



## **FaceIt<sup>®</sup> SDK Guidelines for Image-Capturing Devices**

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Revision B**

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# 1. Introduction

The *FaceIt® SDK Guidelines for Image-Capturing Devices* is intended for use with the Identix® FaceIt® SDK product. The Identix FaceIt SDK provides developers with the ability to develop and deploy custom biometric solutions and to perform biometric validation on Identix technology. Each FaceIt SDK includes five (5) licenses to use for development and testing.

## About This Document

The *FaceIt® SDK Guidelines for Image-Capturing Devices* details specifications and recommendations on using image-capturing devices with the FaceIt SDK. Recommendations on FireWire® are also provided.

## What's New in This Release?

This release reflects minor text edits.

## Technical Support

**US Customers:** 1-888-HELP IDX (1-888-435-7439)

OR 1-952-945-5512

**International Customers:** Contact your System Administrator or Identix Sales Representative for the Service Number for your country.

OR 1-952-945-5512

**E-mail:** [idxsupport@identix.com](mailto:idxsupport@identix.com)

**Website:** [www.identix.com](http://www.identix.com)

## 2. Image-Capturing Device Guidelines

The performance of automatic face recognition is generally determined by the quality of the photographic images used. For high-quality images, the FaceIt G6 algorithm in the Identix FaceIt SDK provides a biometric performance of thousandths of one percent equal error rate (EER). For low-quality, low-resolution images, the performance is several percent EER.

The performance of a face recognition system is highest when enrollment is performed in an environment that is certified for the goals of the biometric project.

### Overview

The image-capturing devices that Identix recommends for use with the FaceIt SDK are devices compliant with Best Practices as defined in the ISO/IEC 19794-5 international standard, *Biometric Data Interchange Formats – Part 5: Face Image Data* or the ANSI approved BSR INCITS 385 American standard, *Face Recognition Format for Data Interchange*. Both documents are publicly available.

### Resolution and Signal/Noise Ratio

The images must be acquired at sufficient resolution and high signal/noise ratio to fully realize the potential of the high-resolution FaceIt G6 algorithms. The resolution should be at least 120 pixels between the eyes, so the image is sharp and free of motion blur and noise artifacts.

**NOTE:** Developers can use the Identix® FaceIt® Quality Assessment (QA) SDK to verify that the images have sufficient resolution and satisfy other quality requirements.

### Black-and-White cameras

The use of black-and-white cameras is recommended:

- For the same pixel count, black-and-white imagers provide higher spatial resolutions than color sensors.
- Moreover, black-and-white imagers are significantly more light-sensitive than their color equivalents.
- The high light sensitivity of the sensor is also a crucial factor, because face capturing devices require short exposure times and deep depth of focus.

## Camera Exposure, Lens Aperture, and Gain

The developer should be aware of the trade-off between camera exposure (measured in seconds), Lens aperture or iris (measured in f-stops), and gain or electronic multiplication factor (measured in arbitrary units):

- Camera exposure should be set to the practical minimum to avoid motion blur, because faces are live objects. Typically, the exposure should not exceed 1/100 sec.
- The lens aperture should be minimized, because a larger aperture opening shortens the depth of focus, making it more difficult in practical setups to acquire sharp images. The lens should provide sharply focused images in the whole working space of the capture device. For digital video lenses, the f# should usually not be smaller than 4.
- Many digital video cameras allow image gain to be adjusted. However, the brighter images that are attained with an increased gain also include an increased noise level. It is preferable to keep the electronic gain low in order to avoid visible noise artifacts. Slightly underexposed images produce a better face recognition signal than slightly overexposed images.

In fully automated digital still cameras, the three parameters detailed above may not be individually controllable through the user interface for the camera.

Optimizing exposure, lens aperture, and gain settings becomes easier when the subject is well lit, because strong lighting allows for reduced exposure, gain, and lens aperture. Providing uniform and constant light sources is always recommended, particularly during the enrollment phase, which typically provides for the best opportunity for controlling the environment.

