

1K x 1K Progressive Scan Monochrome Camera

Pantera TF 1M60 and 1M30



DS-21-01M60

DS-1A-01M30

DS-22-01M60

DS-1B-01M30

User's Manual and Reference

DALSA
technology with vision

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1

Introduction to the Pantera TF 1M60 and 1M30 Area Scan Cameras

1.1 Camera Highlights

Features

- 1024 x 1024 resolution, TrueFrame™ CCD architecture
- The Pantera TF 1M60 offers 60 fps, two outputs at full resolution, 40 MHz data rate
- The Pantera TF 1M30 offers 30 fps, one output at full resolution, 40 MHz data rate
- 12-bit digitization
- High sensitivity with low dark current
- Progressive scan readout
- Exposure control and antiblooming
- Asynchronous image capture, externally triggerable
- Tap to tap matching
- 100% fill factor
- Single 12V to 24V power supply
- Multiple triggering options
- Four vertical binning modes: 1, 2, 4, and 8
- Four horizontal binning modes: 1, 2, 4, and 8

Programmability

- Simple ASCII protocol controls gain, offset, frame rates, trigger mode, test pattern output, up to 8x8 binning, and camera diagnostics

- Serial interface (ASCII, 9600 baud, adjustable to 19200, 57600, 115200), through Camera Link™

Description

The Pantera TF 1M60 and 1M30 digital cameras provide high-sensitivity 12-bit images with a 1k x 1k spatial resolution. The cameras use DALSA's TrueFrame progressive scan CCDs to simultaneously achieve outstanding resolution and gray scale characteristics. A square pixel format and high fill factor provide superior, quantifiable image quality even at low light levels.

Applications

The Pantera TF 1M60 and 1M30 are outstanding performers in fast, very high resolution applications. 12 bit performance provides up to 4096 distinct gray levels – perfect for applications with large interscene light variations. The low-noise, digitized video signal also makes the camera an excellent choice where low contrast images must be captured in challenging applications.

Models

The Pantera TF 1M60 and 1M30 cameras are available in these models.

Table 1: Camera Models Overview

Model Number	Description
DS-21-01M60	Programmable 1 or 2 taps, up to 60fps.
DS-1A-01M30	1 tap, up to 30fps
DS-22-01M60	Programmable 1 or 2 taps, up to 60fps, no glass sensor.
DS-1B-01M30	1 tap, up to 30fps, no glass sensor.

Note: If the camera has a non-standard cover glass (e.g. taped) the warranty is void on the CCD.

1.2 Image Sensor

The FTT 1010-M is a monochrome progressive-scan frame-transfer image sensor offering 1K x 1K pixels at up to 60 frames per second. The combination of high speed and a high linear dynamic range (~12 bits at room temperature without cooling) makes this device the perfect solution for high-end real time medical X-ray, scientific, and industrial applications. The Pantera TF 1M60 offers frame rates at up to 60 frames per second using two output taps to simultaneously read out data. The Pantera TF 1M30 offers frame rates up to 30 frames per second through a single output tap. The device structure is shown in Figure 1.

Optical Interface	Units		Notes
Back Focal Distance M42 Mount	mm	6.5mm	
Lens Mount		C or F mount adapters	
Camera Thread		M42x1	
Aperture	mm	14.34 x 14.34	
Sensor Alignment			
x, y	μm	±400	
z	mm	± 0.30mm	
Θz	°	±1.25	
Parallelism/Tilt	μm	<175 over sensor	
Sensor Flatness	μm	10 peak-peak	

Camera Performance	Units	Min.	Nom.	Max.	Notes
Frame Rate	fps			30 (1M30) 60 (1M60)	2
Data Rate	MHz	40		40	
Data Format		8 bit		12 bit	8,10, or 12 bit user selectable.
Operating Temp	°C	0		40	At front plate.
Nominal Gain Range		1x		4x	1x, 2x, or 4x gain user selectable
Dynamic Range	dB DN:DN	66 2057:1			
Pixel Response Non-Uniformity (PRNU)	%rms			<5	
FPN	%rms			<3.8	
Random Noise	DN rms		1.2	1.75	
Sat. Output Amplitude	DN	3600	3900	4095	1
DC Offset	DN	45	50	52	1
Antiblooming				>100x	1
Responsivity	DN/(nJ/cm ²)			40@540 nm	1
Power Up Duration	sec			10	

Regulatory	
Regulatory Compliance	CE

Notes:

1. Nominal output. Light source: broadband quartz halogen, 3200K, 750nm and IR cutoff filter.
2. No binning, full resolution, and Exposure Control disabled.

Test conditions unless otherwise noted:

- Pixel Rate: 40 MHz
- Exposure Mode 7: 1x1 binning, 1x gain, 60 fps, ECD, internal SYNC, 12 bit
- Light Source: Broadband Quartz Halogen, 3250K, with 500-600 nm bandpass filter installed
- Ambient test temperature 25°C

Figure 2: Pantera TF 1M60 and 1M30 Responsivity

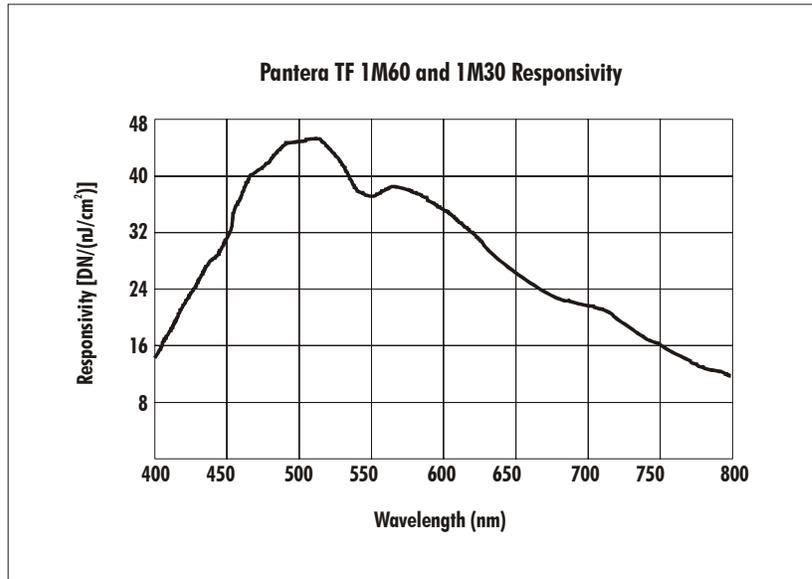


Figure 3: Typical Normalized Noise vs Ambient Temperature

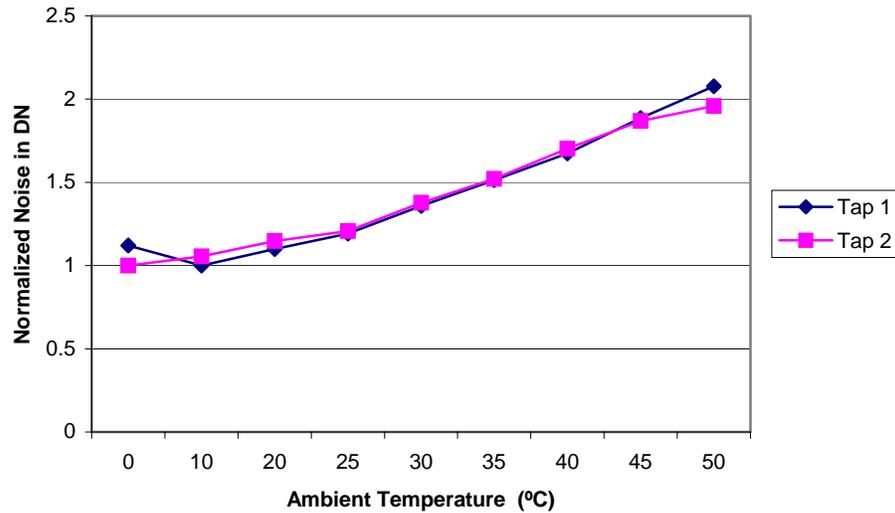


Figure 4: Typical Dark Offset vs Temperature

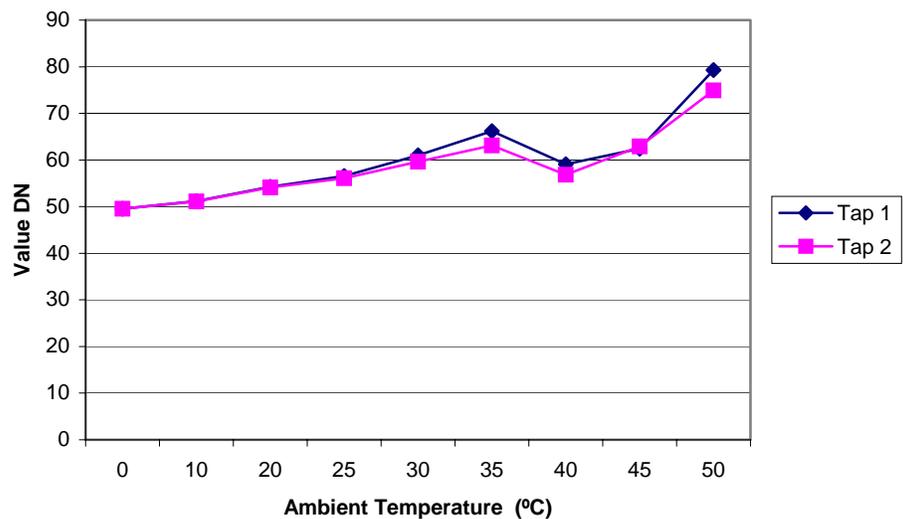
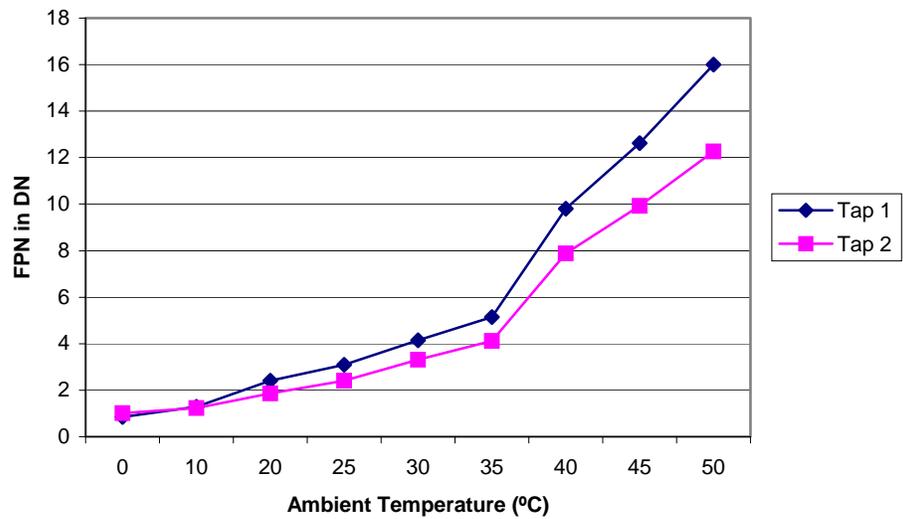


Figure 5: Typical FPN vs Temperature



2

Camera Hardware Interface

2.1 Installation Overview

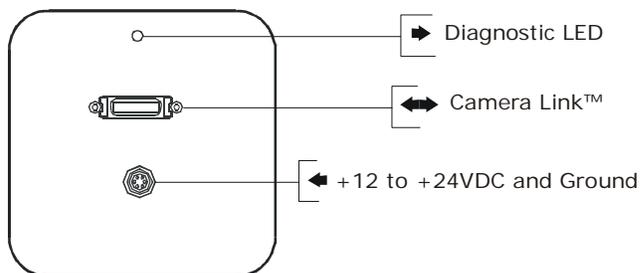
This installation overview assumes you have not installed any system components yet.

