

EFS? Electronic Film System
Transforms Existing 35mm SLR Cameras Into
High-end Digital Imaging Systems

An Overview of the EFS Technology, Benefits and Opportunities
Prepared By
Silicon Film Technologies, Inc.

Overview	2
Market Dynamics.....	2
The Digital Photography Explosion.....	3
Barriers to Digital Camera Adoption by Prosumers	4
The EFS Electronic Film System.....	5
(e)film? Cartridge	5
(e)port? Carrier	6
(e)box? Storage Module	7
Real-world Advantages and Benefits of the EFS System	7
Silicon Film Technologies, Inc.	8
EFS-1 Introduction and Availability.....	8

Overview

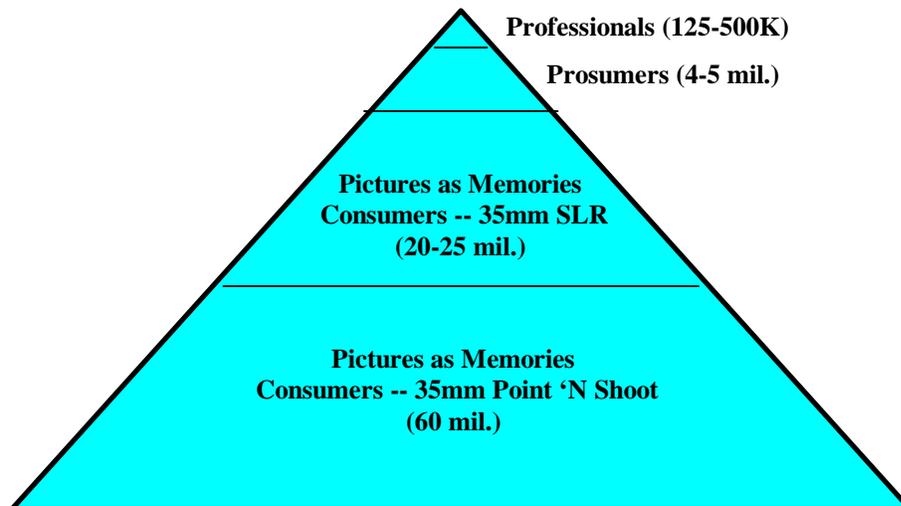
The rapid growth and falling costs of mainstream digital cameras are dramatically expanding the photographic capabilities and opportunities available to many consumers and business users. At the same time, development of ultra, high-end digital imaging systems is also making inroads into the professional photographer community. However, until recently the large market segment of highly knowledgeable “prosumers” have been faced with a dilemma regarding how best to leverage their significant investments in higher-end traditional photography equipment while also tapping into the advantages of digital.

By bridging this gap to turn existing 35mm cameras into full-featured digital imaging systems, the EFS product family from Silicon Film Technologies, Inc. now provides a completely new alternative that combines the best of both conventional photography and digital imaging. In the balance of this overview white paper, we will take a closer look at the market dynamics of traditional photography and emerging digital capabilities, after which we will provide an in-depth look at the EFS system along with detailed descriptions of the key EFS components.

Market Dynamics

During the past hundred years, photography has become a pervasive aspect of our daily lives, perennially ranking among the most popular hobbies in the world. Part of the lure of photography is the ability of people to experience it at many different levels of creative involvement, from the simple point-and-shoot mainstream method of capturing memories up through the carefully planned and executed projects of the near-professional prosumer.

35mm Camera Ownership (est. 100 Million U.S. Households)



As can be seen above, in the United States alone, almost 100 million households already own at least one 35mm camera, with approximately 25-30 million owning higher-end

single lens reflex (SLR) cameras. Thus far, most of the digital camera revolution has focused on the more than 80 million consumers in the point-and-shoot market and the lower end of the SLR market where simplicity and ease of use have dominated the design. This has left the prosumer and professional segments unable to participate in digital photography without spending thousands of dollars for a digital SLR system with the features and specialized capabilities they require.