## Illumination

Subject illumination should be uniform and sufficient. A good lighting system should:

- Consist of at least two light sources symmetrically located at approximately 45 degrees from the front of the subject, which provides good light coverage across the entire face of the subject and reduces glare or reflections from eyeglasses
- Use diffused light sources to prevent a spotlight effect (e.g., linear fluorescent bulbs in a fixture with a plastic diffuser, reflected incandescent/halogen lights)
- NOT use a single spotlight located in the close proximity to the camera.
- NOT use a single spotlight to one side of the camera, because strong non-uniform illumination is produced

When using ambient lighting, test the system over the full period of use in order to correctly understand and adjust for the normal variations in ambient lighting, particularly if natural (sunlight) lighting will have an effect.

## Using Digital Still Image Capturing

Image acquisition with digital still cameras is used for enrollment applications or for applications that do not require high speed and throughput. As a mass-produced commercial product, digital still cameras offer an unprecedented resolution/price ratio (as compared to digital video cameras).

One of the more commonly used digital still camera brands is Canon. Most Canon® PowerShot™ cameras share the same SDK interface, so they can be consistently integrated into a software application.

### Resolution

Even the least expensive cameras have sufficient 3+ Megapixel resolution, so they can be used for capturing token images.

Higher resolution cameras allow for larger working space, so they do not require user feedback for positioning in front of the camera.

### Illumination

If external flash boxes or umbrellas are used, the camera should have an external flash synch output.

External light flashes are recommended for capturing high quality images.

### Compression

Photographs should be acquired with the lowest compression setting allowed.

### Image-Enhancement Filters

Sharpness and other image-enhancement filters should be disabled.

## Scanning Analog Photographs

### Resolution

All analog document photographs should be scanned using at least 600 dpi resolution in order to consistently capture token images with 120 pixels between the eyes. Some small images may require 1200 dpi, so it is best to purchase a scanner with at least 1200 dpi capability. Epson and HP are two popular brands to consider.

### Post-Processing

During scanning, all pre- and post-processing filters should be disabled. The post-processing filters used to increase image contrast, sharpness, color, or brightness can make an image unusable for the face recognition algorithm.

Scanned images should be saved uncompressed or they should be compressed using lossless compression in order to avoid recompression artifacts during subsequent image processing.

### Quality Control

Developers should pay careful attention to quality control when working with scanned images, because of the lack of control over the quality of the original image. Submitted photographs are often scratched, bent, stamped, discolored, or poorly photographed.

## Using Digital Video Capturing

Capturing photographs for national ID, driver's license, insurance identification, passport photo, or building employee ID badges requires different procedures than capturing live digital video images for verification purposes.

### Verification and Identification

If capturing for verification and identification, digital video cameras are recommended.



### Enrollment

If capturing purely for economical enrollment, digital video cameras are NOT recommended.

### High-Resolution Digital Video Camera Manufacturers

There are a significant number of suitable digital video cameras available on the market. These cameras usually connect via FireWire (IEEE 1394a) or USB 2.0. Vendors such as [Point Grey Research](#), [Imaging Source](#), [Lumenera](#), and [Industrial Vision Source](#) provide a range of off-the-shelf cameras.

The following high-resolution digital video cameras are detailed for verification points:

Camera Manufacturer	Product Specifications	
 <p><b>Imaging Source DFK 41F02</b> (shown with lens-lens sold separately)</p>	<b>Effective Pixels</b>	1280 x 960
	<b>Sensor</b>	1/2" CCD
	<b>Lens Mount</b>	C
	<b>Interface</b>	6-pin FireWire 400 (1394a) interface
 <p><b>Point Grey Scorpion SCOR 20SOM-CS</b></p>	<b>Effective Pixels</b>	1600 x 1200
	<b>Sensor</b>	1/1.8" CCD
	<b>Lens Mount</b>	C
	<b>Interface</b>	6-pin FireWire 400 (1394a) interface

## Resolution

**The single most important factor to consider when purchasing a new camera is camera resolution.**

NTSC 640x480 and PAL 768x576 analog cameras are NOT suitable for capturing token facial images (as recommended by the Best Practices of the Standards mentioned above (see the *Overview* on page 2), because the token photograph should have 640x480 resolution with the eye positions fixed, and it becomes impractical to align subjects for every captured image.