In order to set up your camera, you should take these initial steps:

1. Power down all equipment.
2. Following the manufacturer's instructions, install the framegrabber (if applicable). **Be sure to observe all static precautions.**
3. Install any necessary imaging software.
4. Before connecting power to the camera, test all power supplies. **Ensure that all the correct voltages are present at the camera end of the power cable** (The Camera Performance Specifications on page 7 list appropriate voltages). Power supplies must meet the requirements defined in section 2.4 Power Input.
5. Inspect all cables and connectors prior to installation. Do not use damaged cables or connectors or the camera may be damaged.
6. Connect data, serial interface, and power cables.
7. After connecting cables, apply power to the camera. After a few seconds, the LED on the back of the camera should be green to indicate that the camera is operating and ready to receive commands.

2.2 Input/Output

Figure 6: Camera Inputs/Outputs



2.3 LED Status Indicator

Table 3: Status LED

Color of Status LED	Meaning
Flashing Green	Camera Initialization
Solid Green	Camera Ready
Flashing Red	Fatal Error
Solid Red	Warning, such as firmware did not load or voltage out of limit

2.4 Connectors

The camera uses a:

- high-density 26-pin MDR26 connector for Camera Link control signals, data signals, and serial communications. Refer to Figure 7: MDR26 Connector for pin descriptions.
- 6-pin Hirose connector for power. Refer to page 14 for pin descriptions.

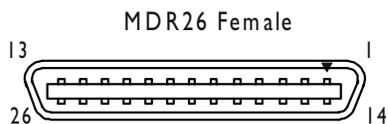
2.4.1 Camera Link Data Connector

The Camera Link interface is implemented as a Base Configuration in the Pantera TF 1M60 and 1M30 cameras. A Base Configuration uses 1 MDR26 connector and 1 Channel Link chip. The main characteristics of the Base Configuration are:

- Ports supported: A, B, C
- Serializer bit width: 28
- Number of chips: 1
- Number of MDR26 connectors: 1

Data Connector

Figure 7: MDR26 Connector



Mating Part: 3M 334-31 series

Cable: 3M 14X26-SZLB-XXX-0LC**

Table 4: MDR26 Connector Reference

Item	Value	Item	Value
Pinout	BASE	Pinout	BASE
1	GND	14	GND
2	X0-	15	X0+
3	X1-	16	X1+
4	X2-	17	X2+
5	Xclk-	18	Xclk+
6	X3-	19	X3+
7	SERTC+	20	SERTC-
8	SERTFG-	21	SERTFG+
9	CC1-	22	CC1+
10	CC2+	23	CC2-
11	CC3-	24	CC3+
12	CC4+	25	CC4-
13	GND	26	GND

Notes:

*Exterior Overshield is connected to the shells of the connectors on both ends.

**3M part 14X26-SZLB-XXX-0LC is a complete cable assembly, including connectors. Unused pairs should be terminated in 100 ohms at both ends of the cable.

Table 5: DALSA Camera Control Configuration

Signal	Configuration
CC1	EXSYNC
CC2	Spare
CC3	Spare
CC4	Spare

Digital Data

The camera digitizes internally to 12 bits and has a user selectable output of 8, 10, or 12 bits in LVDS format on the Camera Link connector. You can select the output using the `oms` command. For details, see section 3.5 Setting the Data Mode.

Data Clocking Signals

These signals indicate when data is valid, allowing you to clock the data from the camera to your acquisition system. These signals are part of the Camera Link configuration and you should refer to the DALSA Camera Link Implementation Road Map, available at , http://vfm.dalsa.com/docs/appnotes/00450-00_03-32_DALSA_Camera_Link_Road_Map.pdf, for the standard location of these signals:



IMPORTANT:

This camera's data should be sampled on the rising edge of STROBE.

Clocking Signal	Indicates
LVAL (high)	Outputting valid line
DVAL (high)	Valid data
STROBE (rising edge)	Valid data

See Appendix A for the complete Camera Link timing, DALSA Camera Link configuration table, and refer to the DALSA Web site, http://vfm.dalsa.com/docs/appnotes/00450-00_03-32_DALSA_Camera_Link_Road_Map.pdf, for the official Camera Link document.

2.4.2 Power Connector

Hirose 6-pin Circular Male



Mating Part: HIROSE
HR10A-7P-6S

Pin	Description	Pin	Description
1	+12VDC to +24VDC	4	GND
2	+12VDC to +24VDC	5	GND
3	+12VDC to +24VDC	6	GND

The camera requires a single voltage input (+12VDC to +24VDC). The camera meets all performance specifications using standard switching power supplies, although well-regulated linear supplies provide optimum performance.

When setting up the camera's power supplies follow these guidelines:

- Protect the camera with a fast-blow fuse between power supply and camera.
- Do not use the shield on a multi-conductor cable for ground.
- Keep leads as short as possible to reduce voltage drop.
- Use high-quality **linear** supplies to minimize noise.

Note: Performance specifications are not guaranteed if your power supply does not meet these requirements

WARNING: It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage the camera. Protect the camera with a fast-blow fuse between power supply and camera.

Visit the www.dalsa.com Web site for a list of companies that make power supplies that meet the camera's requirements. The companies listed should not be considered the only choices.

2.5 Control Inputs

The camera accepts an EXSYNC control input through the Camera Link MDR26F connector. External control signals are optional and enabled through the serial interface.

EXSYNC (Triggers Line Readout)

EXSYNC is an optional input signal that can be used to trigger the line readout rate. Depending on the camera's exposure mode setting, it can use either the rising or falling edge of EXSYNC to trigger line readout. Refer to the following table for details.

Table 6: EXSYNC Edge Description

Mode	EXSYNC Edge Description
4	The rising edge of EXSYNC begins camera integration. The falling edge completes integration.
3	The falling edges of EXSYNC define the frame time.
6	The falling edge of EXSYNC initiates camera integration.

For more information on camera exposure modes, including timing diagrams, refer to section 3.7 Setting Frame Rate, Exposure Time, and Exposure Mode on page 20.

NOTE: EXSYNC should not be clocked faster than the camera's specified maximum frame rate. The camera ignores the EXSYNC pulse until it has completed reading the last line out.

3

Software Interface: How to Control the Camera



This chapter outlines the more commonly used commands. See Appendix B for a list of all available commands.

All camera features can be controlled through the serial interface. The camera can also be used without the serial interface after it has been set up correctly. This chapter explains the most commonly used and important commands, including:

- Saving and restoring settings, described on page 19.
- Setting the output mode, described on page 19.
- Setting the exposure mode and frame rate, described on page 20.
- Setting gain, described on page 27.

The serial interface uses a simple ASCII-based protocol. For a complete list of all available commands, refer to the Communications Protocol on page 55.

Online Help

For quick help, the camera can return all available commands and parameters through the serial interface. To generate this list, send the command `h` to the camera.

Retrieving Camera Settings

To read current camera settings, send the command `gcp`.

3.1 Communications Protocol Overview

Serial Protocol Defaults:

- 8 data bits
- 1 stop bit
- No parity
- No flow control
- 9.6Kbps

- Camera does not echo characters

When entering commands, remember that:

- A carriage return (CR) ends each command. The linefeed character is ignored.
- The camera will answer each command with either "OK >" or "Error x: Error Message >". The ">" is always the last character sent by the camera.
- The following parameters are used throughout the manual:

i = integer
f = float
t = tap
[] = optional parameter

3.2 Overview: Setting up the Camera to Send Commands

The following steps describe how to begin using the Pantera TF 1M60 and 1M30 commands.

1. If you have not already set up your camera cables, connect your cables as described in section 2.1 Installation Overview.
2. Using a terminal program (e.g., Microsoft HyperTerminal), open a terminal window.

Note: In order to communicate with the camera, a serial connection in the Camera Link cable needs to be established. The framegrabber manufacturers should be able to provide a solution in order to communicate through this serial link. The terminal software can be also provided by the framegrabber manufacturer. Standard terminal software such as HyperTerminal can be used in case if COM port is allocated by the framegrabber.

Terminal should be set at 9600 baud during the camera power up.

3. When the terminal window is set up, power on the camera.
4. The boot-up message should appear on the terminal window:

```
Camera Initialization in progress, Please Wait ...
```

```
OK>
```

You can now communicate with the camera through the terminal using the software commands described in this manual.

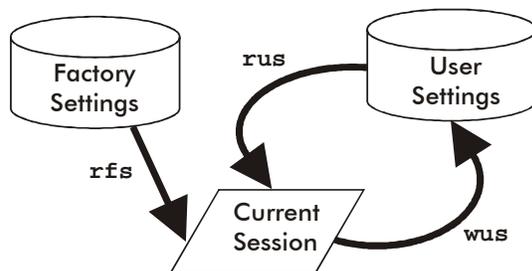
5. Set up the framegrabber to receive the data. Following the framegrabber manufacturer's instructions, set up the parameters described in the Camera Link™ Configuration Table on page 52.
6. Once the framegrabber is set up for data processing and the camera is powered up, run your image processing software. You should be able to see an image from the camera when exposed to a light source.
7. You can now set the other camera parameters described in this chapter.

3.3 Saving and Restoring Settings

The camera provides a number of commands for restoring, storing, and saving settings.

- To restore the original factory settings, use the command **rfs**.
- To save all current user settings to EEPROM, use the command **wus**. The camera will automatically restore the saved user settings when powered up.
- To restore the last saved user settings, use the command **rus**.

