

14. Reference Information

14-1 Introduction to DVD

14-1-1 The Definition of DVD

DVD is the next generation medium and is the acronym of the Digital Versatile Disc or the Digital Video Disc, which maximizes the saving density of the disk surface using the MPEG-2 compression technology to enable the storage of 17G bytes of data on the same size CD.

1) 7 times the storage capacity of the conventional CD

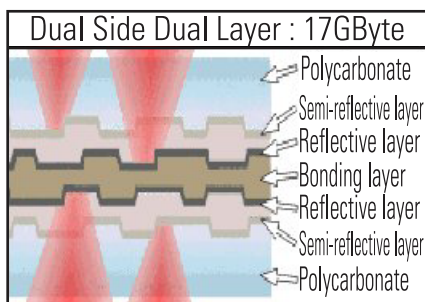
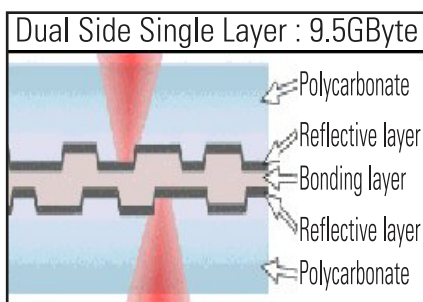
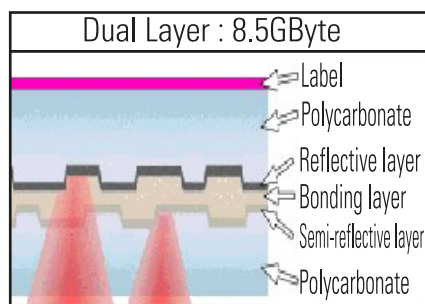
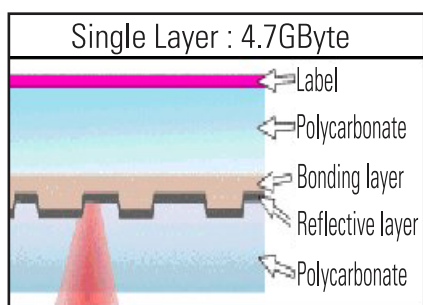
- Minimized the track pitch and pit size to 1/2 of conventional CD.
- Uses red laser with short-wavelength of 650nm (635nm).

DVD Vs. CD-ROM

	CD-ROM	CD-R/RW	DVD-ROM	DVD-R/RW	DVD-RAM
Disc Thickness	1.2mm	1.2mm	0.6*2mm	0.6*2mm	0.6*2mm
Lens NA	0.45	0.45(0.5)	0.6	0.6	0.6
Laser wavelength	780um	780um	650um	650um	650um
Track pitch	1.6pm	1.6pm	0.74pm	0.74pm	0.615pm
Capacity	0.65GB	0.65GB	4.7GB	4.7GB	4.7GB
Track structure	Pit train	Groove	Pit train	Groove	Land/Groove

2) Disc Formats

DVD consists of two 0.6mm discs attached together, enabling access to the upper and lower side of the disk, and 4 sides could be used at maximum.



14-1-2 DVD Types

FORMAT	TYPE	APPLICATIONS
DVD-Video	Playback Only	High quality image and sound for movies and other video media.
DVD-ROM	Read Only	Multi-functional, multi-media software that requires large storage capacity.
DVD-Audio	Playback Only	High quality sound that exceeds the CD, multi-channel Audio.
DVD-R	1 Time Recording	As with CD-R, write only once
DVD-RAM	Rewritable (more than 100,000 times)	This can be virtually used as hard-disk, with a random read-write access
DVD-RW	Rewritable (About 1,000 times)	Similar to DVD-RAM except than its technology features a separated read-write access more like phonograph than a hard disk.

14-2 DVD-Video Format

14-2-1 Main Features

- 1) Able to store up to 160 minutes of Movie by utilizing the MPEG-2 compression technology. (Aver. 133min.)
- 2) Enables more than 500 lines of horizontal resolution. (Class corresponding to the Master Tapes used in broadcasting stations)
- 3) Provides Dolby Digital 5.1ch Surround 3D sound, which enables theater quality sound (NTSC area).
 - For PAL areas, 1 of either MPEG-2 Audio or Dolby Digital must be selected.
- 4) Multi-Language
 - Able to store up to 8 languages of dubbing.
 - Able to store up to 32 subtitle languages.
- 5) Multi-Aspect Ratio
3TV Mode alternatives ; 16:9 Wide Screen (DVD Basic)/4:3 Pan & Scan/Letter Box.
- 6) Multi-Story
Possible to implement Interactive Viewing which enables the user to select the scenario.
- 7) Multi-Angle
Able to view the camera angle you selected among the scenes recorded with multiple camera angles.

