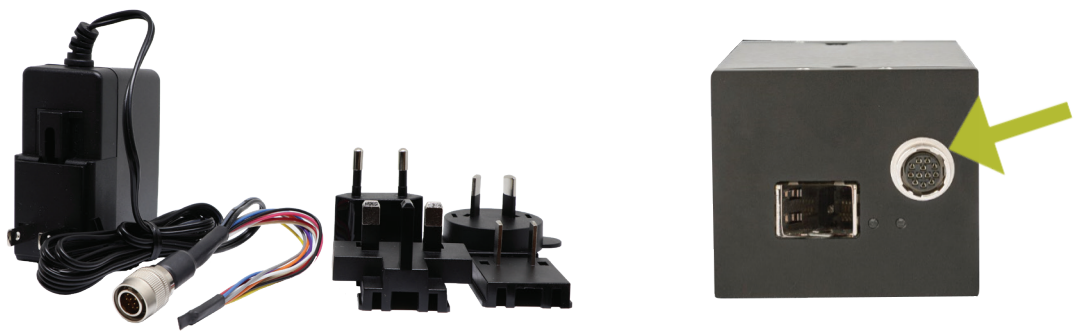
Part number: PWR



Power Adapter w/GPIO Breakout

This adapter is used to power the camera and supply unused IO via breakout. The 10cm long breakout wires are color coded and colors and signal descriptions are documented at the beginning of this section. Pins 1 and 9 are not provided but 12V VEXT and GND are provided through pins 2 and 8 for external use. Plug the 12-pin Hirose power connector into the 12-pin camera Hirose port.

Part number: PWR_BREAK

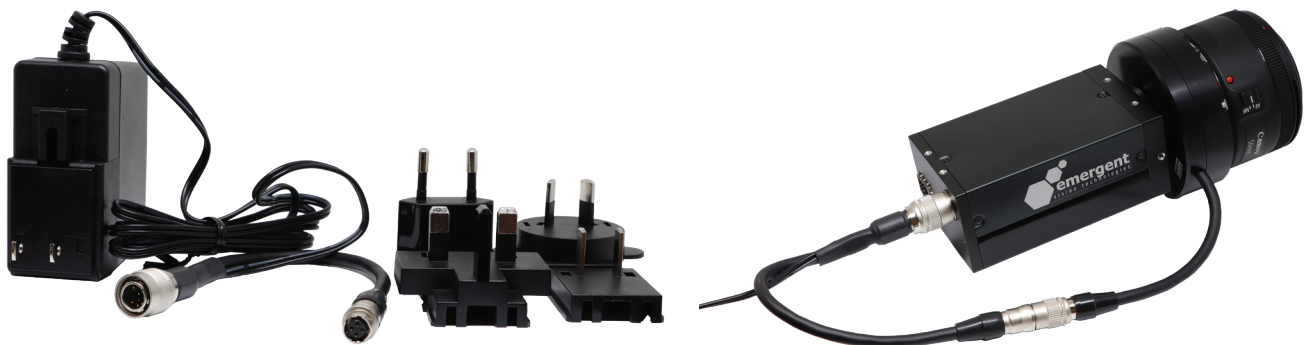


Power Adapter w/Birger EF Mount support

This adapter is used to supply power to camera and to also connect in the Birger EF adapter to support software-controlled Focus and Iris.

Plug the 12-pin Hirose connector into the camera 12-pin Hirose port and the 4-pin connector into the Birger Mount assembly 4-pin connector.

Part number: PWR_BIRGER



Power Adapter w/Birger EF Mount support w/GPIO Breakout

This adapter is used to supply power to the camera, connect in the Birger EF adapter to support software-controlled Focus and Iris, and to also supply unused IO via breakout cabling. On all cameras, GPO_3 and GPI_5 will be used for Birger support so all but these IO are available to the user via the 10cm flying leads. The breakout wires are color coded and colors and signal descriptions are documented at the beginning of this section. Pins 1 and 9 are not provided but 12V VEXT and GND are provided through pins 2 and 8 for external use. Plug the 12-pin Hirose connector into the camera Hirose port and the 4-pin connector into the Birger Mount assembly 4-pin connector.

Part number: PWR_BREAK_BIRGER



GPIO Breakout Cable

This adapter is used to make all Hirose 12-pin power input and IO fully available to the user. The 10cm breakout wires are color coded and colors and signal descriptions are documented at the beginning of this section. Note that the 12V power supply must still be Emergent approved. Plug the 12-pin Hirose breakout connector into the camera 12-pin Hirose port.

Part number: GPIO_BREAK



GPIO Area Scan Triggering Options

External hardware triggering can be implemented in a few different ways using Emergent camera products.

The system designer can provide an external signal (called EXT TRIG in the timing diagrams below) and this signal can be connected for example to the GPIO signal GPI_4 to fully control and synchronize the camera exposure to some external process. In all cases of hardware triggering, the user would set the camera registers as follows:

- TriggerMode = On (enum)
- TriggerSource = Hardware (enum)

Additional settings are needed as below depending on the specific hardware triggering mode.