Figure 8: Saving and Restoring Overview



3.4 Setting Output Mode (1M60 Only)

The Pantera TF 1M60 has two data output taps (or channels). You can configure the camera to read out data using a single tap or you can double your frame rate by simultaneously reading out of both taps. **This command is not available in the Pantera TF 1M30.**

To select dual or single output mode, use the command:

Syntax: `sos i`

Syntax Elements: `i`

0 Single tap readout, maximum 30 fps

1 Dual tap readout, maximum 60 fps (factory setting)

Related Commands: `sec`

Example: `sos 0`

3.5 Setting the Data Mode

The Pantera TF 1M60 contains two output taps, each are 12 bits. The 24 bits of data (two taps) that are sent from the camera to the frame grabber are divided into three ports: A, B, and C. Each port is 8 bits. The **oms** command selects the number of bits that the camera sends to the frame grabber from each tap. In the table below, ports A-C refer to the Camera Link specification.

The Pantera TF 1M30 contains one output tap that sends 12 bits of data.

To set the data mode for the camera output, use the command:

Syntax: `oms i`

Syntax Elements: `i`

- 12** 12 bit (Factory setting),
 - Tap 1 Data bits 0 to 7 are linked to Port A
 - Tap 1 Data bits 8 to 11 are linked to Port B bits 0 to 3
 - Tap 2 Data bits 8 to 11 are linked to Port B bits 4 to 7 (1M60 only)
 - Tap 2 Data bits 0 to 7 are linked to Port C (1M60 only)
- 10** 10-bit,
 - Tap 1 Data bits 0 to 7 are linked to Port A
 - Tap 1 Data bits 8 and 9 are linked to Port B bits 0 and 1
 - Tap 2 Data bits 8 and 9 are linked to Port B bits 4 and 5 (1M60 only)
 - Tap 2 Data bits 0 to 7 are linked to Port C (1M60 only)
- 8** 8-bit,
 - Tap 1 Data bits 0 to 7 are linked to Port A
 - Tap 2 Data bits 0 to 7 are linked to Port B (1M60 only)

Notes:

- To obtain the current output data format, use the command `gcp`

Example: `oms 8`

3.6 Setting Baud Rate

To set the speed of the camera serial communication port, use the command:

Syntax: `sbr i`

Syntax Elements: `i`

Baud rate. Available baud rates are: **9600** (Default), **19200**, **57600**, and **115200**.

Notes:

- Power-on rate is always 9600 baud.
- The `rc` (reset camera) command will *not* reset the camera to the power-on baud rate.

Example: `sbr 57600`

3.7 Setting Frame Rate, Exposure Time, and Exposure Mode

With five different exposure mode settings, the Pantera TF 1M60 and 1M30 deliver many possibilities for flexible camera timing. Table 7 outlines each of these five exposure modes, and is followed by a full explanation on how to set the camera's frame rate and exposure time.

Table 7: Overview of Pantera TF 1M60 and 1M30 Exposure Modes

Mode	SYNC	Exposure Time	Exposure Control	Notes
2	-Internal -Programmable using the ssf command.	-Programmable with set command	-Not programmable -Enabled -Maximum frame rate of 57 fps (1M60)	The parameter being programmed (i.e. Frame rate or Exposure time) will be the driving factor so that when setting frame rate, exposure time will change to accommodate the new frame rate and visa-versa. <i>Factory Setting.</i>
3	-External	-Not programmable -Maximum exposure time	-Programmable using the sec command	Disabling exposure control allows the 1M60 camera to operate at a maximum of 60 fps. When exposure control is enabled, the maximum 1M60 frame rate is 57 fps.
4	-External	-Not programmable -Exposure time is the inverse of the frame time	-Not programmable -Enabled -Maximum frame rate of 57 fps (1M60)	"Smart EXSYNC" Mode: external exposure time - high time of external signal is exposure time and 1/period is frame rate.
5	N/A			
6	-External	-Programmable with set command	-Not programmable -Enabled -Maximum frame rate of 57 fps (1M60)	The user is responsible for not violating timing constraints for the external sync signal used in this mode.
7	-Internal -Programmable using the ssf command	-Not programmable -Maximum exposure time	-Not programmable -Disabled -Maximum frame rate of 60 fps (1M60)	

Overview: Setting Frame Time and Exposure Time

The camera's frame rate (synchronization) can be generated internally through software commands or input externally from a frame grabber/host system. To select how you want the camera's frame rate to be generated:

1. You must first set the camera mode using the **sem** command. Refer to Step One on the next page for details.
2. If operating in exposure mode 3, use the command **sec** to enable or disable exposure control.

- Then, when applicable, use the commands **ssf** (mode 2 or 7) to set the frame rate and/or **set** (mode 2 or 6) to set the exposure time. Refer to Step Two on page 25 for details.

3.7.1 Step 1: Setting the Exposure Modes

In internal sync modes, (modes 2 and 7), the camera delivers, independent of external signals, data according to the timing set internally. In external sync modes (modes 3, 4, and 6), the camera starts integration after an external trigger pulse.

To set the camera exposure mode, use the command:

Syntax: **sem i**

Syntax Elements: **i**

Exposure mode to use. Default is 2.

- Notes:
- Refer to Table 7 for a quick list of available modes or to the following sections for a more detailed explanation.
 - To obtain the current value of the exposure mode, use the command **gcp**.

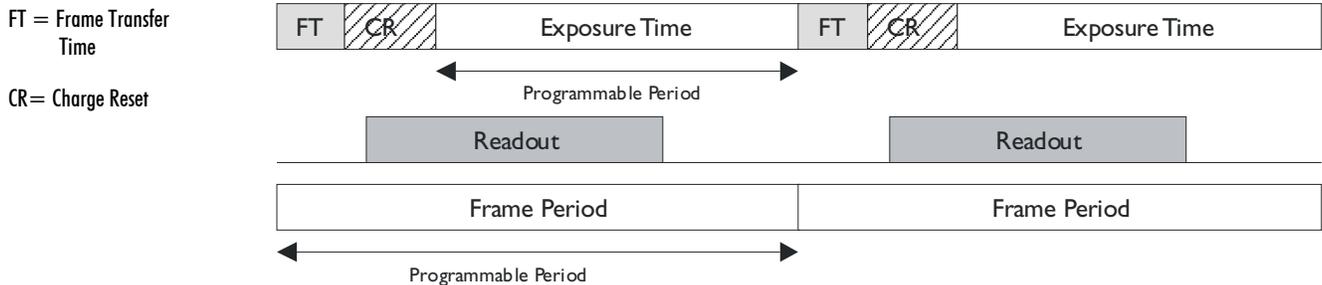
Related Commands: **ssf, set**

Example: **sem 3**

Mode 2: Internally Programmable Frame Rate and Exposure Time

When setting the frame rate (using the **ssf** command), exposure time will change to accommodate the new frame rate. The exposure time will always be set to the maximum time (frame period - frame transfer time - charge reset time) for that frame rate when a new frame rate is entered.

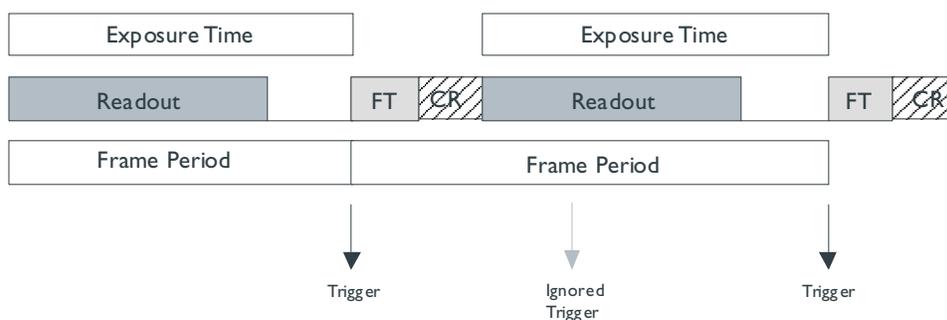
Example 1: Exposure Time less than Frame Period



Mode 3: External Trigger with Maximum Exposure

Frame rate is set by the period of the external trigger pulses. Since there is no electronic shuttering, any trigger pulses faster than the read out time are ignored. The falling edge of the external trigger marks the beginning of the exposure.

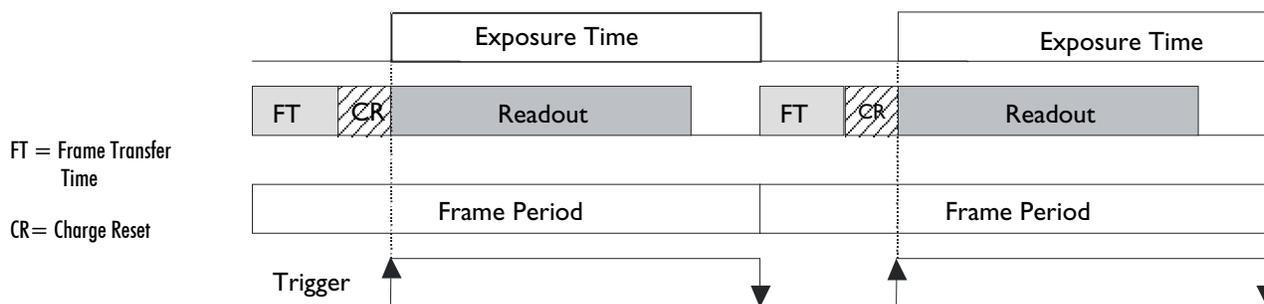
During the frame transfer state, 1030 lines are transferred down from the sensor's image area to the storage area (see Figure 1: FTT 1010-M Image Sensor for sensor architecture). If you are operating the camera with exposure control enabled (see page 25 for an explanation on how to disable or enable exposure control), an extra line is transferred to the storage area. While the last line is being transferred, the charge reset also occurs.

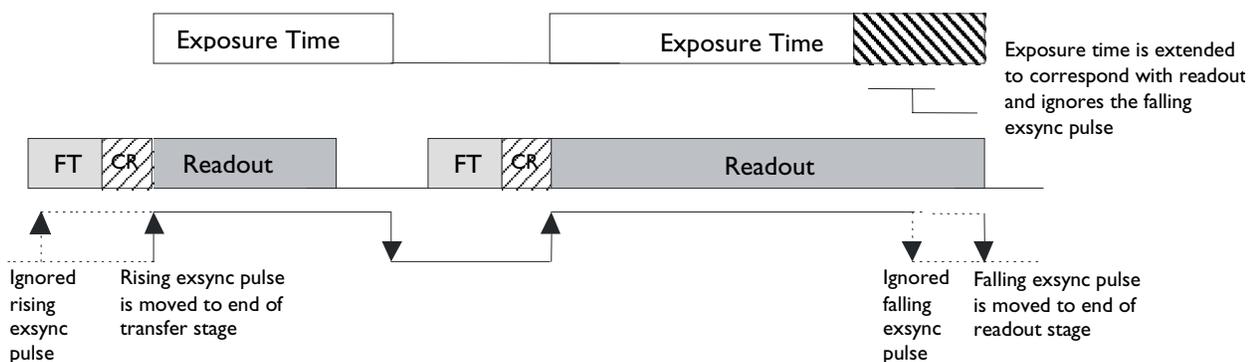
Example 2: Frame Rate is set by External Trigger Pulses.**Mode 4: Smart EXSYNC, External Frame Rate and Exposure Time**

In this mode, the external trigger rate sets both the frame rate and the exposure time. The rising pulse of the external trigger marks the beginning of the exposure and the falling edge ends the exposure and initiates frame transfer. During frame transfer, 1030 lines of data are transferred down from the image area to the storage area of the sensor (see Figure 1: FTT 1010-M Image Sensor for sensor architecture). After the frame transfer had completed, one more line is transferred down and the charge reset occurs, initiating readout.