Note ; The above media features must have the DVD Title that contains the appropriate contents to function properly.

14-2-2 Audio & Video Specifications

Classification		DVD-Video		Video-CD	LD
VIDEO	Compression	MPEG-2		MPEG-1	Analog
	Pixel	720 x 480		352 x 240	
	Horizontal resolution	Max. 500 Lines		Max. 250 Lines	Max.420 Lines
	Compression rate	1/40		1/140	Analog
	Transmission speed	Max. 9.8Mbps (variable)		1.15Mbps (fixed)	
	TV aspect	16:9 / 4:3		4:3	4:3
AUDIO	Audio	Max. 8 streams		2CH stereo	2 Analog CH. 2 Digital CH. (16Bit/44.1KHz)
	Recording type	Dolby Digital	Linear PCM	MPEG-1 Layer 2	
	Transmission rate	448Kbps/stream	6.144Mbps/stream	224Kbps	or 1 Analog CH. 1 Stream of Dolby Digital 2 Digital CH. (16Bit/44.1KHz)
	Channel	5.1CH/stream	8CH/stream	2CH	
	Sampling frequency	48KHz	16, 20, 24Bit/48, 96KHz	16Bit/44.1KHz	

14-2-3 Detailed Feature

DVD-Video Feature 1

When Developing the DVD Software, various addition and modification is possible.

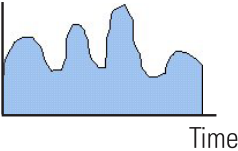
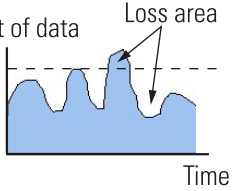
As the storage capacity increases, the DVD-Video separates the main data and the additional data such as the Multi-Function into different data areas, enabling the control of time-data ratio to provide the format that enables the flexible Software development

- 1 Movie (3.5Mbps)
 - + Subtitle (1 Language)
 - + Surround Audio (1 Language)
 - = 160min storage (4.673Gbytes)
- 1 Movie (3.5Mbps)
 - + Subtitle (4 Language)
 - + Surround Audio (4 Language)
 - = 160min storage (4.680Gbytes)
- 1 Music Video (4Mbps)
 - + 2ch High quality Audio (96kHz / 24bit)
 - = 72min storage (4.648Gbytes)

DVD-Video Feature 2

Application of the MPEG-2 compression technology.

DVD-Video uses the variable compression technology, the MPEG-2 to compress the moving image optimally, minimizing the Data loss to Provide a clear, natural screen while increasing the storage time.

DVD-Video	• MPEG-2 (Variable compression : Max. 1 / 40) - Field unit compression. - Compression rate change according to the amount of Data. - Differentiates the still image and the moving image compression rate, reducing Data loss and enables efficient compression.	Amount of data  Time
Video-CD	• MPEG-1 (Fixed compression : Max. 1 / 140) - Frame unit compression. - Compresses all data using the same ratio. - Fast movements are jagged, and unnatural	Amount of data  Time

DVD-Video Feature 3**High quality surround audio.**

DVD-Video can store the audio using the 5.1ch Dolby Digital compression or the advanced Linear PCM method, providing the better-than-CD quality and theater like audio quality.

- **DTS (Digital Theater System)**

Home theatre and music playback in the home, DTS provides high quality 5.1-channel surround sound with many extras not offered by other consumer formats. As well as handling DTS-branded releases from a growing number of music labels and consumer software producers, DTS provides enhanced 6.1 matrix and DTS 6.1 discrete decoding that envelopes the listener in sound. DTS technology is featured in a wide cross section of receiver/pre-amplifiers, DVD players and add-on components from leading consumer audio vendors

- **Dolby Digital (AC-3)**

- Unlike the traditional Dolby pro-Logic method, the Dolby Digital method separates all 5 main channels (Front L/R, Center, Surround (Rear) L/R) and the Sub woofer to provide live surround audio.
- Using the Down Mix method, the conventional Dolby Pro-Logic and Stereo are all compatible.
- Each separated channels are played back at CD quality sound. (Frequency band: 20Hz ~ 20KHz)

- **Linear PCM (Pulse Code Modulation)**

- Provides the high quality Digital sound without the audio data compression.
- Various Digital Recordings are possible as shown in the table to the right.