The Digital Photography Explosion

Over the past few years digital photography has exploded into the mainstream marketplace, driven by a combination of steadily improving price/performance for digital cameras along with a rapid proliferation of powerful, easy-to-use digital imaging software, photo-quality printers and digital-oriented support services. In addition, the rise of the Internet as a global communications phenomenon has also spurred the widening usage of digital images via e-mail and web sites. Millions of personal and commercial web sites are already filled with both amateur and professional images and the demand for more is almost insatiable. As consumer-oriented digital cameras continue to become lower in cost and easier to use, their inherent convenience is making them the overwhelming choice for these new-breed applications where the image is often disseminated in digital form and sometimes never even goes to hardcopy.

While digital photography is now growing at an extraordinary rate, it is important to keep in perspective the fact that the huge market for conventional photography is not in danger of being immediately supplanted. For example, a recent study by Salomon Smith Barney predicts that the total number of digital exposures will grow at a compound annual growth rate of 78 percent, going from 1.9 billion in 1997 to 33.8 billion in 2002. However, in comparison, the much larger raw numbers of conventional film exposures are also predicted to continue growing during the same period, from 84.4 billion in 1997 to 89.0 billion in 2002.

In addition to creating new exposures directly with digital cameras, the advantages of digital image manipulation and ease-of-sharing are also driving the use of other means to get conventional photos into digital formats. For example, many film developing services now routinely offer options for scanning film output directly to CD-ROM and the falling costs of flatbed scanners have given consumers another option for converting their conventional prints to digital. Lyra Research Inc. predicts that more than 5 billion images per year will be digitized from film by 2002.

Other driving forces that are helping to expand the digital marketplace are the trends toward standardization and the lower cost of removable media for digital cameras, as well as the evolution of un-tethered “smart” peripherals, such as printers that can produce photos directly from the cameras’ media, without the need for a personal computer.

Barriers to Digital Camera Adoption by Prosumers

Originally, Kodak launched photography into the hands of consumers with an overriding commitment to simplicity – embodied in the phrase “you press the button, we’ll do the rest.” This original “black box” principle of not needing to know how the thing worked, but knowing that you would get acceptable prints, became the cornerstone of consumer photography. On the other hand, prosumer and professional photographers have always required more control over the process — along with much higher-quality imaging capabilities – and their investments in film equipment have reflected this.

To a great extent, the digital photography revolution has served to expand the gap between lower-end, consumer-oriented cameras and higher-end prosumer and professional equipment. Because digital cameras have essentially represented a convergence of many different technologies, the first wave of product development had to necessarily make many compromises. Practical resolutions were much lower than film-based alternatives, memory capacities were limited, battery life was unacceptably short and most of the optical systems were fixed and inflexible. As digital cameras gained a foothold with the consumer market, most of the second-wave development efforts have focused upon improving resolutions to the mega-pixel and beyond range, while also driving down camera costs.

However, significant improvements to the optics have remained almost an afterthought. Although many second-generation consumer digital cameras include some limited optical zoom capabilities, in reality they go little beyond matching the optics in most conventional point-and-shoot cameras. In addition, digital camera users typically have no manual control over such 35mm SLR staples as shutter speed and light exposure settings.

Although the second wave of digital cameras has also included development of a limited segment of very high-end photography systems with superior optics and exposure control, these systems are generally targeted at the professional photographer. As a result they often carry prices in the \$5000 to \$20,000 range, thus keeping the higher end of the digital-camera offerings well beyond the range of the typical prosumer or knowledgeable photography hobbyist.

Nonetheless, many prosumer photographers, who are technically savvy, remain among the leaders in early adoption of digital camera innovations because they see the inherent advantages of digital and have a natural interest in exploring the possibilities. Unfortunately, this usually leads to the phenomena of “dual neck-strapping” where we increasingly see dedicated camera buffs carrying both a high-end SLR for their serious photography as well as a mid-range digital camera as a point-and-shoot alternative to capture digital photos.

As will be shown in the following sections, the EFS digital photo system from Silicon Film Technologies effectively puts a digital camera right into the film cavity of an existing SLR, giving the prosumer truly the best of both worlds.