The higher the resolution of the camera, the larger the working space of the verification point, so digital video cameras with a resolution of at least 1 megapixel should be used in high-performance face recognition biometric systems.

Whereas 1-megapixel cameras require an operator for repositioning in order to accommodate the range of human heights and distances from the camera, higher resolution cameras can operate unsupervised. Surveillance environments in which the capture occurs as a subject walks can employ 2+ megapixel cameras.

**NOTE:** Black-and-white cameras provide higher effective camera resolutions and thus larger working space than equivalent color cameras.

## Hardware Drivers

At the hardware driver level, all digital video cameras are required to be Microsoft DirectShow-compatible to interface with the FaceIt media libraries. These low-level libraries allow for the “grabbing” of facial images directly through the FaceIt software libraries, thus saving the developer the expense of creating custom camera interfaces.

## CMOS Sensors and Rolling Shutter

Although the use of CMOS sensors is acceptable, the use of CMOS sensors with rolling shutter is NOT recommended. The rolling shutter feature indicates that the imager is continuously read out, so the effective shutter speed is dictated by the frames per second (FPS) rate of the camera.

High-resolution digital video cameras typically operate at low FPS due to limited bandwidth. The images from rolling-shutter cameras often appear distorted and unusable.

## Interlaced Camera

The use of interlaced cameras is NOT recommended, because even a slight motion of the human head produces distinct interline artifacts that are destructive for automatic face recognition.

## Limitations of WebCams

Although the use of WebCams is common in technology demonstrations, the current generation of WebCams is NOT generally suitable for high-performance production installations. For software compatibility purposes, we suggest [Logitech](#) WebCams.

- Currently available WebCams can acquire megapixel images, but usually only through a proprietary camera interface that does not allow for digital video-rate capturing; the maximum resolution that can be achieved through the DirectShow API is 640x480, which is typically not sufficient for high biometric performance.
- WebCams frequently have low-quality lenses and low-performance CMOS or CCD sensors that result in noisy and poorly focused images.
- The short focal lengths of WebCam lenses cause unacceptable perspective distortions of the images. The same concerns apply to cameras built into cell phones.
- Although WebCams visually seem to provide reasonable biometric performance, significant deterioration of a facial biometric signal can be easily observed when system testing is performed on a statistically significant population.

## Digital Video Camera Lenses

Selecting lenses for digital video cameras is a matter of practicality. The lenses should be purchased after the operational scenario becomes known, because the focal length of the camera determines the optimal capturing distance from the camera.

### Megapixel Images

The lenses should be suitable for megapixel images, so look for the following terminology: “megapixel,” “machine vision,” or “factory automation” lenses. You can also look for lenses that are meant to be used with high-resolution (>1 megapixel) digital video cameras.

### Lens Format

The lens format, often quoted as 1”, 2/3”, 1/2”, or 1/3”, is derived from the ratio of the diameter of the lens to the image size produced. The usual practice is to match the lens format to the CCD sensor size, but it is possible to use larger format lenses on cameras with smaller CCD sensors (e.g. a 1/2” format lens on a camera with a 1/3” CCD).

The rule when selecting a format is: the image size produced by the lens must always be larger than the CCD sensor. In practice, a 1/3” format lens is not compatible with a camera fitted with a 1/2” CCD, because the image projected by such a lens would not entirely cover the surface of the CCD and the corners would be truncated (i.e., vignetted).

Larger format lenses can offer advantages, such as a greater depth of field, and the image will have less distortion at the edges than one produced by a smaller format.

### Focus and Aperture

Use fixed-focus, manual iris lenses with set-screw lockable adjustments for the focus and aperture rings.

## Focal Length

To assist with selecting an appropriate focal length for your lens, use the separate Excel document (**Choosing a Lens Focal Length.xls**) sent with these Guidelines.