Sampling Frequency	Bit Rate
48KHz	16bit
	20bit
	24bit
96KHz	16bit
	20bit
	24bit

- **Dolby Digital compatible Audio Mode**

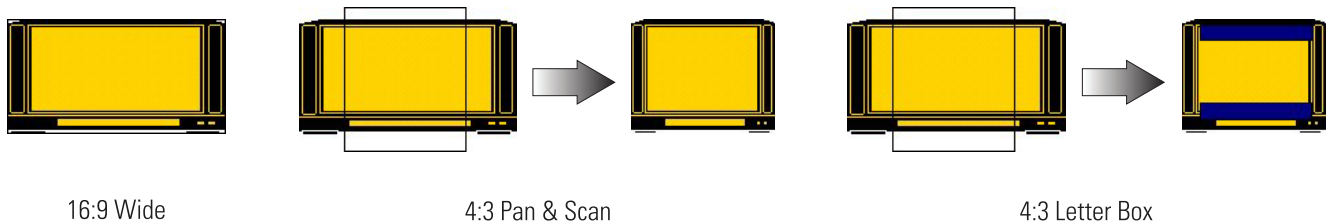
Audio Coding Mode	Channel Format					Remark
		Front		Surround (Rear)		
	L	C	R	L	R	
1/0		0				Mono
2/0	0		0			Stereo
3/0	0	0	0			Surround
2/1	0		0	Mono		
3/1	0	0	0	Mono		
2/2	0		0	0	0	
3/2	0	0	0	0	0	

DVD-Video Feature 4**Multi-Language**

- Audio Dubbing - Max. 8 Languages
- Subtitle - Max. 32 Languages. Capable of storing, and selectiong.
- Linear PCM (Pulse Code Modulation)

DVD-Video Feature 5**Multi-Aspect**

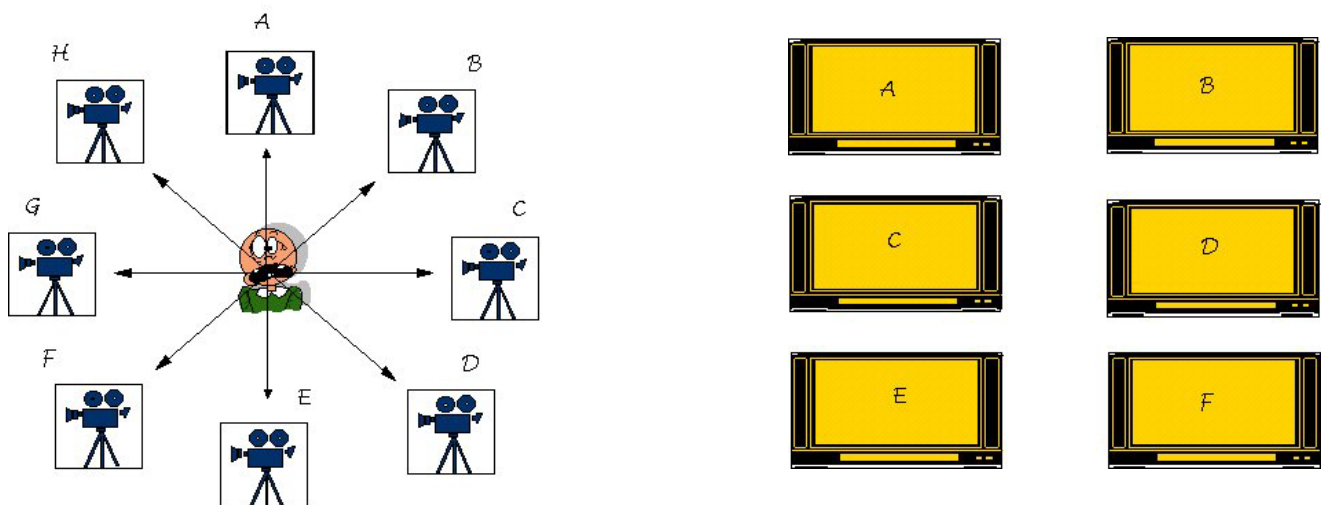
- Unlike the conventional VCD or LD, DVD-Video has the default of 16:9 Wide, and can be viewed using the conventional 4:3 TV, enabling the expansion of viewer selection capabilities.
 - 16 : 9 TV : Wide Mode (16:9 Wide Full Screen)
 - 4 : 3 TV : Letter Box Mode, Pan & Scan Mode



Note ; This function is disc-dependent, may not work on all DVDs.

