Ensuring fresh “force of growth” in printing and a wide variety of other industries transcending the category
An innovation that changes the world sets itself clearly apart from the rest.

Fujifilm Inkjet Technology is backed with the power of synergy and integration for development.

Inkjet technology has the “power of innovation” that pioneers the future of various industries. Yet, not all of the manufacturers could generate this power easily. Holding the key is not a collection of “individual technologies” but the “power of integration” to coordinate them for overall system optimization. Fujifilm is one of a limited number of truly comprehensive manufacturers in the world that have both the “individual power” and “integration power” at the same time. The company has the strength of being able to develop printheads, inks and image processing systems within the Fujifilm Group, in addition to the ability to deliver stable distribution of advanced inkjet technology worldwide.

Fujifilm Inkjet Technology is superior in terms of the scope of applications and level of reliability.

Innovation involves the power to deepen its benefits and the power to broaden the scope of application. Fujifilm Inkjet Technology has pursued and fulfilled both of them. The company has identified a series of fresh needs in the printing industry, and pioneered new business potential in a variety of industries outside the printing world. Fujifilm Inkjet Technology will continue to bring innovation in increasing depth, width and beauty.

Fields that utilize Fujifilm Inkjet Technology

Since the company can freely combine high-performance inks and printheads to build systems optimized for specific usage, Fujifilm Inkjet Technology has applications even outside the world of printing. Not only has it been applied in general commercial printing, printers for general use and sign displays, the inkjet’s refined expressive powers are being exerted in diverse fields such as textile, 3D print, laboratory equipment and films.

Fujifilm Inkjet Technology

Three powers and five superiorities

Requests from customers always excite developers. Fujifilm always takes on multiple challenges from the user’s perspective for the innovation of inkjet technology. Fully utilizing the “power of image design,” “power of material development” and “power of system integration,” allowed all five characteristics, “high productivity”, “versatility”, “safety”, “reproducibility” and “durability” that were previously in a tradeoff relationship and difficult to develop simultaneously, to be improved at the same time.

High durability

The introduction of the ink recirculation mechanism to a printhead has increased the reliability jittering with the most complex ink and improved printhead durability. Detailed design perspectives are needed to achieve operation “reliability” instead of “security.”

High Quality

The Fujifilm proprietary image processing technologies to pursue high quality from various angles.

Advanced safety

Making use of advanced organic material technologies.

Media versatility

Fujifilm has developed highly versatile inks that can be set in a variety of media, facilitating inkjet use in various types of businesses and diverse range of jobs.
Fujifilm Inkjet Innovation is Based on Core Technology with Great Magnitude, Creating New Values for the Future

Like a tree having strong roots in all directions, growing many branches, sprouting leaves and bearing many fruits, it is important for an innovating company to have “technological roots” that cannot be seen directly by the client. Fujifilm’s inkjet innovation is based on a core technology with great magnitude. This gives great strength and flexibility in its connection with partners, and brings about a difference in the number of successful results and the scale of its success. Fujifilm’s inkjet technology has continued to grow vividly, absorbing the needs of the time and not being shortsighted. New values will continue to be created for the future of various industries.
It takes around 100 microseconds for a typical inkjet droplet to be formed, travel to the substrate, land on the surface and start forming the image. In this time, an Olympic sprinter will run 1mm, and a Formula 1 race car will travel less than 1cm.

In the inkjet printer itself, an individual nozzle may fire up to a further 10 droplets of ink while the first droplet is still in flight. To understand the technologies needed to make this happen and how these technologies work together, it is useful to consider what is actually going on while an inkjet droplet makes its journey from nozzle plate to substrate, and to review the technology that makes all of this possible.