## Manufacturers for High-Resolution Digital Video Cameras Lens

The following list includes manufacturers with lenses suitable for high-resolution digital video cameras. The internet is an effective method for finding a local distributor.

- Computar (Megapixel series)
- Fujinon (Machine Vision series)
- Pentax/Cosmicar (Machine Vision series)
- Tamron (Factory Automation series)

The table below includes typically used lenses:

Lens	Description
<b>Computar M0814-MP</b>	8.0mm F1.4 C-Mount w/ Locking Iris & Focus, Megapixel
<b>Computar M1214-MP</b>	12.0mm F1.4 C-Mount w/ Locking Iris & Focus, Megapixel
<b>Computar M1614-MP</b>	16.0mm F1.4 C-Mount w/ Locking Iris & Focus, Megapixel
<b>Computar M2514-MP</b>	25.0mm F1.4 C-Mount w/ Locking Iris & Focus, Megapixel
<b>Computar M5018-MP</b>	50.0mm F1.8 C-Mount w/ Locking Iris & Focus, Megapixel
<b>Fujinon HF35HA-1B</b>	35.0mm F1.6 for C-Mount

## Lens Terminology

Common lens terminology is listed below.

**aperture** The "opening" of the lens controlled by the iris and measured in F numbers. Generally, the lower the F number, the larger the aperture (so more light can pass through the lens). The F number is equal to the focal length of the lens divided by the diameter of the aperture. Some examples are:

f/1.0	aperture wide open
f/1.4	aperture lets in 1/2 as much light as f/1.0
f/2.0	aperture lets in 1/2 as much light as f/1.4
f/16	aperture lets in 1/2 as much light as f/11
f/22	aperture lets in 1/2 as much light as f/16

**manual iris** The iris is manually controlled by turning a ring on the lens to open or close the iris. Lenses with a manual iris typically include a set screw for locking the iris in place.

**auto iris** For outside conditions or conditions in which the scene illumination is constantly changing, a lens with some sort of automatically adjustable iris can be used. The iris aperture is controlled by the camera and is constantly changed to maintain the optimum light level to the CCD.

There are two main types of auto iris: Video and DC Iris. A video iris lens requires a video signal input from the camera and converts it to a DC input through its built-in amplifier circuit. A DC iris lens, often referred to as direct drive, does not have this circuitry and simply requires a DC input from the camera.

Auto-iris lenses are not commonly available for high resolution video cameras.

### **C and CS Mount Lenses**

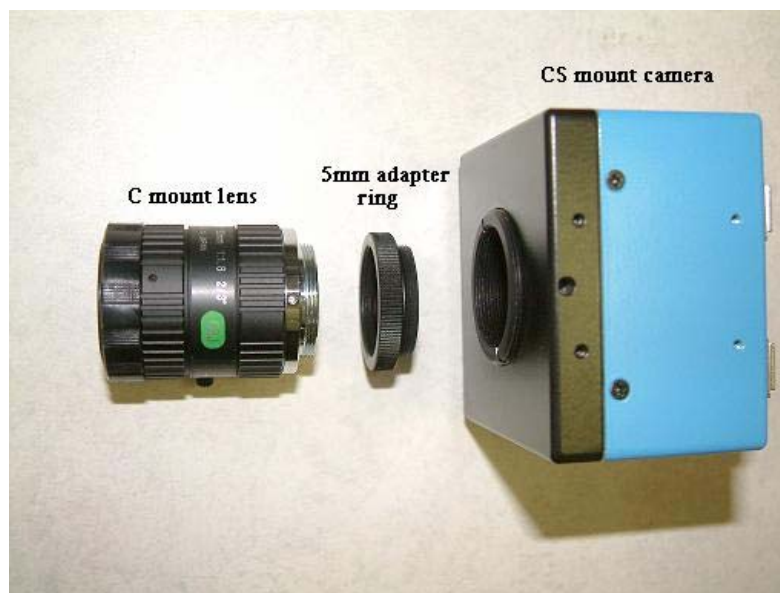
The difference between C and CS mount lenses is the distance between the flange of the lens (the part of the lens that butts up against the camera) and the focal plane of the lens (where the CCD sensor is positioned). This is known as the flange-back distance. On C mount lenses, the distance is 17.5mm. On CS mount lenses, the distance is 12.5mm.