Restrictions:

- At the end of the exposure time, the collected data will be transferred to the readout area only if it is not already in the process of reading out. If readout is already in process, the exposure time will be extended until the readout is finished
- If the rising edge of the exsync signal occurs during the frame transfer stage, the pulse is moved to the end of the frame transfer.

Example 3: Trigger Period is Repetitive and Greater than Read Out Time.

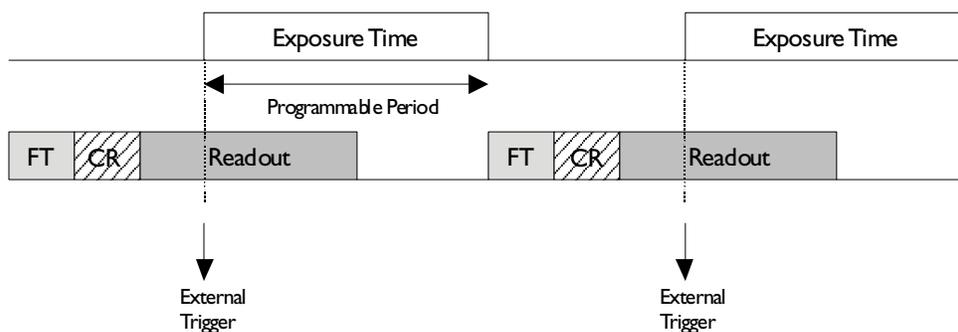
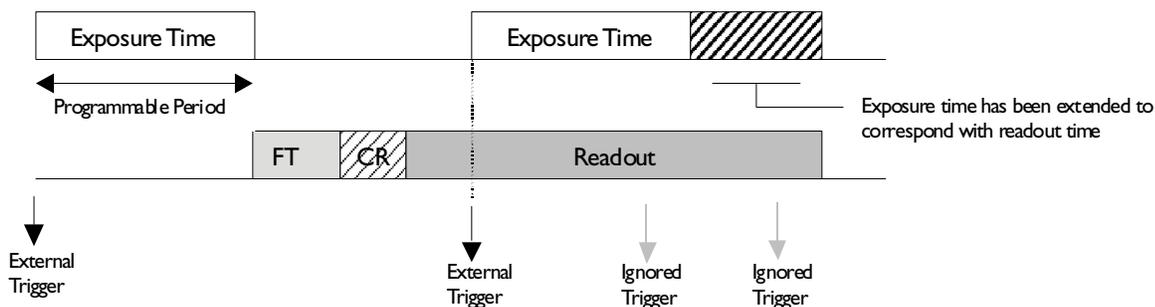
Example 4: Trigger Period is Intermittent and Occasionally Shorter than Read Out Time.

Note: The Pantera TF 1M60 and 1M30 do not use Mode 5.

Mode 6: External Frame Rate and Internal Exposure Time

This mode differs according to the trigger rate and the exposure time setting. However, the following rules apply to any condition:

- Any additional external triggers occurring during the exposure time will be ignored.
- All non-ignored external triggers will pulse an electronic shutter to dump any current exposure data at the start of the trigger pulse and start the exposure time.
- At the end of the exposure time, the collected data will be transferred to the readout area **only** if it is **not** already in the process of reading out. If readout is already in process, the exposure time will be extended until the readout is finished, as is illustrated in Example 6.

Example 5: Trigger Period is Repetitive and Greater than Read Out Time**Example 6: Trigger period is Nonreptitive and Occasionally Shorter than Read Out Time**

Mode 7: Internal Line Rate, Maximum Exposure Time

In this mode, the line rate is set internally with a maximum exposure time.

Figure 9: Mode 7 Camera Timing



3.7.2 Step 2: Enabling or Disabling Exposure Control (Exposure Mode 3 Only)

Camera must be operating in exposure mode 3.

Disabling exposure control allows the Pantera TF 1M60 camera to operate at a maximum of 60 fps. When exposure control is enabled, the maximum Pantera TF 1M60 frame rate is 57 fps.

The frame rate is not affected in the Pantera TF 1M30 and remains a maximum of 32 fps with exposure mode enabled or disabled.

To enable or disable exposure control, use the command:

Syntax: `sec i`

Syntax Elements: `i`

- 0 Exposure control disabled resulting in a frame rate of 60 fps (1M60) or 32 fps (1M30).
- 1 Exposure control enabled resulting in a frame rate of 57 fps (1M60) or 32 fps (1M30).

- Notes:
- Exposure control is only programmable when the camera is operating in exposure mode 3.
 - See Table 7: Overview of Pantera TF 1M60 and 1M30 Exposure Modes for details on which exposure modes operate with exposure control enabled and which operate with exposure mode disabled.

Example: `sec 1`

3.7.3 Step 3: Setting Frame Rate and Exposure Time

Setting Frame Rate

Camera must be operating in exposure mode 2 or 7.

To set the frame rate, use the command:

Syntax: `ssf i`

Syntax Elements: `i`

Desired frame rate in Hz. Allowable ranges are (assuming 1x1 binning and dual output in 1M60):

Pantera TF 1M60

- 1-57 Hz if exposure control is enabled
- 1-60 Hz if exposure control is disabled

Pantera TF 1M30

- 1-32 Hz if exposure control is enabled or disabled

- Notes:
- To read the current line rate frequency, use the command `gcp`.
 - If you enter an invalid line rate frequency, the valid range of values will be displayed.
 - Exposure control is set using the `sec` command. See page 25 for details.

Related Commands: `sec, set`

Example: `ssf 50`

Setting Exposure Time

Camera must be operating in exposure mode 2 or mode 6. The following table lists exposure mode time limits.

Table 8: Exposure Mode Time Ranges

Mode	Exposure Time Range
2	Fixed by <code>ssf</code> command
6	Limited by current frame rate (EXSYNC frequency)

To set the camera exposure time, use the command:

Syntax: `set f`

Syntax Elements: `f`

Floating point number in μs . Allowable range is one line time to 1000000.0 μs . Line times are listed in Table 15 to Table 18 for each camera operating mode.

- Notes:
- To read the current line rate frequency, use the command `gcp`.
 - If you enter an invalid exposure time, the valid range of values will be displayed.

Related Commands: `sem, ssf`

Example: `set 5500.3`

3.8 Setting Gains

Optimizing gain in the analog domain allows you to achieve a better signal-to-noise ratio (dynamic range) than you would achieve by trying to optimize the gain in the digital domain. As a result, perform all analog gain adjustments (**ssg** command) prior to any digital gain adjustments (**gm** command).

Setting Analog Gain

To set the analog gain, use the command:

Syntax: `ssg i i`

Syntax Elements: `i`

Tap value. Either **1** for the left tap or **2** (1M60 only) for the right tap.

`i`

`0-4095`. 0 corresponds to low gain, 4095 corresponds to high gain

Related Commands: `gm`

Example: `ssg 1 4000`

Setting Digital Gain

To set the digital gain, use the command:

Syntax: `gm i`

Syntax Elements: `i`

`0` 1x Output Gain Mode (Factory setting)

`1` 2x Output Gain Mode

`2` 4x Output Gain Mode

Related Commands: `ssg`

Example: `gm 2`

3.9 Increasing Sensitivity with Binning

Binning increases the camera's light sensitivity by decreasing horizontal and vertical resolution—the charge collected by adjacent pixels is added together.

Note: The vertical binning setting directly affects the camera's sensitivity, readout time and frame rate. The horizontal binning mode affects sensitivity but does not change timing.

To set the binning value, use the command:

Syntax: `sbm i I`

Syntax Elements: `I`

Horizontal binning value. The valid horizontal binning values include 1, 2, 4, and 8.

`I`

Vertical binning value. The valid vertical binning values include 1, 2, 4, and 8.

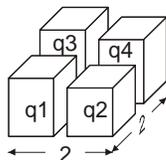
Notes:

- Available binning modes are 1x1 (factory setting), 1x2, 1x4, 1x8, 2x1, 2x2, 2x4, 2x8, 4x1, 4x2, 4x4, 4x8, 8x1, 8x2, 8x4, or 8x8.

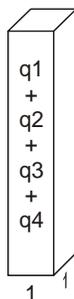
Example: `sbm 2 2`

Figure 10: 2x2 Binning

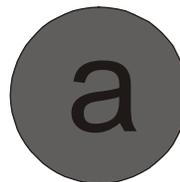
More charge
=
brighter pixel



Charge in
4 adjacent pixels



Charge binned:
1 pixel output



Normal image



Binned image

Table 9: Pantera TF 1M30 or 1M60 (Using Single Output) Binning vs. Speed and Exposure Control Disabled

Binning (HxV)	Read out Time (mS)	Frame Rate
1x1, 2x1, 4x1, 8x1	29.987 ms	31.932 fps
1x2, 2x2, 4x2, 8x2	15.654 ms	58.846 fps
1x4, 2x4, 4x4, 8x4	8.5952 ms	100.66 fps
1x8, 2x8, 4x8, 8x8	4.9152 ms	159.89 fps

Table 10: Pantera TF 1M30 or 1M60 (Using Single Output) Binning vs. Speed and Exposure Control Enabled

Binning (HxV)	Readout Time (ms)	Frame Rate
1x1, 2x1, 4x1, 8x1	29.978 ms	31.903 fps
1x2, 2x2, 4x2, 8x2	15.654 ms	58.745 fps
1x4, 2x4, 4x4, 8x4	8.5952 ms	100.336 fps
1x8, 2x8, 4x8, 8x8	4.9152 ms	158.949 fps

Table 11: Pantera TF 1M60 Binning vs. Speed using Dual Output and Exposure Control Enabled

Binning (HxV)	Read out Time (mS)	Frame Rate
1x1, 2x1, 4x1, 8x1	16 ms	57.626 fps
1x2, 2x2, 4x2, 8x2	8.614 ms	100.312 fps
1x4, 2x4, 4x4, 8x4	5.017 ms	156.865 fps
1x8, 2x8, 4x8, 8x8	3.1744 ms	220.415 fps

Table 12: Pantera TF 1M60 Binning vs. Speed using Dual Output and Exposure Control Disabled

Binning (HxV)	Read out Time (mS)	Frame Rate
1x1, 2x1, 4x1, 8x1	15.3856 ms	59.792 fps
1x2, 2x2, 4x2, 8x2	8.5112 ms	102.984 fps
1x4, 2x4, 4x4, 8x4	4.941 ms	159.241 fps
1x8, 2x8, 4x8, 8x8	3.136 ms	223.464 fps

3.10 Rebooting the Camera

The command `rc` reboots the camera. The camera starts up with the last saved settings.

