Paper & Pre-printed Media

Applications Guide for the
imageRUNNER 110/110M/Pro 150+
Product Family

Contents

Introduction

To help you to maximize your results, you need to know what papers and inks to use for digital applications. This *Paper and Pre-Printed Media Applications Guide,* developed by Canon, will enable you to keep your imageRUNNER 110/110M/Pro 150+ Print System running reliably to provide high-quality, high-volume output. This guide is an update to the *Pre-Printed Media Applications Guide* released in May 2000. In response to requests from our customers, many new sections have been added that provide general information on papers and inks for use in digital printing applications.

You'll find this a useful reference, especially for operators, in understanding what types of papers, inks, coatings, and overcoats are best suited for the imageRUNNER 110/110M/Pro 150+ Product Family. Inside you'll find insights on media operating strategies and preventative maintenance for your imageRUNNER 110/110M/Pro 150+ Print System. A sensitivity diagram (p.7) provides awareness to the general input-output relationships and sensitivities that may exist in running various types of pre-printed media.

This guide also provides information to help you understand what media to run and the effects of different media on the imageRUNNER 110/110M/Pro 150+. It is also important to understand the four general areas of interaction when using an electrophotographic based product like the imageRUNNER 110/110M/Pro 150+. The following should be considered when using pre-printed media:

- Effect(s) of the imaging process on pre-printed images and media substrates
- Overall quality of the toned images
- Effect of non-bond types of paper in paper handling and reliability performance
- Effects of pre-printed media on product reliability

To help answer your questions, tables are included at the end of this guide to provide responses the following:

- *What media can run well within acceptable performance limits?*
- *What media can run marginally with limitations?*
- *What strategies should you use to avoid problems?*

The information in this guide will enable you to produce jobs combining offset ink and toner with satisfactory results. These guidelines were established based on data generated from *our* completed tests, therefore the more deviation the greater the risk for producing unsatisfactory output. To produce the best results for printed output and overall imageRUNNER 110/110M/Pro 150+ performance, use these guiding principles for selecting media.

The Printing Process

The process for producing high-quality prints, that are a combination of both offset and digital printing, involves many variables. The sensitivity chart on the following page depicts many of the variables that must be considered when combining these two printing processes.

The key to producing printed media that will be compatible with the electrophotographic imaging process is to choose laser compatible inks and papers. In addition, it is important to allow enough time for proper drying and curing of the printed sheets.

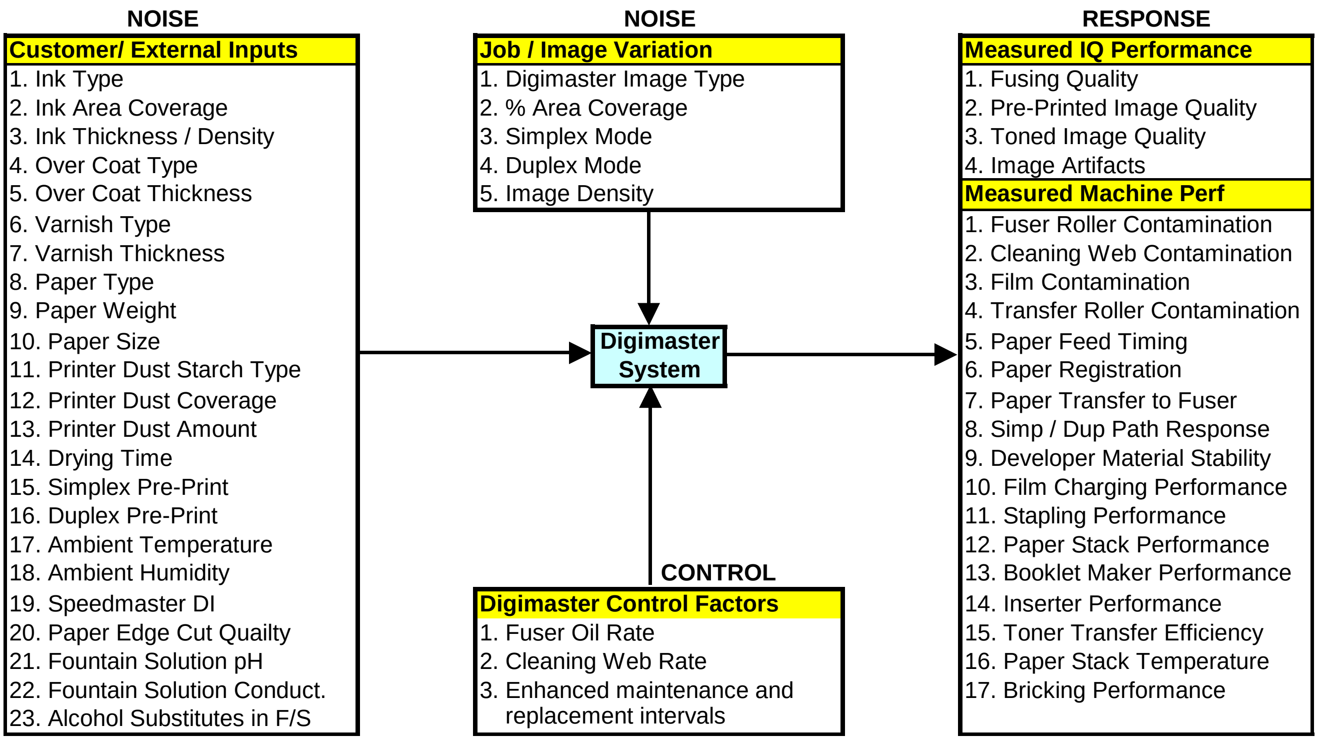
To avoid drying and curing problems, the ink film thickness (ink density) and the amount of fountain solution on the press should be kept to a minimum. The fountain solution pH should also be balanced for the pH and filler content of the paper -- a fountain solution pH that is too low can increase the possibility of ink drying and curing problems.