If you have a CS mount camera and a C mount lens, you can add a 5mm spacer to obtain the correct focus. If you have a C mount camera and a CS mount lens, correct focus cannot be achieved.

### **C Mount and CS Mount Interchangeability**

	<b>C Mount Camera</b>	<b>CS Mount Camera</b>
<b>C Mount Lens</b>	Yes	Yes*
<b>CS Mount Lens</b>	No	Yes

\* A C-CS adapter (5mm spacer) between camera and lens is required.

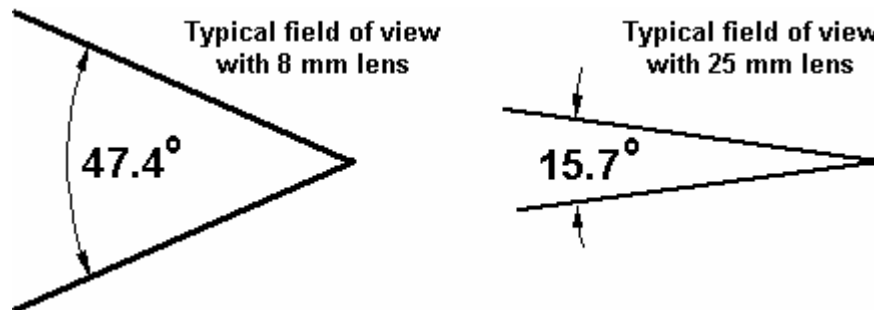


**depth of field** When an object is focused, an area in front of and behind the object is also in focus. The range in focus is called "depth of field." As objects get further outside of the depth of field (either further from the lens or closer to it), the objects will lose focus.

The depth of field can be controlled by the iris setting on the camera. As the iris aperture is decreased in size, the depth of field will improve. However, as the amount of light admitted to the camera is reduced, the image becomes darker.

The depth of field also varies with the focal length of the lens. Wide-angle lenses (i.e., those with small focal lengths) have a greater depth of field than telephoto types.

**field of view** The part of the scene visible with a particular lens. Generally, shorter focal length lenses will have a wider field of view than lenses with longer focal lengths.



**fixed or monofocal lens** A lens with only one focal length and a fixed field of view (depending on the format of the camera), such as a 16mm lens.

**variable or varifocal lens** A lens with a variable focal length that can be set manually, such as 8mm-40mm. Any adjustment in the focal length requires the lens to be refocused. The focal length is changed by turning a ring on the lens.

**zoom lens** A lens with a variable focal length that can be set manually by turning a ring on the lens. Focal length can also be set using a motor via a rocker control on the camera or via software control. Unlike the varifocal lens, the image should stay in focus as the focal length is altered, assuming the back focus is correctly set.

**back focus** The mechanical aligning of the imaging device with the focal point of the lens. Correct back-focusing is most important on zoom lenses to ensure that the image stays in focus throughout the zoom range.