DVD-Video Feature 6**Multi-Angle**

- Up to 9 angles of view may be stored, enabling the viewer to select a specific viewpoint at a given time.
 - > Especially, for the Music Video and Sports Title, this provides a more lively image of the scene.



Note ; This function is disc-dependent, may not work on all DVDs.

DVD-Video Feature 7**Multi-Story**

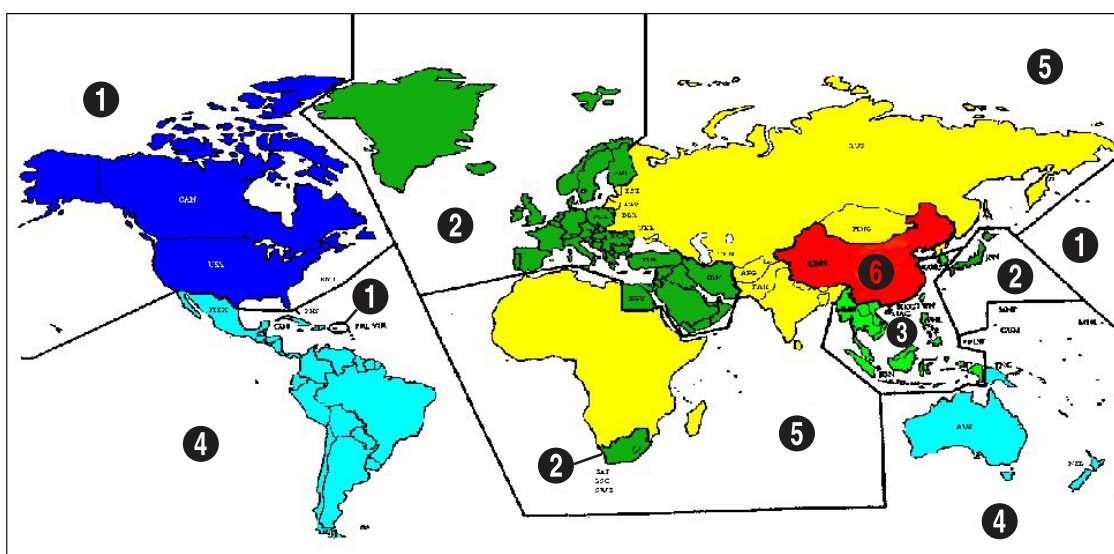
- DVD-Video provides the environment suitable for the bi-directional Software development, providing multiple scenarios. This feature enables the Multi-Story function.

OPTION**Parental Lock**

- For the titles that are not suitable for children viewing, Parental Locks are set, requesting user defined passwords for viewing
- Parental Locks may be set on specific frames of the Title, enabling the player to skip those frames during playback.

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- Classify the world into 6 regions, and if the DVD Title and the Player's "Regional Code" do not agree, playback is prohibited.
- **Regionnal Coding is optional for the Soft developers (Region 0 All Code), but the Hardware developers must adopt the appropriate regionnal code for sale.**
 - Region 1 : The United States and its territories, Canada.
 - Region 2 : Europe, Japan, Greenland, Egypt, South Africa, the Middle East.
 - Region 3 : Taiwan, Hongkong, Korea, South East Asia.
 - Region 4 : Mexico, South America, Australia, New Zealand.
 - Region 5 : Russia, Eastern Europe, India, Africa.
 - Region 6 : China.
 - Region 0 : Worldwide (All Code)