To prevent damages to sheets, minimize the amount of moisture that is added to the paper during printing. This will also help in preventing the finished sheets from having curl, cockle and loose or tight edges. Damaged sheets can result in poor paper feeding and handling when they are used in an electrophotographic printer and its finishing accessories.

To maintain the proper moisture content of the paper after printing, the printed sheets should be kept in a controlled environment. Remember that tightly wrapping the finished work may lengthen the cure time and could increase the possibility of curled or damaged sheets.

These guidelines were produced based on the results of limited in-house tests of pre-printed media using a relatively small sampling of the variety of papers and inks that are available. The test images used to generate the information in this guide were printed using a screen frequency of 150 lpi and dot screen percentages of 30, 50, and 100% coverage. At this screen frequency, the most acceptable ink/toner performance occurred at 30% coverage. Note that screen angles should be positioned to avoid Moiré patterns on the combined inked and toned image.

Offset Print Papers and Pre-Printed Media System Sensitivity



An additional source of assistance for printing related problems is the Graphic Arts Technical Foundation (GATF, www.gain.org, 1-800-662- 3916 US; 412-741-5733 Outside US).

Ink and Pre-printed Media

Overview

The production of sheets printed on an offset press (pre-printed media) intended for subsequent electrophotographic printing must employ laser-compatible or laser-safe inks and papers in order to avoid damaging the imageRUNNER 110/110M/Pro 150+. The following guidelines are provided to assist you in producing a satisfactory printed product with minimal impact on the performance of the imageRUNNER 110/110M/Pro 150+ print system.

Machine Conditions

The fusing system operates at high temperature and pressure. This can place stresses on the pre-printed media, which may cause unacceptable performance with incompatible inks and papers. Additionally, inks that contaminate fuser components may be exposed to further temperature stresses. The following temperature and pressure information is provided to assist you in selecting an appropriate ink and paper when you consult with your pre-printed media provider, ink supplier or manufacturer, and paper provider.

Paper and ink will be exposed to the following:

imageRUNNER 110/110M/Pro 150+	**iR 110**	**iR Pro 150+***	**iR 110M**
Fuser roller temperature (ºF)	355	365	375
Pressure (PSI)	150	150	150
Time (millisecond)	16	12	16

Note: *The imageRUNNER Pro 150+ has not been tested with pre-printed media

The web cleaner cleans the contamination (i.e. ink and toner) that transfers to the fuser roller. The web cleans the surface of heater rollers that remove contamination from the fuser roller surface. Before removal by the web, contamination is exposed to the following:

Heater roller surface temperature: 550ºF (max); 500ºF continuous.

Recommended Materials

Only laser-safe papers and inks should be used in the imageRUNNER 110/110M/Pro 150+. Canon does not make any representation or warranty concerning the types of pre-printed media that may be safely used on the imageRUNNER 110/110M/Pro 150+ nor has Canon evaluated the emissions, if any, caused by the use of pre-printed media. You are strongly advised to consult with the paper and ink supplier and/or manufacturer to determine whether their products are safe for use in the imageRUNNER 110/110M/Pro 150+ fusing system, referring to the temperatures and times listed above for the fuser. Inks and papers, which are not laser-safe, may emit chemicals that produce undesirable odors and degrade machine components. When printing with unknown papers or inks, the room or immediate area around the printer should be well ventilated.