3.11 Setting the Pre-trigger

A pre-trigger may be required for some frame grabbers.

To set the pre-trigger, use the command:

Syntax: `sp i`

Syntax Elements: `i`

Pretrigger value from 0 to 15.

Example: `sp 10`

3.12 Setting the Video Mode and Generating Test Patterns

To set the video mode, use the command:

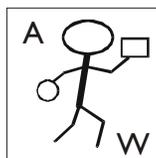
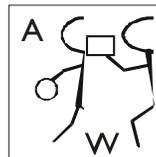
Syntax: `svm i`

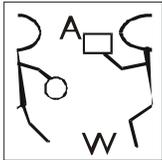
Syntax Elements: `i`

Video mode to use.

- Notes:
- All modes are available in the 1M60.
 - Modes 0, 3, 12, and 15 are available in the 1M30
 - See table below for mode descriptions

Table 13: Pantera TF 1M60 and 1M30 Video Modes

Mode	Description	Example Image
0	Normal operating mode. Available in both the 1M60 and 1M30.	
1	Test pattern left side. Available in the 1M60 only .	
2	Test pattern right side. Available in the 1M60 only .	
3	Test pattern both sides. Available in both the 1M60 and 1M30.	
4	Flip image left side. Available in the 1M60 only .	
5	Flip image left side. Test pattern left side. Available in the 1M60 only .	
6	Flip image left side. Test pattern right side. Available in the 1M60 only .	
7	Flip image left side. Test pattern both sides. Available in the 1M60 only .	
8	Flip image right side. Available in the 1M60 only .	
9	Flip image right side. Test pattern left side. Available in the 1M60 only .	
10	Flip image right side. Test pattern right side. Available in the 1M60 only .	
11	Flip image right side. Test pattern both sides. Available in the 1M60 only .	

Mode	Description	Example Image
12	Flip image both sides. Available in both the 1M60 and 1M30.	
13	Flip image both sides. Test pattern left side. Available in the 1M60 only .	
14	Flip image both sides. Test pattern right side. Available in the 1M60 only .	
15	Flip image both sides. Test pattern both sides. Available in both the 1M60 and 1M30.	

Test Patterns

Figure 11: 8 Bit Test Pattern (One Output)

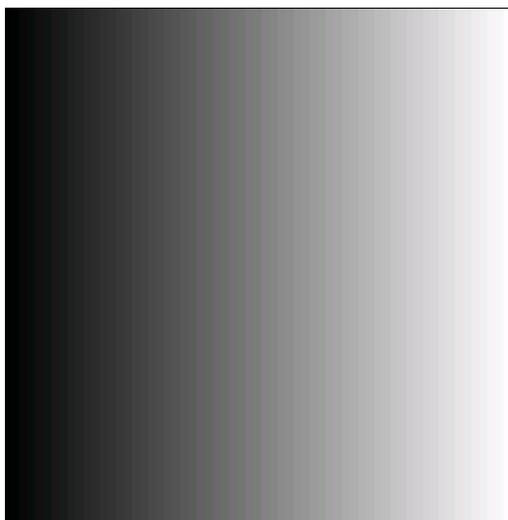


Figure 12: 10 Bit Test Pattern (One Output)

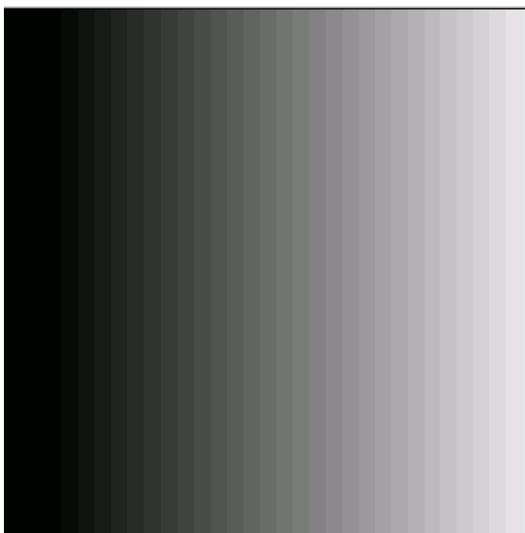


Figure 13: 12 Bit Test Pattern (One Output)



Figure 14: 8 Bit Test Pattern (Two Outputs-1M60 Only)

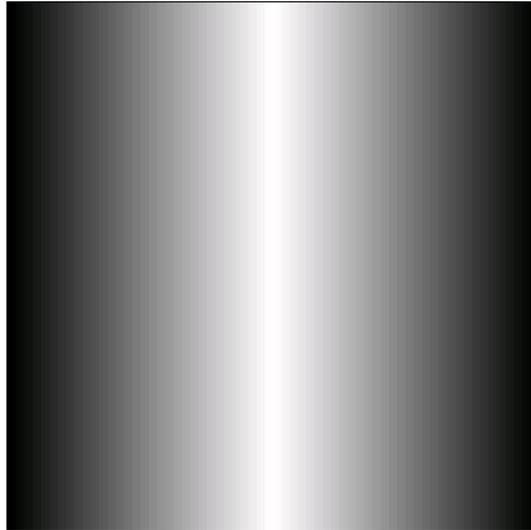


Figure 15: 10 Bit Test Pattern (Two Outputs-1M60 Only)

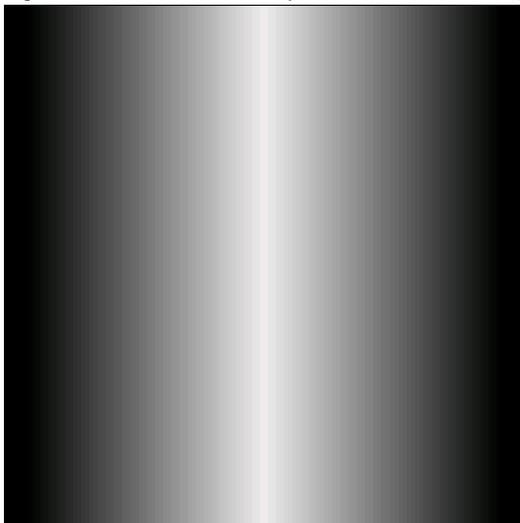
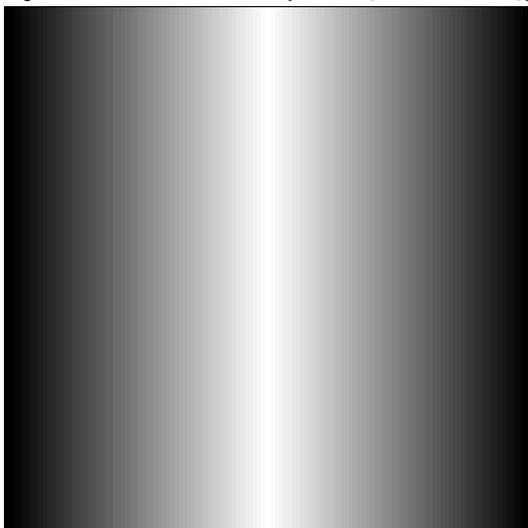


Figure 16: 12 Bit Test Pattern (Two Outputs- 1M60 Only)

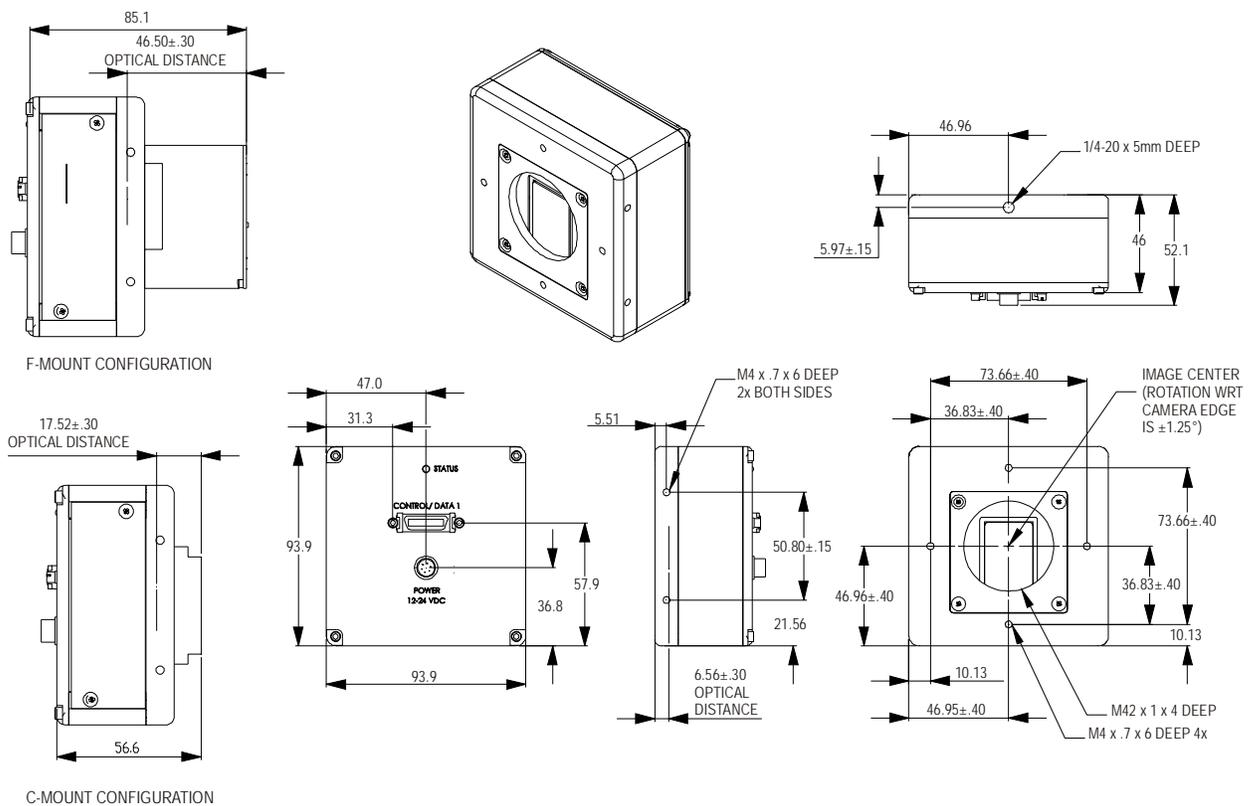


4

Optical and Mechanical Considerations

4.1 Mechanical Interface

Figure 17: Housing Dimensions



4.2 Lens Mounts

All F-mount adapters have the appropriate back focal distance for the lens type being used. Ensure that the image circle diameter of the lens to be used is as great as the length of the imaging region. The following table provides information regarding the lens mount used and the back focal distance. The M42 lens adapter originated from the high-end photography standard. Distances to its inner flat surface and the outer flat surface are provided.