To generate exposures that are based on with the width of the trigger and using GPI_4 for this EXT TRIG signal we would set the camera registers as follows:

- GPI_Start_Exp_Mode = GPI_4 (enum)
- GPI_Start_Exp_Event = RisingEdge (enum)
- GPI_End_Exp_Mode = GPI_4 (enum)
- GPI_End_Exp_Event = FallingEdge (enum)



Figure 1

For the next timing diagram, a user may wish to have an exposure started some fixed time period after the EXT TRIG signal. In this case, we would additionally set the Trigger_Delay register as follows:

- Trigger_Delay = 100 (measured in us)

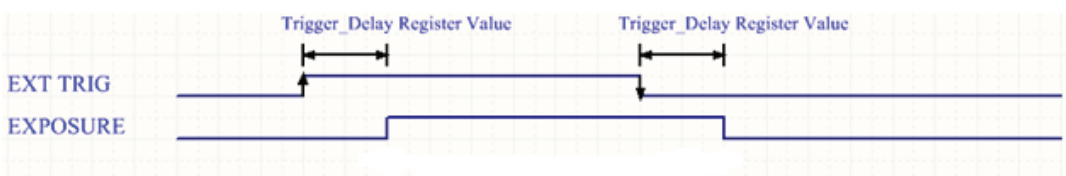


Figure 2

To generate exposures which are based on the internally generated exposure counter but have the beginning of the exposure triggered by an external signal. For this, we would set up the registers as follows:

GPI_Start_Exp_Mode = GPI_4 (enum)

GPI_Start_Exp_Event = RisingEdge (enum)

GPI_End_Exp_Mode = Internal (enum)

And, again, this mode can utilize the Trigger_Delay feature if needed to accomplish the timing also shown in this figure:

Trigger_Delay = 100 (measured in us)

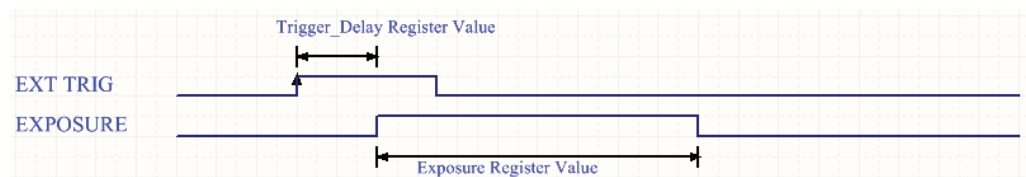


Figure 3

Some camera systems may wish to synchronize multiple cameras and yet have no external triggering signal to work with. The Test Generator feature can be used to output from a camera GPIO output port a programmable signal in both duty cycle (set high time) and period. For this, the registers are set as follows (for example to use GPO_0):

GPO_0_Mode = Test_Generator(enum)

GPO_0_Polarity = TRUE (Bool) (Positive or negative)

TG_Frame_Time = 16000 (us) (ie. or 62.5 fps)

TG_High_Time = 1000 (us) (ie. to set exposure of 1ms)

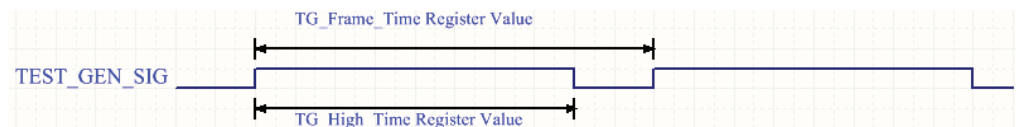


Figure 4

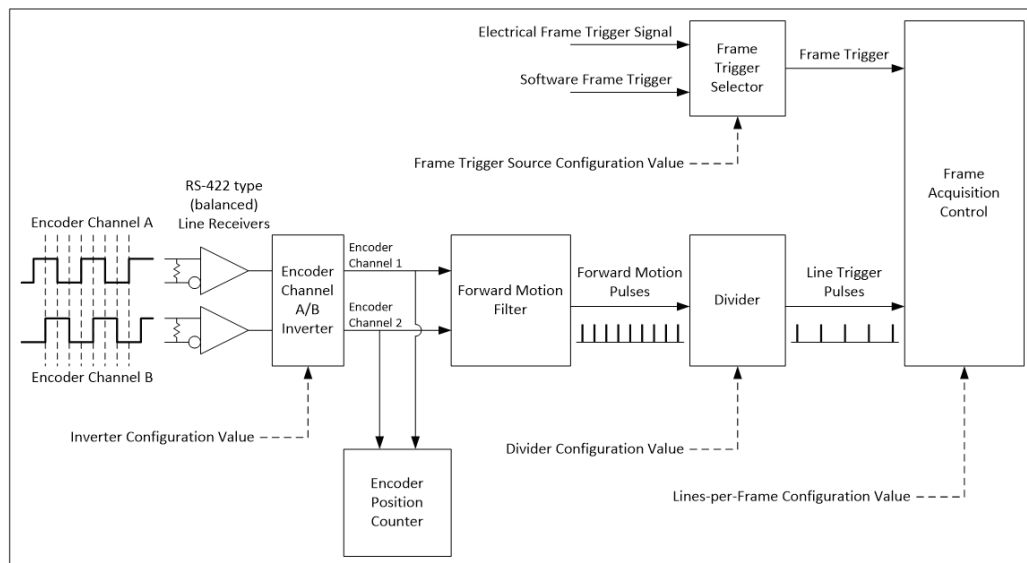
This signal can feed other GPI_n input triggering signals including its own GPI_n signal. Other options of GPO usage are as follows and can be used to synchronize external system components to a camera exposing in Continuous (non-external trigger mode).