The diagram below shows inkjet droplets in flight and details some of the characteristics of the various components that must all be tuned in order for the overall operation to be optimized. There are a great many of these properties that need to work together in order to obtain the best overall performance so it is useful to split these into three groups:

1. **Jetting performance**
   - Print head design
   - Nozzle plate wetting characteristics
   - Waveform
   - Ink fluid characteristics
   - Optimized viscosity
   - Acoustic properties
   - Surface tension
   - Resolution

2. **Ink functionality**
   - Surface wetting
   - Drop spread
   - Intercolor bleed
   - Pinning response
   - Curing speed
   - Adhesion
   - Resistance properties
   - Color lightfastness

3. **System reliability**
   - Reliable jetting at high duty cycle
   - Print head and ink design
   - Consistent manufacturing
   - Long shelf life
   - Stable pigment dispersion
   - Optimized particle size
   - Maintenance

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Jetting performance

The printhead is the heart of any inkjet printer, and the design and construction of the printheads determine a number of key properties including spatial resolution, print speed and ink deposit. Fujifilm industrial printheads are designed for a range of applications, and versions are available that are compatible with most common ink types including UV, water based, hybrid and oil based systems. Once the printhead has been integrated into a suitable system, it receives ink at the correct temperature and flow rate from the ink delivery system.

The printhead is also fed with image data that tells the head when to fire a droplet, and a waveform that tells it how to fire the droplet. Finally, the environment including temperature and pressure is regulated to ensure optimum performance.

The fluid characteristics of the ink itself are carefully matched to the printhead in order to optimize drop formation. These fluid characteristics are what makes the droplet round, and keep it moving in the right direction without breaking up, ensuring that satellite or mist formation is minimized. The ability to match printheads and inks for a particular application and to tune waveforms to optimize jetting performance is a key Fujifilm technology, and this is illustrated below. This, together with the ability to tune the fluid characteristics of the inks mean that Fujifilm is able to optimize jetting performance and ensure maximum performance and reliability.

### Waveform development

A waveform is a series of electronic signals that is used to fire an ink droplet from a drop-on-demand piezo printhead. It determines everything from the size and velocity of an inkjet droplet to the speed of printing and is a major contributor to overall system reliability.

This diagram shows a series of waveforms that would be used to produce droplets in a greyscale printhead. Each of the larger pulses starts to eject a droplet that combine on the nozzle plate to form a large droplet. A ‘cancel pulse’ can be included to break the droplet off cleanly, minimizing satellite and mist formation.

Waveforms have to be precisely tuned to the dynamic response between the ink and the printhead itself, and Fujifilm is able to create highly optimized waveforms due to its in depth knowledge of printheads and inks.

#### A typical three pulse waveform in a greyscale printhead

1. **Initial pulse**: Drop size and velocity are determined by the slope and amplitude of the pulse.
2. **Time between droplets**: Is determined by resonant frequency of the head and acoustic properties on the ink.
3. **Cancel pulse**: To break the droplet away and minimize satellite and mist formation.

#### Typical multi-pulse waveforms in a greyscale printhead

- **Single pulse**: Small drop
- **Double pulse**: Medium drop
- **Triple pulse**: Large drop

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### Image Optimization

Fujifilm Dimatix produce a range of inkjet printheads for industrial and package printing applications as well as established wide format graphic printing. These class leading printheads employ a range of proprietary Fujifilm technologies and combine these properties to produce some of the best and most reliable printheads available today. These technologies include:

- **Redijet technology** incorporating ink recirculation past the nozzle for quick start up, long standby times and reliable operation
- **Fujifilm non-wetting nozzle plate coating**, reducing contamination and helping to maximize up time with high duty cycles
- **Silicon MEMS architecture** allowing ‘printhead on a chip’ construction, maximizing nozzle density and minimizing drop size
- **Versadrop variable drop management**, allowing greyscale printing to enhance visual print quality
- **High frequency operation** providing high speed printing
- **Compatibility with most inkjet ink technologies** including water based, UV, hybrid, oil based ceramic and the associated maintenance fluids
- **Unique Fujifilm piezo ceramic with superior piezoelectric performance**