Table 14: Lens Mounts

Mount	Back Focal Distance (sensor die to adapter)
M42	6.56 ± 0.3mm – outer flat surface

4.3 Mounting the Camera

The Pantera TF 1M60 and 1M30 can be mounted via the 3/8" deep, 1/4"-20 threaded tripod mount located on the bottom of the camera.

4.4 Thermal Management

For any CCD camera optimal performance is achieved by transferring heat away from the sensor. Keeping a sensor "cool" reduces the amount of dark current generated. Dark current is the leading contributor to FPN, PRNU, dark offset, random noise and other performance specifications, especially when a camera is significantly gained (i.e. +10db). Generally, dark current doubles for every 7°C increase in temperature at the sensor and increases linearly with integration time.

The Pantera TF 1M60 and 1M30 mechanicals have been optimized to transfer heat from the sensor to the front of the housing. Mount fans away from the camera to avoid vibration, and direct the airflow across the housing to decrease the temperature delta between ambient and housing temperatures. Convection is the ideal method to minimize camera warm-up times and reduce dark current generation. Both methods: either conduction through heat sinking, or convection through air flow, greatly reduce dark current and will improve you systems performance.

4.5 Environment

The camera and cables should be shielded from environmental noise sources for best operation. The camera should also be kept as cool as possible. The specified operating temperature is 0–40°C measured at the top of the camera.

5

Cleaning and Maintenance

5.1 Cleaning

Electrostatic Discharge and the CCD Sensor

Charge-coupled device (CCD) image sensors are metal oxide semiconductor (MOS) devices and are susceptible to damage from electrostatic discharge (ESD). Although many sensor pins have ESD protection circuitry, the ESD protection circuitry in CCDs is typically not as effective as those found in standard CMOS circuits.

Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. When charge buildup occurs, surface gated photodiodes (SGPDs) may exhibit higher image lag. Some SGPD sensors may also exhibit a highly non-uniform response when affected by charge build-up, with some pixels displaying a much higher response when the sensor is exposed to uniform illumination. The charge normally dissipates within 24 hours and the sensor returns to normal operation.

Preventing ESD Damage

To prevent ESD damage, DALSA advises you to take the following handling precautions.

1. Ground yourself prior to handling CCDs.
2. Ensure that your ground and your workbench are also properly grounded. Install conductive mats if your ground or workbench is non-conductive.
3. Use bare hands or non-chargeable cotton gloves to handle CCDs. NOTE: Rubber fingercots can introduce electrostatic charge if the rubber comes in contact with the sensor window.
4. Handle the CCD from the edge of the ceramic package and avoid touching the sensor pins.
5. Do not touch the window, especially in the region over the imaging area.

6. Ground all tools and mechanical components that come in contact with the CCD.
7. DALSA recommends that CCDs be handled under ionized air to prevent static charge buildup.
8. Always store the devices in conductive foam. Alternatively, clamps can be used to short all the CCD pins together before storing.

The above ESD precautions need to be followed at all times, even when there is no evidence of CCD damage. The rate which electrostatic charge dissipates depends on numerous environmental conditions and an improper handling procedure that does not appear to be damaging the CCDs immediately may cause damage with a change in environmental conditions.

Protecting Against Dust, Oil, and Scratches

The CCD window is part of the optical path and should be handled like other optical components, with extreme care.

Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

Dust can normally be removed by blowing the window surface using clean, dry, compressed air, unless the dust particles are being held by an electrostatic charge, in which case either an ionized blower or wet cleaning is necessary.

Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber fingercots and rubber gloves can prevent contamination. However, the friction between rubber and the window may produce electrostatic charge that may damage the sensor. To avoid ESD damage and to avoid introducing oily residues, only hold the sensor from the edges of the ceramic package and avoid touching the sensor pins and the window.

Improper handling, cleaning or storage of the sensor can cause scratches. Vacuum picking tools should not come in contact with the window surface. CCDs should not be stored in containers where they are not properly secured and can slide against the container.

Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels will change with the angle of illumination.

Cleaning the Sensor Window

1. Use clean, dry, compressed air to blow off loose particles. This step alone is usually sufficient to clean the sensor window.
2. If further cleaning is required, use a lens wiper moistened with alcohol.
3. We recommend using lint free, ESD safe cloth wipers that do not contain particles that can scratch the window.
4. Wipe the window carefully and slowly.

5.2 Maintenance

There are no user serviceable parts on this camera. Please contact DALSA service.

6

Troubleshooting

The information in this chapter can help you solve problems that may occur during the setup of your camera. Remember that the camera is part of the entire acquisition system. You may have to troubleshoot any or all of the following:

- power supplies
- frame grabber hardware & software
- light sources
- operating environment
- cabling
- host computer
- optics
- encoder

Your steps in dealing with a technical problem should be:

1. Try the general and specific solutions listed in sections 6.1, 6.2, and 6.3.
2. If these solutions do not resolve your problem, see section 6.4 on getting product support.

6.1 Common Solutions

Connections

The first step in troubleshooting is to verify that your camera has all the correct connections.

Power Supply Voltages

Check for the presence of all voltages at the camera power connector. Verify that all grounds are connected.

EXSYNC

When the camera is powered on for the first time, the factory setting is exposure mode 2 (no external inputs required). After a user has saved settings, the camera powers up with the saved settings.

Data Clocking/Output Signals

To validate cable integrity, have the camera send out a test pattern and verify it is being properly received.

6.2 Troubleshooting Using the Serial Interface

The following commands can aid in debugging. (The complete command protocol is described in Appendix B.)

Communications

- To quickly verify serial communications send the help command. The **h** command returns the online help menu.

Verify Parameters

- To verify the camera setup, send the **gcp** command.

Verify Factory Calibrated Settings

- To restore the camera's factory settings, send the **rfs** command.
- After executing this command send the **gcp** command to verify the factory settings.

Verify Timing and Digital Video Path

- Use the test pattern feature to verify the proper timing and connections between the camera and the frame grabber and verify the proper output along the digital processing chain. See below.

Generating Test Patterns

The camera can generate a test pattern to aid in system debugging. Use the command **svm 3** to activate the test pattern. Use the test pattern to verify the proper timing and connections between the camera and the frame grabber.

- **No test pattern or bad test pattern** – May indicate a problem with the camera (e.g. missing bit) or a system setup problem (e.g. frame grabber or timing). Verify the presence of the LVAL and STROBE signals.
- **Test pattern successful** – Run the **svm 0** command to deactivate video correction.

Verify Temperature

- To check the camera's internal temperature, use the **vt** command. If it is within the proper range, the camera returns OK>. Otherwise the camera returns an error message.

LED Status

Located on the back of the camera is a red/green LED used to display the operational status of the camera. Red lights indicate errors or warnings and green lights indicate progress and OKs. Error and warning states are accompanied by corresponding messages further describing current camera status. See section 2.3 LED Status Indicator for the complete LED information.

6.3 Specific Solutions

No Output or Erratic Behavior

If your camera provides no output or behaves erratically, it may be picking up random noise from long cables acting as antennae. Do not attach wires to unused pins. Verify that the camera is not receiving spurious inputs (e.g. EXSYNC, if camera is in exposure mode that regulates external signals).

Line Dropout, Bright Lines, or Incorrect Line Rate

Verify that the frequency of the internal sync is set correctly, or when the camera is set to external sync that the EXSYNC signal supplied to the camera does not exceed the camera's maximum specified line rate.

Noisy Output

Check your power supply voltage outputs for noise. Noise present on these lines can result in poor video quality. Low quality or non-twisted pair cable can also add noise to the video output.

Dark Patches

If dark patches appear in your output the optics path may have become contaminated. Clean your lenses and sensor windows with extreme care.

1. Take standard ESD precautions.
2. Wear latex gloves or finger cots
3. Blow off dust using a filtered blow bottle or dry, filtered compressed air.
4. Fold a piece of optical lens cleaning tissue (approx. 3" x 5") to make a square pad that is approximately one finger-width
5. Moisten the pad on one edge with 2-3 drops of clean solvent – either alcohol or acetone. Do not saturate the entire pad with solvent.
6. Wipe across the length of the window in one direction with the moistened end first, followed by the rest of the pad. The dry part of the pad should follow the moistened end. The goal is to prevent solvent from evaporating from the window surface, as this will end up leaving residue and streaking behind.
7. Repeat steps 2-4 using a clean tissue until the entire window has been cleaned.
8. Blow off any adhering fibers or particles using dry, filtered compressed air.

Horizontal Lines or Patterns in Image

A faulty or irregular encoder signal may result in horizontal lines due to exposure time fluctuations; ensure that your exposure time is regular. If you have verified that your exposure time is consistent and patterns of low frequency intensity variations still occur, ensure that you are using a DC or high frequency light source.

6.4 Product Support

If there is a problem with your camera, collect the following data about your application and situation and call your DALSA representative.

Note: You may also want to photocopy this page to fax to DALSA.

Customer name	
Organization name	
Customer phone number fax number	
Complete Product Model Number (DS-21-01M60, DS-1A-01M30...)	
Complete Serial Number	
Your DALSA Agent or Dealer	
Acquisition System hardware (frame grabber, host computer, light sources, etc.)	
Acquisition System software (version, OS, etc.)	
Power supplies and current draw	
Data rate used	
Control signals used in your application, and their frequency or state (if applicable)	<input type="checkbox"/> EXSYNC <input type="checkbox"/> BIN <input type="checkbox"/> MCLK <input type="checkbox"/> Other _____ <input type="checkbox"/> PRIN
Results when you run the gcp command	
Detailed description of problem encountered.	<i>please attach description with as much detail as appropriate</i>

In addition to your local DALSA representative, you may need to call DALSA Technical Sales Support:

	North America	Europe	Asia
Voice:	519-886-6000	+49-8142-46770	519-886-6000
Fax:	519-886-8023	+49-8142-467746	519-886-8023

Appendix A

Camera Link™ Reference, Timing, and Configuration Table

Camera Link is a communication interface for vision applications. It provides a connectivity standard between cameras and frame grabbers. A standard cable connection will reduce manufacturers' support time and greatly reduce the level of complexity and time needed for customers to successfully integrate high speed cameras with frame grabbers. This is particularly relevant as signal and data transmissions increase both in complexity and throughput. A standard cable/connector assembly will also enable customers to take advantage of volume pricing, thus reducing costs.

The camera link standard is intended to be extremely flexible in order to meet the needs of different camera and frame grabber manufacturers.

The [DALSA Camera Link Implementation Road Map](http://vfm.dalsa.com/support/appnotes/00450-00_03-32_DALSA_Camera_Link_Road_Map.pdf) (available at http://vfm.dalsa.com/support/appnotes/00450-00_03-32_DALSA_Camera_Link_Road_Map.pdf) details how DALSA standardizes its use of the Camera Link interface.