The EFS Electronic Film System

The EFS Electronic Film System consists of three basic components designed to turn the user's existing 35mm SLR camera into a full-featured, high-end digital imaging system. The user simply inserts an (e)film cartridge into the camera's film cavity to make use of all of the SLR's superior optics and control capabilities to capture up to 24 high-resolution photos directly on the (e)film cartridge. Then, by inserting (e)film into the (e)port, the user has the option of downloading directly into a laptop or desktop PC, or an unlimited number of images can be stored in the (e)box on industry-standard Compact Flash memory cards. Either way, the user retains the highest quality "digital negative" to meet a variety of requirements.



eFilm cartridge + *ePort carrier* + *eBox storage module*

The EFS System Includes Hardware and Software



Actual size = 6-1/2" long, 2-3/4" wide

Not only does the EFS system provide a bridge between conventional SLR cameras and the world of digital photography, it also gives prosumers a flexible and extendable alternative that is designed to preserve and expand their existing investment. The EFS architecture provides highest picture quality by leveraging high-resolution image capture through the SLR's own interchangeable lenses and advanced optics, and by providing an original uncompressed image file. In addition, the core EFS system is designed to be media-neutral, thereby allowing for architectural compatibility with existing and/or yet-to-be developed digital media standards and image processing software. The EFS system also preserves the prosumers' existing investment in experience and knowledge since there is no need to learn a new camera system.

(e)film? Cartridge

The (e)film cartridge is designed to fit easily into the SLR's film cavity and to take full advantage of all the SLR's normal operating features. Leveraging the power of digital, the user can shoot, upload and reuse the same (e)film cartridge for thousands of exposures, while also freely swapping between (e)film and traditional 35mm film as required, all without modification to the camera.

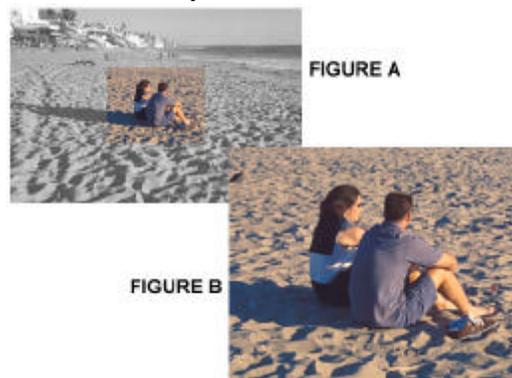


The initial EFS-1 (e)film design consists of a high-resolution 1280x1024 36-bit CMOS image sensor array on the cartridge's "flag" which is combined with the "canister" section that houses the system's image processing electronics, 48MB of non-volatile memory plus enough battery capacity to capture and download up to 500 exposures. CMOS technology was selected for the sensor array because of its distinct advantages for implementing a high-resolution array while controlling overall system cost and minimizing power consumption to optimize battery life.



Even using state-of-the-art microelectronics sensor technologies, the practical size limitations of today's digital imaging arrays are inherently much smaller than the standard frames used in 35mm film.

Therefore the EFS-1 (e)film cartridge is designed to utilize the central region consisting of approximately 35 percent of the SLR's overall field of view. To assist the user in composing photographs to effectively target the digital array's "sweet spot," the EFS-1 kit also includes a framing overlay template that can be easily applied to SLR's focusing window.



By conserving both space and power consumption, the EFS-1 design is able to include a large amount of on-board memory, which enables all images to be quickly stored in a "raw" uncompressed format, thereby ensuring highest image quality and preserving downstream processing flexibility. Each raw image is stored in its original lossless format consisting of 2 MB per image. This eliminates processing overhead for compression and allows for lower time-of-image-capture and faster shooting. After transfer to the host computer, the user can then use the EFS system's bundled software to select the most appropriate format (such as JPEG, TIFF, BMP) to meet their specific requirements. For example, while the user might choose to convert the raw 2 MB image to a compressed JPEG image comprising 1 MB or less for use in a specific application, the original (e)film "digital negative" could also be retained for future use in applications requiring more image detail.