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Printheads

- **Fujifilm Starfire™ printhead** for high volume printing with most ink types
- **Fujifilm Samba™ ultra high resolution, high speed Silicon MEMS printheads**, designed to be compatible with most ink types

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Ink functionality

The properties of the finished print are determined to a large degree by the chemical make-up or 'functionality' of the ink. These properties include all of the end use requirements such as color, adhesion and resistance properties, together with any specific properties that may be needed for the end application. In addition, the chemistry of the ink plays a major part in the way that the image is formed. Many of these properties come into play a fraction of a second after the inkjet droplet has landed on the substrate. During this time, the droplet has to wet the surface by a predetermined amount so that the image is formed correctly, and has to start the process of bonding with the surface. A short time later, the ink needs to dry if it is a water based ink, or cure if it is a UV system. It is during this process that the properties such as chemical and physical resistances are formed. The lightfastness is determined partly by the selection of the pigment, and partly by the balance of the ink system, so these properties are incorporated into the design specification for the ink. Pigments have to be dispersed into the ink, and dispersion science is a key Fujifilm technology. All of the components in the ink have to be tuned to each other as the overall performance requires everything to work together.

Inks for industrial applications

Fujifilm produces a range of UV and water based inks for a variety of industrial and package printing applications. This includes inks for labels, flexible packaging, corrugated packaging, textiles and decorative laminates. In addition, there are specially designed inks for specific applications including ultra high lightfast inks for exterior design, thermo forming inks and inks for glass and other difficult materials.
In order to increase system reliability, the printhead, ink, and image processing system must function as one to bring out the maximum potential of its performance. For example, even if a printhead creates high precision ink droplets and places them quickly and accurately on the substrate, if the ink does not adhere to the substrate, high quality dot shape cannot be achieved. In order to maximize the capability of the printhead and ink, technology such as special coating for the substrate and catalysts to speed up the chemical reaction will be necessary. Such technology like the “Rapic technology” implemented in the “Jet Press720S” and “EUCON technology” implemented in the “MJP20W” shall be highlighted and introduced.

Image optimization

System reliability

System reliability is critical for inkjet printers as they are true binary devices in every sense of the word, and therefore either work or not at all. There are two aspects to system reliability:

- Sustainability, where the printer will perform as expected irrespective of run length or some external factor such as temperature.
- Consistency, where every printhead and every batch of ink performs as expected.

Sustainability is achieved through the implementation of various technologies within printhead and ink design. A number of Fujifilm printheads incorporate ink recirculation that is designed to prevent any pigment settlement, and sweep any bubbles that may form in the ink. Special non-wetting coatings can be applied to printhead nozzle plates in order to minimize ink build up that would, if left unchecked, lead to incorrect jetting behavior. Fujifilm inkjet inks are designed for extreme sustainability, so pigments are dispersed to a precisely defined particle size using unique Fujifilm technology, and manufacturing systems are designed to maximize system reliability.

Consistency is ensured through a combination of design, where the operating parameters of printheads and inks are precisely defined, and stringent manufacturing process control.

Manufacturing operations

Fujifilm has a manufacturing philosophy where quality and reliability is built into the products that it makes, and the processes that it uses to make them. Raw material selection and consistency are key parts of the process and Fujifilm has established close business partnerships with its suppliers. These partnerships make sure that raw materials meet an agreed specification and that suppliers operate appropriate quality systems in order to maintain consistency of product and continuity of supply.

Inkjet printheads are produced at the Fujifilm Dimatix facilities in Santa Clara, California and in Lebanon, New Hampshire. The manufacturing operation in Santa Clara includes a state of the art Silicon MEMS fabrication foundry that produces the core components of many of Fujifilm Dimatix’ leading printheads. Water based colorants and inks are manufactured by Fujifilm Imaging Colorants in production facilities at Grangemouth, Scotland and New Castle, Delaware. These facilities offer a unique combination of product development and scale up capabilities with significant economies of scale.