LVDS Technical Description

Low Voltage Differential Signaling (LVDS) is a high-speed, low-power general-purpose interface standard. The standard, known as ANSI/TIA/EIA-644, was approved in March 1996. LVDS uses differential signaling, with a nominal signal swing of 350mV differential. The low signal swing decreases rise and fall times to achieve a theoretical maximum transmission rate of 1.923 Gbps into a loss-less medium. The low signal swing also means that the standard is not dependent on a particular supply voltage. LVDS uses current-mode drivers, which limit power consumption. The differential signals are immune to ± 1 V common volt noise.

Camera Signal Requirements

This section provides definitions for the signals used in the Camera Link interface. The standard Camera Link cable provides camera control signals, serial communication, and video data.

Video Data

The Channel Link technology is integral to the transmission of video data. Image data and image enable signals are transmitted on the Channel Link bus. Four enable signals are defined as:

- FVAL—Frame Valid (FVAL) is defined HIGH for valid lines.

- LVAL – Line Valid (LVAL) is defined HIGH for valid pixels.
- DVAL – Data Valid (DVAL) is defined HIGH when data is valid.
- Spare – A spare has been defined for future use.

All four enable signals must be provided by the camera on each Channel Link chip. All unused data bits must be tied to a known value by the camera. For more information on image data bit allocations, refer to the official Camera Link specification on the <http://vfm.dalsa.com> Web site.

Camera Control Signals

Four LVDS pairs are reserved for general-purpose camera control. They are defined as camera inputs and frame grabber outputs. Camera manufacturers can define these signals to meet their needs for a particular product. The signals are:

- Camera Control 1 (CC1)
- Camera Control 2 (CC2)
- Camera Control 3 (CC3)
- Camera Control 4 (CC4)

Communication

Two LVDS pairs have been allocated for asynchronous serial communication to and from the camera and frame grabber. Cameras and frame grabbers should support at least 9600 baud. These signals are

- SerTFG – Differential pair with serial communications to the frame grabber.
- SerTC – Differential pair with serial communications to the camera.

The serial interface will have the following characteristics: one start bit, one stop bit, no parity, and no handshaking. It is recommended that frame grabber manufacturers supply both a user interface and a software application programming interface (API) for using the asynchronous serial communication port. The user interface will consist of a terminal program with minimal capabilities of sending and receiving a character string and sending a file of bytes. The software API will provide functions to enumerate boards and send or receive a character string. See Appendix B in the Official Camera Link specification on the <http://vfm.dalsa.com> Web site.

Power

Power will not be provided on the Camera Link connector. The camera will receive power through a separate cable. Camera manufacturers will define their own power connector, current, and voltage requirements.

Camera Link Video Timing

Figure 18: Pantera TF 1M60 and 1M30 Timing (Input and Output Relationships)



IMPORTANT:

This camera uses the **falling** edge of EXSYNC to trigger line readout, unlike previous DALSA cameras, which used the rising edge.

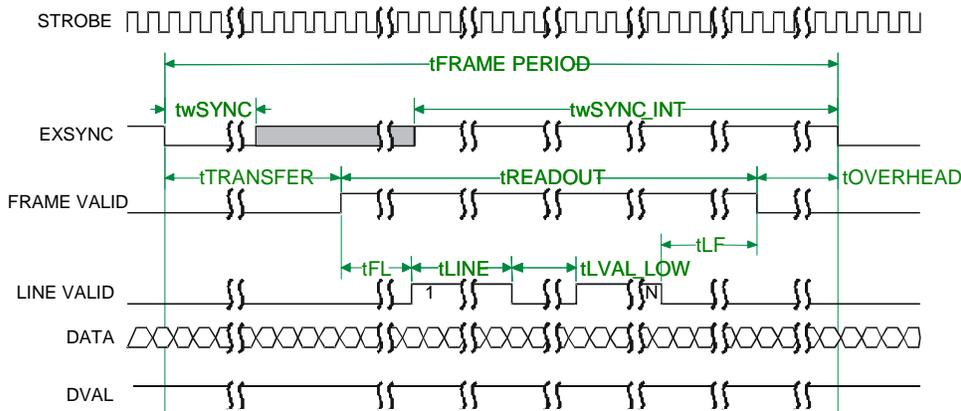


Table 15: 1 Output, ECE Mode of Operation

Symbol	Binning (HxV)			
	1 x 1 2 x 1 4 x 1 8 x 1	1 x 2 2 x 2 4 x 2 8 x 2	1 x 4 2 x 4 4 x 4 8 x 4	1 x 8 2 x 8 4 x 8 8 x 8
twSYNC (min sync pulse, not SMART SYNC)	100 ns	100 ns	100 ns	100 ns
twSYNC (min sync pulse in SMART SYNC)	1.3377 ms	1.3377 ms	1.3377 ms	1.3377 ms
TTRANSFER (time from falling edge of EXSYNC to start of readout in SMART SYNC, pretrigger=0)	1.3377 ms	1.3377 ms	1.3377 ms	1.3377 ms
TREADOUT (frame readout time, pretrigger=0)	29.978 ms	15.654 ms	8.5952 ms	4.9152 ms
tOVERHEAD (time after readout before next EXSYNC)	1.6 μs	1.6 μs	1.6 μs	1.6 μs
TwSYNC_INT (min integration pulse, not SMART SYNC)	29.275 μs	30.575 μs	33.575 μs	38.4 μs
TwSYNC_INT (min integration pulse, in SMART SYNC)	29.275 μs	30.575 μs	33.2 μs	38.0 μs
tFRAME PERIOD (min frame period)	31.344 ms	17.023 ms	9.9665 ms	4.9152 ms
tFL (time from FVAL to first LVAL)	3.075 μs	4.375 μs	6.975 μs	11.8 μs
tLINE (LVAL high time)	25.6 μs	25.6 μs	25.6 μs	25.6 μs

Symbol	Binning (HxV)			
	1 x 1	1 x 2	1 x 4	1 x 8
	2 x 1	2 x 2	2 x 4	2 x 8
	4 x 1	4 x 2	4 x 4	4 x 8
	8 x 1	8 x 2	8 x 4	8 x 8
tLVAL_LOW (LVAL low time)	3.675 μ s	4.975 μ s	7.975 μ s	12.8 μ s
tLF (time from last LVAL to end of FVAL)	600 ns	600 ns	1.0 ns	1.0 ns

Table 16: 1 Output, ECD Mode of Operation

Symbol	Binning (HxV)			
	1 x 1	1 x 2	1 x 4	1 x 8
	2 x 1	2 x 2	2 x 4	2 x 8
	4 x 1	4 x 2	4 x 4	4 x 8
	8 x 1	8 x 2	8 x 4	8 x 8
twSYNC (min sync pulse, not SMART SYNC)	100 ns	100 ns	100 ns	100 ns
twSYNC (min sync pulse in SMART SYNC)	1.339 ms	1.339 ms	1.339 ms	1.339 ms
tTRANSFER (time from falling edge of EXSYNC to start of readout in SMART SYNC, pretrigger=0)	1.339 ms	1.339 ms	1.339 ms	1.339 ms
tREADOUT (frame readout time, pretrigger=0)	29.978 ms	15.654 ms	8.5952 ms	4.9152 ms
tOVERHEAD (time after readout before next EXSYNC)	1.6 μ s	1.6 μ s	1.6 μ s	1.6 μ s
TwSYNC_INT (min integration pulse, not SMART SYNC)	29.275 μ s	30.575 μ s	33.575 μ s	38.4 μ s
TwSYNC_INT (min integration pulse, in SMART SYNC)	29.275 μ s	30.575 μ s	33.575 μ s	38.4 μ s
tFRAME PERIOD (min frame period)	31.316 ms	16.994 ms	9.9342 ms	6.2542 ms
tFL (time from FVAL to first LVAL)	3.075 μ s	4.375 μ s	6.975 μ s	11.8 μ s
tLINE (LVAL high time)	25.6 μ s	25.6 μ s	25.6 μ s	25.6 μ s
tLVAL_LOW (LVAL low time)	3.675 μ s	4.975 μ s	7.975 μ s	12.8 μ s
tLF (time from last LVAL to end of FVAL)	600 ns	600 ns	1.0 μ s	1.0 μ s

Table 17: 2 Output, ECE Mode of Operation

Symbol	Binning (HxV)			
	1 x 1	1 x 2	1 x 4	1 x 8
	2 x 1	2 x 2	2 x 4	2 x 8
	4 x 1	4 x 2	4 x 4	4 x 8
	8 x 1	8 x 2	8 x 4	8 x 8
twSYNC (min sync pulse, not SMART SYNC)	100 ns	100 ns	100 ns	100 ns
twSYNC (min sync pulse in SMART SYNC)	1.3377 ms	1.3377 ms	1.3377 ms	1.3377 ms
tTRANSFER (time from falling edge of EXSYNC to start of readout in SMART SYNC, pretrigger=0)	1.3377 ms	1.3377 ms	1.3377 ms	1.3377 ms
tREADOUT (frame readout time, pretrigger=0)	16.0 ms	8.614 ms	5.017 ms	3.1744 ms
tOVERHEAD (time after readout before next EXSYNC)	1.6 μs	1.6 μs	1.6 μs	1.6 μs
TwSYNC_INT (min integration pulse, not SMART SYNC)	15.625 μs	16.825 μs	19.4 μs	24.8 μs
TwSYNC_INT (min integration pulse, in SMART SYNC)	15.625 μs	16.825 μs	19.4 μs	24.8 μs
tFRAME PERIOD (min frame period)	17.355 ms	9.9689 ms	6.8749 ms	4.5369 ms
tFL (time from FVAL to first LVAL)	2.825 μs	4.025 μs	6.425 μs	11.625 μs
tLINE (LVAL high time)	12.8 μs	12.8 μs	12.8 μs	12.8 μs
tLVAL_LOW (LVAL low time)	2.825 μs	4.025 μs	6.8 μs	12.0 μs
tLF (time from last LVAL to end of FVAL)	0 ns	0 ns	375 ns	375 ns

Table 18: 2 Output, ECD Mode of Operation

Symbol	Binning (HxV)			
	1 x 1	1 x 2	1 x 4	1 x 8
	2 x 1	2 x 2	2 x 4	2 x 8
	4 x 1	4 x 2	4 x 4	4 x 8
	8 x 1	8 x 2	8 x 4	8 x 8
twSYNC (min sync pulse, not SMART SYNC)	100 ns	100 ns	100 ns	100 ns
twSYNC (min sync pulse in SMART SYNC)	1.339 ms	1.339 ms	1.339 ms	1.339 ms

Symbol	Binning (HxV)			
	1 x 1	1 x 2	1 x 4	1 x 8
	2 x 1	2 x 2	2 x 4	2 x 8
	4 x 1	4 x 2	4 x 4	4 x 8
	8 x 1	8 x 2	8 x 4	8 x 8
tTRANSFER (time from falling edge of EXSYNC to start of readout in SMART SYNC, pretrigger=0)	1.339 ms	1.339 ms	1.339 ms	1.339 ms
tREADOUT (frame readout time, pretrigger=0)	15.3856 ms	8.5112 ms	4.941 ms	3.136 ms
tOVERHEAD (time after readout before next EXSYNC)	1.6 μs	1.6 μs	1.6 μs	1.6 μs
TwSYNC_INT (min integration pulse, not SMART SYNC)	15.025 μs	16.35 μs	19.3 μs	24.5 μs
TwSYNC_INT (min integration pulse, in SMART SYNC)	15.025 μs	16.35 μs	19.3 μs	24.5 μs
tFRAME PERIOD (min frame period)	16.725 ms	9.7102 ms	6.2798 ms	4.475 ms
tFL (time from FVAL to first LVAL)	2.225 μs	3.55 μs	6.125 μs	11.325 μs
tLINE (LVAL high time)	12.8 μs	12.8 μs	12.8 μs	12.8 μs
tLVAL_LOW (LVAL low time)	2.225 μs	3.55 μs	6.5 μs	11.7 μs
tLF (time from last LVAL to end of FVAL)	0 ns	0 ns	375 ns	375 ns

Camera Link™ Configuration Table

The following table provides tap reconstruction information. DALSA is working with the machine vision industry to use this table as the basis for auto configuration. Visit the <http://vfm.dalsa.com> Web site and view the DALSA Camera Link Implementation Road Map document, 03-32-00450, for further details.