(e)port? Carrier

The (e)port Carrier provides a multi-purpose solution for protecting the (e)film cartridge and for directly uploading images to a PC or MAC host computer. The (e)port Carrier supports a Type 2 PC Card format to enable it to be plugged directly into a laptop in the field. It also includes a USB interface for flexible high-speed interfacing directly to either PC or MAC desktop computer systems.



In addition, the (e)port Carrier is designed to plug directly into the (e)box Storage Module for quick and easy transfer of images to standard digital camera media in the field, without requiring the use of any external computer.

(e)box? Storage Module

The (e)box Storage Module gives the user maximum flexibility for continuous field usage of the EFS system in an un-tethered mode. By supporting the direct transfer of digital images to standard CompactFlash™ media cards, the (e)box allows for unlimited reuse of a single (e)film cartridge, without requiring an intervening connection to any host computer system.



Real-world Advantages and Benefits of the EFS System

For the prosumer photographer, the combination of the (e)film Cartridge, the (e)port Carrier and the (e)box Storage Module provides virtually unlimited freedom to leverage an existing 35mm SLR camera into a complete high-end digital photography system. Without requiring any modifications to the conventional SLR camera, the EFS system makes maximum usage of the SLR's superior optics, interchangeable lenses and advanced exposure-control features to go well beyond the capabilities of any consumer-oriented digital camera.

In actual practice, the EFS system empowers the photographer in the field to use all of their creative abilities while interchangeably switching between conventional film and digital image capture. Whether shooting for high-definition film reproduction or high-resolution digital results, the photographer no longer needs to carry two separate camera systems or juggle between different methodologies. All of the optics, lens selections, exposure settings and use of other camera attachment can be seamlessly carried over from film-based photography to the digital domain.

The bottom line is that, with the EFS Electronic Film System:

Going Digital Is a Snap?



Silicon Film Technologies, Inc.

Silicon Film Technologies, Inc. is a subsidiary of Irvine Sensors Corporation, the inventor of 3D semiconductor technology and an industry leader in the development of sensors and image processing solutions for nearly two decades. Established in June 1998 to commercialize the Electronic Film System opportunity, Silicon Film Technologies has augmented its parent company's semiconductor sensor expertise by bringing together a broadly experienced management team and board of directors, with the skills and knowledge necessary to successfully bring the EFS system to market.

As the first-mover in this new market arena, Silicon Film holds several patent rights, including those to the electronic film concept and methodology — that is, “an electronic module that fits inside a camera in place of conventional film, allowing the camera to capture digital images without modification to the camera”. The company has also filed several additional patents relating to the specific operating methods of the EFS system and its components.

With Silicon Film's recent announcement of an alliance with Kodak's PhotoNet Online service, the company will be able to offer an end-to-end solution for customers including digital capture, manipulation, storage and Internet connectivity and fulfillment services.

EFS-1 Introduction and Availability

- o The initial offerings in the Electronic Film System family, collectively known as EFS-1, will be available for shipment in the first half of 2000.
- o The EFS-1 product kit, priced at \$699, will include:
 - o (e)film Cartridge
 - o (e)port Carrier
 - o (e)box Storage Module
 - o USB Cable
 - o Batteries (4 ea. 1/3N type) sufficient for up to 500 exposures
 - o EFS-1 Carrying bag
 - o Field-of-view Template Overlay and installation kit
 - o Photoshop 5.0 LE software
 - o User manual on CD with Twain and Device Driver Software
 - o Printed users manual and EFS-1 Pocket-sized Quick Reference Guide



Because different SLR camera systems have unique form factor dimensions, specific versions of the EFS-1 system must be ordered to match the users' existing SLR.

Initially, the EFS-1 system will be available for use with the following SLR models:

- o Nikon Models: F5, F3, N90/F90
- o Canon Models: EOS 1N, EOS A2/5

More information on the EFS system and updates on shipping schedules can be obtained at: www.siliconfilm.com