UV and hybrid inks are produced at the state of the art manufacturing facility at Fujifilm Specialty Ink Systems operation in Broadstairs, UK. This multi award winning facility has won the Best Process Plant award in both 2011 and again in 2015. This independent assessment is a testament to the process controls that enable production of Fujifilm’s high quality inkjet products.

Integration
Fujifilm Inkjet Technology has a Broad Support Network

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FUJIFILM Dimatix, Inc.
Established in 1984 under the name “Spectra”. It later grew rapidly as the world’s number one printhead manufacturer under the corporate name “Dimatix”. Being acquired by Fujifilm in 2006, the company became a great pillar that supports the inkjet business. Among the many lineups, the “SAMBA” is known worldwide as a high resolution printhead manufactured using the high precision MEMS technology.

FUJIFILM India Pvt., Ltd.
Manufacturing ink for inkjet press
Dusseldorf, Germany

FUJIFILM Imaging Colorants Ltd.
Established in 1985 as the “Imperial Chemical Industries Ltd.” It rose in a short period as the top manufacturer of ink dyes for inkjet printers, and was acquired by Fujifilm in 2006. It plans to expand its business with advanced technology that have won them high shares in the field of water-based/pigment ink for consumer use inkjet printers and also by implementing Fujifilm’s synthetic chemistry and technology for dispersal and processing raw materials.

FUJIFILM Speciality Ink Systems Ltd.
Established in 1951 as the “Sericol Group”, the company was acquired by Fujifilm in 2005. Beginning with the development of ink for screen printing, the company now focuses mainly in manufacturing ink for industrial inkjet printers. In particular, it develops the advanced wide format printing system using its wealth of knowledge regarding UV ink accumulated since the establishment of the company.

FUJIFILM Speciality Ink Systems Ltd.
Manufacturing ink for inkjet press

FUJIFILM Imaging Colorants Ltd.
Established in 1984 as the “Spectra Group”. It developed ink for flexo printing and was acquired by Fujifilm in 2005. The company plans to expand its business in various fields, including ink for inkjet printing and high-speed printing system and ink for screen printing.

FUJIFILM Europe GmbH
Europe, Africa, Middle East Regional Headquarters

FUJIFILM Synthetic Organic Chemistry Laboratory
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EJTTFNJOBUJPOPGNBSLFUFEJOLKFUQSJOUFSTCZVOWFJMJOHUIFDPMPSSFUBSEBUJPONFDIBOJTNPGUIFEZFVTFEGPSJOLBOEHSFBUMZJODSFBTJOHUIFP[POFSFTJTUBODF5IFSFTVMUTXFSFIJHIMZQSBJTFEOPUPOMZXJUIJOUIFJOEVTUSZCVUBMTPGSPNUIFBDBEFNJDXPSME

FUJIFILM Sericol India Pvt. Ltd.
Ink manufacturing

FUJIFILM Advanced Marking Research Laboratories
A state-of-the-art laboratory established to bring about innovation unique to Fujifilm in the field of color marking where diversification of methodology and the expansion of market are taking place. Fujifilm’s color material technology, device technology, equipment development technology developed over the years have been fused to provide a variety of industries, not limited to the printing industry, with a high-speed high-quality inkjet print system. The research efforts are shared with partner companies as feedback. The laboratory makes daily efforts to bring innovation to “printhead handling technology”, “marking process technology”, such as applying and setting of ink, and “image processing technology”.

FUJIFILM Synthetic Organic Chemistry Laboratory
Utilising advanced organic material technology at the Fujifilm Advanced Research Laboratories, materials for coloring and additives are being developed. Contributed to the wide dissemination of marketed inkjet printers by unveiling the color retardation mechanism of the dye used for ink and greatly increasing the ozone resistance. The results were highly praised not only within the industry but also from the academic world.

FUJIFILM Advanced Marking Research Laboratories

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