Pantera TF 1M60 and 1M30 Interface Parameters

Table 19: Frame Grabber Interface Parameters (Unverified)

Item (when programmable configuration the options are separated with a)	1M60	1M30
Imager Dimension <1,2 or 1 2>	2	2
Imager Columns<number of active columns, X>	1024	1024
Imager Rows<number of active rows, Y> Line Scan/TDI are defined as 1	1024	1024
Number of Imager Taps <1,2,3,....>	2	1

Item (when programmable configuration the options are separated with a)	1M60	1M30
Tap Clock Rate <xx MHz>	40	40
Camera Standard <NTSC, PAL, VS, VW, MW>	VS	VS
Variable Window <Column Start, Column End, Row Start, Row End>	(0,0,0,0)	(0,0,0,0)
Multiple Window Number of Windows, (Column Start 1, Column End 1, Row Start 1, Row End 1) (Column Start 2, Column End2, ...	0,(0,0,0,0)	0,(0,0,0,0)
Camera Color <Hybrid, Mono, Pattern, Solid>	Mono	Mono
Pattern Size <(T1,Columns*Rows)(T2,Columns*Rows)(T3,Columns*Rows....>	(T0, 1*1)	(T0, 1*1)
Color Definition <T1= R,G,B, CY, MG, Y, or M>	(T0=(1.1M)	(T0=(1.1M)
Row Color Offset <0,1,2,3...>	0	0
Column Color Offset <0,1,2,3...>	0	0
Number of Camera Configurations<1,2,3,...>	2	2
Configuration Definition Cx= HDW, Number of Output Taps, Bit Width, Number of Processing Nodes where Cx is the configuration ID x is <1,2,3...> HDW is <Base, Medium, Full> Number of Output Taps is <1,2,3...> Bit width is <8, 10,12...> Number Processing Nodes is <1 or 2>	C1 = Base 2,12,1	C1 = Base 1,12,1
Tap Reconstruction In some configurations the reconstruction may change. C0 is the default output format and must be listed. Output configurations that don't conform are listed separately. <Cx,Tn (Column Start, Column End, Column Increment, Row Start, Row End, Row Increment>	CO,T1(1,512,1,1,1024,1) CO,T2(513,1024,1,1,1024,1)	N/A
Row Binning Factor <1,2,3 or 1 2 3>	1 2 4	1 2 4
Column Binning Factor <1,2,3 or 1 2 3>	1 2 4	1 2 4
Pretrigger Pixels <0,1,2...or 0..15>	0..15 (programmable)	0..15 (programmable)
Pretrigger Lines <0,1,2.. or 0..15>	0	0
Line/Frame Time Minimum <xx ns>	TBD	TBD
Line/Frame Time Maximum <xx ns>	TBD	TBD
Internal Line/Frame Time Resolution <xx ns> 0 if not applicable	N/A	N/A
Pixel Reset Pulse Minimum Width <xx ns> 0 if not applicable	N/A	N/A
Internal Pixel Reset Time Resolution <xx ns> 0 if not applicable	N/A	N/A
Pixel Reset to Exsync Hold time <xx ns>	TBD	TBD
BAUD Rate <9600....>	9600	9600
CC1 <Exsync>	Exsync	Exsync

Item (when programmable configuration the options are separated with a)	1M60	1M30
CC2 <Spare>	Spare	Spare
CC3 <Forward, Spare>	Spare	Spare
CC4 <Spare>	Spare	Spare
DVAL out <Strobe Valid, Alternate>	Tied High	Tied High
FVAL out <Frame Valid, Alternate>	Frame Valid	Frame Valid
Spare out <Spare>	Spare	Spare

Appendix B

Commands and Error Handling

B1 All Available Commands

This table provides a brief overview of all of the available user commands. For a detailed explanation of these commands, refer to Chapter 3.

Table 20: All Available Commands

Parameters:

i = integer

f = float

t = tap

Command	Syntax	Parameters	Description
gain mode	gm	i	Sets the digital gain mode. Available values are: 0: 1x output gain 1: 2x output gain 2: 4x output gain
get camera model	gcm		Read the camera model number
get camera parameters	gcp		Read all of the camera parameters.
get camera serial	gcs		Read the camera serial number
get camera version	gcv		Read the firmware version and FPGA version
get sensor serial	gss		Read the sensor serial number
help	h		Display the online help
output mode select	oms	i	Sets the data mode to use. Available values are: 8: 8 bit mode 10: 10 bit mode 12: 12 bit mode
reset camera	rc		Reset the entire camera (reboot)
restore factory settings	rfs		Restore the camera's factory settings.
restore user settings	rus		Restore the camera's last saved user settings.
set baud rate	sbr	i	Set the speed of camera serial communication port. Baud rates: 9600 , 19200 , 57600 , and 115200 . Default baud: 9600

Parameters:

i = integer
f = float
t = tap

Command	Syntax	Parameters	Description
set binning mode	sbm	i i	Set the camera's binning mode. The first value sets the horizontal binning. The second value sets the vertical binning. Available modes are: 1x1, 2x1, 4x1, 8x1, 1x2, 2x2, 4x2, 8x2, 1x4, 2x4, 4x4, 8x4, 1x8, 2x8, 4x8, 8x8. The factory setting value is 1x1 .
set exposure control	sec	i	Enables or disables exposure control. Only applicable if you are operating in exposure mode 3. Available values are: 0: Exposure control disabled resulting in a frame rate of 60fps for 1M60 or 30fps for 1M30 1: Exposure control enabled resulting in a frame rate of 57fps for 1M60 or 27fps for 1M30
set exposure mode	sem	i	Set the exposure mode. Available values are: 2: Internal SYNC and PRIN, programmable frame rate and exposure time using commands ssf and set 3: External SYNC, internal PRIN, maximum exposure time 4: Smart EXSYNC 6: External SYNC, internal PRIN, programmable exposure time 7: (Factory Setting) Internal programmable SYNC, maximum exposure time.
set exposure time	set	f	Set the exposure time in exposure mode 2 or 6. Value will be a floating point number in μ secs.
set output mode	sos	i	Sets whether to read out data using one or two taps. Only applicable to the 1M60.
set pretrigger	sp	i	Set the pretrigger to a value from 0 or 15
set sync frequency	ssf	f	Sets the frame rate in modes 2 and 6.
set system gain	ssg	t i	The first value is the tap value. Either 1 for the left tap or 2 (1M60 only) for the right tap. The second value is the analog gain with an available range from 0-4095 .

Parameters:

i = integer*f* = float*t* = tap

Command	Syntax	Parameters	Description
set video mode	svm	i	Set video mode. Available values are: 0: Normal operating mode 1: Test pattern Left side (1M60 only) 2: Test pattern Right side (1M60 only) 3: Test pattern Both sides 4: Flip image Left side (1M60 only) 5: Flip image Left side Test pattern Left side (1M60 only) 6: Flip image Left side Test pattern Right side (1M60 only) 7: Flip image Left side Test pattern Both sides (1M60 only) 8: Flip image Right side (1M60 only) 9: Flip image Right side Test pattern Left side (1M60 only) 10: Flip image Right side Test pattern Right side (1M60 only) 11: Flip image Right side Test pattern Both sides (1M60 only) 12: Flip image Both sides 13: Flip image Both sides Test pattern Left side (1M60 only) 14: Flip image Both sides Test pattern Right side (1M60 only) 15: Flip image Both sides Test pattern Both sides
write user settings	wus		Write all of the user settings to EEROM
verify temperature	vt		Displays the temperature of the digitizer board and the sensor board. Condition <0°C or >85°C will produce an error condition.

B2 Error Messages

Code	Description	Suggested Cause
0	SUCCESS	Command executed without major error detected
3	Invalid command	Command not recognized
4	Command parameters incorrect or out of range	Command parameters are invalid or out of range

Code	Description	Suggested Cause
5	Command not available in current exposure mode	ssf and set are allowed only in mode 2 (ssf and set) and in mode 6 (set)
11	Unable to configure DSP	DSP (FPGA) configuration failure
12	DSP configuration reset failure	DSP (FPGA) could not be placed in configuration mode
14	DSP echo test error	DISC bus communication test failure
18	External supply voltage is out of specification	vv command result
19	The camera's temperature is outside the specified operating range	vt command result
23	CRC check failure while attempting to restore the camera settings	Camera setting will initialize to default settings, since restore of USER/FACTORY settings failed (internal micro EE memory failure)
24	Camera settings not saved	rus , rfs attempted but settings were not saved

Appendix C

EMC Declaration of Conformity

We, **DALSA**
605 McMurray Rd.,
Waterloo, ON
CANADA N2V 2E9

declare under sole responsibility, that the product(s):

DS-21-01M60
DS-1A-01M30

fulfill(s) the requirements of the standard(s)

EMC: **CISPR-22:1997**
EN 50082-1:1997
EN 61000-4-2; +/- 6kV CD, +/-8kV AD:1995
EN 61000-4-3; 3V/m:1995
EN 61000-4-4; 500V, 1100V:1995
EN 61000-4-6; 3V:1996

This product complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE mark accordingly.

Place of Issue	Waterloo, ON, CANADA
Date of Issue	January 2004
Name and Signature of authorized person	Hank Helmond Quality Manager, DALSA Corp.



This Declaration corresponds to EN 45 014.

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