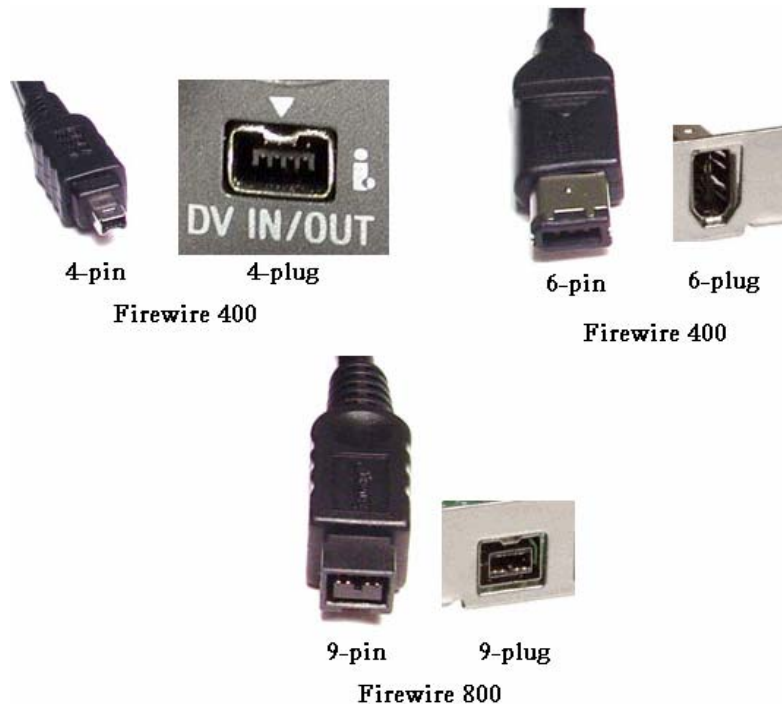
**iris (iris diaphragm)** Mechanically adjustable leaves or plates that regulate the amount of light passing through a lens.

### 3. FireWire® Guidelines

FireWire is a digital interface based on the IEEE-1394 standard. There are two types of FireWire: FireWire 400 (IEEE-1394a) and FireWire 800 (IEEE-1394b)

- FireWire 800 is relatively new and not widely used yet. It has a 9-pin connector.
- FireWire 400 is the most common interface. It has a 4- or 6-pin connector.

Besides the shape of the connector, the main difference between the 4- and 6-pin interface is that the 4-pin interface does not provide power for the camera. Also, FireWire digital video cameras typically require a 6-pin interface to supply power to the camera.



FireWire cable usually has a maximum length of 4.5m (15ft), but the cable can be increased using a FireWire Hub/ Repeater or a FireWire Repeater extension cable. One manufacturer, [Unibrain](#), produces a reliable 1394a cable for desktop PCs that is 10m (33ft) long. This cable has not been reliable with notebook PCs.

Many desktop and laptop/notebook PCs do not have native FireWire support. FireWire PCI and PCMCIA cards are used to solve this problem:

- A PCI card adds one or more FireWire ports to any PC with a free PCI slot
- A PCMCIA card does the same for any laptop/notebook with a free CardBus slot

## FireWire PCI Cards for Desktop PCs

The following is a list of tested 1394a OHCI-compliant PCI cards:

- [Adaptec FireConnect 4300](#)
- [ADS Pyro Basic DV](#)
- [SIIG Low Profile 1394 Adapter](#) (for low-profile PCI slots found in some small form factor PCs)

Many other manufacturers supply fully compliant FireWire PCI cards.

## FireWire PCMCIA Cards for Laptop and Notebook PCs

The following is a list of tested 1394a OHCI-compliant PCMCIA cards:

- [ADS Pyro 1394DV Cardbus](#) (requires an optional power supply\*)
- [SIIG 1394 Dual-Port CardBus](#) (requires an optional power supply)

Many other manufacturers supply FireWire PCMCIA cards, but 1394a compliance is more problematic for laptop and notebook PCs than for desktop PCs, because some PCMCIA card may not work at all with certain brands of laptops.

You must obtain a power supply if it is not included with the card. Many multimedia notebooks come with a built-in 4-pin FireWire port, but it does not provide any power for the camera. The solution is to use a FireWire Hub/Repeater available from many vendors or another form of FireWire power supply (e.g., a [FireCable Universal Power Adapter](#)).

The power supply must provide sufficient power for the camera you are using. Check the camera specifications or contact the manufacturer to find out the power requirements. The Point Grey Scorpion and Imaging Source cameras will work fine with a 12VDC power supply.

*\* The optional power supply for this card has an output of only 5VDC, which will not provide enough power for the Scorpion or Imaging Source cameras referred to earlier. Contact [ADS Technologies](#) and purchase a 12VDC power supply for this card.*

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