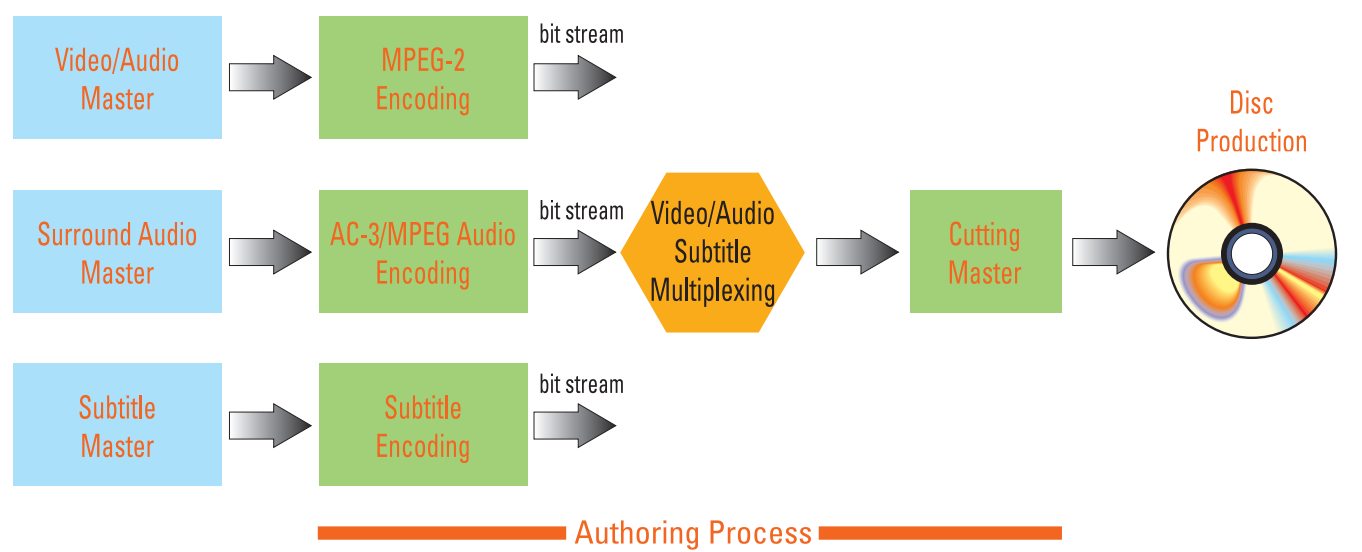


- Adoption of the Macrovision System disables the copying on to other media.

Remark	DVD-Video Authoring Process
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- The image quality of the DVD-Video may vary according to the quality of the Master and the Authoring Process
 - The image quality of the DVD-Video varies according to the Digital Mastering Source such as the conventional LD, VCD, or Original Film.
 - Different Authoring Process are used according to the Software developers, and this may affect the DVD image quality.

• **Authoring Process**



14-3 About IEEE1394

14-3-1 Comparison between IEEE-1394 and other digital interfaces

Since there are many different interfaces available, for example, RS422, RS644, and USB, vision system integrators are very likely to be confused when choosing the right interface for their application. For the ideal design of a vision system, it is vital to have the right bus/interface. To make things even more complex, there is no easy answer such as IEEE-1394 is the best choice.

Furthermore, the new CameraLink standard, promoted by companies such as Pulnix, Basler AG, and many frame grabber companies, seems to be the state of the art interface. So why should IEEE-1394 be an alternative?

These questions are as complex as most vision applications and there is no simple guideline.

Each of these interfaces offers many benefits and each of them has its individual drawbacks and restrictions. In the table below, we try to give a brief comparison of the most popular interface systems.

	RS 644 [1]	CameraLink	IEEE-1394	USB 2
Topology	Link	Link	Bus	Bus
Windows Driver	Proprietary	Proprietary	Native (Win 200, Win 98)	Native (Win 200, Win 98)
"Guaranteed" Bandwidth	~20 to 40 MByte/s	~255 MBytes/s	~32 MBytes/s[2]	~38 MBytes/s[2]
Cable Length	~10 m @ 40MHz ~20 m @ 200MHz	~10 meters	4.5 meters	5 meters
Wires Needed for 8 Data Bits	22[3]	10	4	2
Parameter Port	No	≥ 1 KByte/s	~8 MBytes/s [2]	~9 MBytes/s [2]

[1] These specs are for a typical 8-bit camera application operating at 20 MHz or at 40 MHz.

[2] 80% of the bus bandwidth is used for image data and 20% is used for parameter data.

[3] 16 wires are used for data bit transfer and two wires each are used for the separate Line Valid, Frame Valid, and Pixel Clock signals required with RS-644 transmission.