Each GPO_n signal can be programmed with any of the following options:

- Exposure: To alert the system that the camera is exposing.
- Readout: To alert the system that the camera is reading out data from the ccd.
- GPO: With this option, the GPO_n signal will be set by the GPO_n_Polarity signal.
- Test_Generator: As described above.

GPIO Line Scan Triggering Options

The following block diagram illustrates the overall line scan triggering functionality.



External hardware triggering can be implemented in a few different ways using Emergent Line Scan camera products. This all comes down to the Line Scan mode desired which are described in the following sections.

A) All internal triggering

This mode allows the user to simply open the camera and click AcquisitionStart to begin grabbing frames. The default settings enable this mode.

In this mode, the user can adjust FrameRate, LineTime, and Exposure parameters to control acquisition.

B) External Trigger (still internal parameter line time control)

This mode uses a single external hardware trigger to start each frame but uses internal line time counter to control timing of line acquisition.

Configure the camera as follows:

- TriggerMode = On
- TriggerSource = Hardware
- GPI_Start_Frame_Mode = GPI_1 (ie) (or GPI_2)
- GPI_Start_Frame_Event = Rising_Edge (ie) (or Falling_Edge)
- GPI_1_Debounce_Count = 50000 (ie)

The user can adjust LineTime and Exposure parameters to control acquisition but the Frame_Rate parameter is now ignored.

C) External Trigger, Encoder line time control

This mode uses an external trigger to start each frame but uses an external encoder to control timing of line acquisition.

Configure the camera as follows:

- TriggerMode = On
- TriggerSource = Hardware
- GPI_Start_Frame_Mode = GPI_1 (ie) (or GPI_2)
- GPI_Start_Frame_Event = Rising_Edge (ie) (or Falling_Edge)
- GPI_1_Debounce_Count = 50000 (ie)
- GP_ENC_MODE = On
- GP_ENC_LINE_DIVIDER = 4

(last parameter is set for proper aspect ratio since 4 phases per encoder cycle)

The user can adjust Exposure parameter to control acquisition.

In this mode, LineTime and FrameRate parameters are ignored.

D) Encoder line time and frame time control,
Frame start trigger from divided encoder counts (ie. 24000).
This mode uses an external encoder to start each frame and to also control timing of line acquisition.

Configure the camera as follows:

```
TriggerMode = On
TriggerSource = Hardware
GPI_Start_Frame_Event = Encoder_Frame_Divider
GP_ENC_FRAME_DIVIDER = 24000
(ie. encoder has 24000 pulses per rotation so one trigger per rotation)
GP_ENC_LINE_DIVIDER = 4
(ie. for proper aspect ratio since 4 phases per enc cycle)
GP_ENC_MODE = On
```

The user can adjust Exposure parameter to control acquisition.
In this mode, LineTime and FrameRate parameters are ignored.

E) External Trigger pulse, Encoder line time control
In this mode, the rising edge of an external trigger signal starts frame capture.
Subsequent frames are started once encoder counter reaches its limit and the external trigger signal is still high. The line time is controlled with encoder pulses as in other modes.

```
TriggerMode = On
TriggerSource = Hardware
GPI_Start_Frame_Mode = GPI_1 (ie) (or GPI_2)
GPI_Start_Frame_Event = Pulse_High or Pulse_Low
GPI_1_Debounce_Count = 50000 (ie)
GP_ENC_FRAME_DIVIDER = 24000
(ie. encoder has 24000 pulses per rotation so one trigger per rotation).
(This defines the frame time while pulse is high/low).
GP_ENC_LINE_DIVIDER = 4
(for proper aspect ratio since 4 phases per enc cycle)
GP_ENC_MODE = On
```

The user can adjust Exposure parameter to control acquisition.
In this mode, LineTime and FrameRate parameters are ignored.



Document History

Version	Date	Description
1.01	29 May 2012	Initial Version
1.02	3 Mar 2013	Adding Linux Details
1.03	10 Dec 2013	Clarified IP configuration, added PCIe slot requirements.
1.04	16 July 2014	Added 2.x.x software notes
1.05	4 Sept 2014	Added additional warning for GPIO pinout
1.06	22 Jan 2015	Reworked GPIO pin-out to match Hirose numbering
1.07	15 July 2019	Rewrite