A careful comparison of the specifications shown in the table should be your first selection guide for the interface. For example, for an integrator who needs very high speed, USB 2 and IEEE-1394 are not the first choice. On the other hand, these buses are the ones to select in cases

where multiple cameras are needed or cost is a critical issue. Also, the user needs to be aware that the D-Cam specification currently does not specifically support Line Scan cameras.

However, the specification is open and line scan support could be achieved via Format 7. As

for USB 2, it is still in its infancy in machine vision and we are not aware of any kind of machine vision support.

14-3-2 Flexibility and Cost Reduction

Many image processing application engineers face a familiar group of problems when designing and building a system. The end user requires system flexibility, simple adaptation, fast delivery times, and most importantly a reasonable price. With conventional systems, whether analog or digital, engineers must confine themselves to certain combinations of the existing cameras, frame grabbers, and software. The product choice for this system configuration is limited. Unless the decision is made to use a high cost frame grabber that supports multiple cameras, sometimes known as multi-norm, it is usually not possible to operate cameras with different resolutions from the same frame grabber.

For many applications, the introduction of digital cameras is hindered by the cost specified by the end customer, however technically effective digital cameras may be. With the increased use of IEEE-1394 in the industrial image processing business, many of these problems are solvable in a sure, safe, and cost effective way.

1) Hardware Cost Example

This example compares two similar vision systems. Each system uses four Megapixel resolution digital cameras. The traditional solution consists of one frame grabber per camera, one parallel digital data cable per camera, and one power supply per camera.

The 1394 solution requires one hub and one interface card to connect the four cameras, along with five inexpensive 1394 cables. The 1394 cables carry power to the cameras directly from the computer's internal power supply. (Note that not all computers are capable of supplying enough power for the cameras. In some cases a separate power supply may be required.)

Traditional Solution with multiple frame grabbers	Price	1394 Solution	Price
Four Cameras	18,000	Four 1394 Cameras	18,000
Four Frame Grabbers	4,400	One 1394 Interface Card	100
Four Cable	400	One 1394 Hub	120
Four power Supplies	320	Five Cables	150
Total	\$23,120	Total	\$18,370

14-3-3 Application Examples

Today, there are already applications realizing the benefits of IEEE-1394 technology. For example, at one of our customer sites, Basler was faced with a vision system which has the following specifications:

The machine is a high-speed assembly system. Two independent robots take different parts (different in size, shape, and reflection) from a support unit and mount these parts on a mounting plate. Timing is crucial, and in the worst case, a part must be taken from the tray every 100 ms. Accuracy of parts mounting is also critical (0.5 mm). To have a vision system inspecting these operations, 4 cameras (2 on each of the robots) are needed:

- 2 low resolution Basler A302f cameras (640 x 480) for checking if the mounting plate is in place
- 2 high-resolution Basler A101f cameras (1300 x 1030) for checking the components to be mounted.

Since most of the parts are different, the two A101f cameras must be reconfigured before almost every image acquisition. In the worst case, the AOI, shutter, and sometimes gain need to be adjusted.

1) Solution used before Basler's Intervention

The customer used analog cameras with CCIR resolution (768 x 582) only. This drastically restricted the number of parts which could be mounted using the robots. Since these cameras had no communication port for configuration, adjusting the AOI was not possible and differences in reflection of the parts needed to be adjusted for by driving a flash circuit. All cameras were interfaced into one frame grabber (one PC).

2) Possible solution with digital cameras using RS 644 OR Camera Link

Using RS 644 or CameraLink based cameras, the customer would need one frame grabber for each camera. It is very likely that the user would need two PCs (one for each robot). Changing the camera-configuration on the fly would require advanced grabber cards since simple grabbers are not capable of easily changing their registers for different AOIs.

3) IEEE-1394 solution

All cameras are attached to a single interface card in the PC. The Basler A302f is only used when a new mounting plate is positioned by the handler. In normal operation, only the two Basler A101f cameras will be sending data at the same time and they will be operating at about 10 FPS. This results in a data rate of about 27 MBytes/s, which is well within the specification for IEEE-1394.

Since IEEE-1394 supports bi-directional communication between the camera and the PC, before each frame capture, the PC can easily change resolution, gain, offset, shutter speed, or whatever is required.

The IEEE-1394 solution results in the several advantages for the customer:

- Only one PC,
- Only one interface card (very inexpensive compared with frame grabber cards),
- Easy and inexpensive cabling,
- The system meets the expectations for speed and accuracy,
- The range of inspectable parts is much bigger than with the old system.

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