Pre-printed Media Paper Considerations

Coated vs. Uncoated Stock

The paper can affect the performance of the ink in the imageRUNNER 110/110M/Pro 150+ by affecting the holdout or amount of ink at the surface, and by impacting the curing process of the ink. Glossy coated stock or similar stock has a high holdout that keeps most of the ink at the surface of the sheet. Inks that are not 100% laser-safe will tend to generate more contamination (i.e. ink offset) of the fuser components under these conditions. Lower ink coverage (less than 30%) or a more absorbent stock will tend to reduce contamination of the fuser system by reducing the quantity of surface ink. Coated stock having a waxy surface may transfer a wax build-up to components, which could lead to reduced paper handling performance.

Paper pH

The paper pH may impact the cure of the ink. Acid papers (low pH) may inhibit the ink cure by interfering with the cure catalyst in the ink. Consult with your ink manufacturers, as they may be able to recommend certain paper properties best suited for their particular ink. Most of today's papers are alkaline based (neutral to high pH).

Inks

Inks contain a variety of components including binders, pigments, and oils that have the potential to soften or to melt at elevated temperatures. Certain types of inks are formulated to resist softening, while other types will always soften or melt, resulting in contamination of the components. There are a variety of factors that may affect the performance of ink, and its impact on the reliability of the imageRUNNER 110/110M/Pro 150+.

Inks to Use

Use only laser-safe offset lithography inks, including laser-safe oxidative and laser-safe UV cured inks. Your ink or pre-printed media supplier should consult with the ink manufacturer to select laser-safe inks that may be suitable for use in the imageRUNNER 110/110M/Pro 150+. The performance of laser-safe inks can vary widely between manufacturers. The ink manufacturer can often provide ink that has been specially formulated to resist elevated temperatures. If laser-safe ink is not performing satisfactorily, the ink supplier may be able to suggest additives or printing process modifications, or to prepare a modified formulation that improves the heat resistance. Other factors may also affect the performance of laser-safe inks: these include ink cure, spray powder, ink coverage, varnish, and paper or fountain pH.

Hint: Pre-printed shells that will be used in an imageRUNNER 110/110M/Pro 150+ must be cured after offset printing in a temperature/humidity-controlled environment for a minimum of 72 hours. The recommended temperature range is 68 F to 75 F. Recommended relative humidity range is 40% to 60%. Pre-printed shells should not be wrapped in a moisture proof material while curing.

Inks to Avoid

Any ink that is not designated laser-safe by the ink manufacturer must not be used. Particularly problematic inks are those that do not cure by using oxidative or UV cure reactions. Rubber based inks, newsprint, cold-set inks and some quickset inks are examples. Cold-set inks penetrate into the paper but never cure, and then they may re-melt in the fuser, thereby causing contamination. Newsprint and other inks, which dry primarily from the loss of a volatile solvent, must also be avoided. Some quickset inks contain additives that will contaminate the fuser, although some laser-safe quickset inks are available. Ink additives that may re-melt in the fuser are non-laser-safe pigments, rosins, and some waxes for scuff resistance. These should be avoided. Some high temperature waxes such as PTFE powders are available to provide laser-safe scuff resistance. Very high quality prints may contain high levels of rosin, which has a low melt temperature and may cause contamination of the fuser. Any ink that is easily smeared (for example, by finger oil) may also cause reduced performance. Metallic inks tend to cure poorly and will likely cause contamination problems. Avoid conductive inks since they may interfere with the electrophotographic process or they may contaminate machine components.

Note: The "laser-safe" designation is not a guarantee that the ink will not contaminate or damage the imageRUNNER 110/110M/Pro 150+. It is the responsibility of the ink manufacturers to assess the compatibility of their products for use in the imageRUNNER 110/110M/Pro 150+ print system.

Hint: For best performance, keep dot coverage to 30% or less for documents that will be run through the imageRUNNER 110/110M/Pro 150+. Higher levels of ink coverage are very likely to contaminate the fuser system and cause premature failure of the transfer roller, fuser roller, wick, and heater rollers.

Ink Cure

Proper cure of the ink is important for preventing re-softening of the ink. Inks that use an oxidative cure require oxygen from the air, a catalyst such as a cobalt additive, and time. Restricting or inhibiting any of these components will lead to increased ink contamination.

Air. A paper stack normally has sufficient air in the sheets to allow for proper curing. However, heavy or thick ink layers and large coverage areas may require additional air. Tightly wrapping stacks in plastic may negatively affect the cure of these prints. If airtight wrapping cannot be avoided, allow the stack to cure for 5-7 days before sealing.

Catalyst. The catalyst can be inhibited by extremes of fountain pH, or by extremes of paper pH. The ink supplier should be able to recommend an appropriate fountain pH and suggest methods of monitoring the pH value. Additives such as accelerators or dryers can speed the process. Additives, such as anti-oxidants to prevent skinning, should not reduce the final level of cure, since this may increase ink contamination.

Cure Time. Oxidative cure inks require time for the cure process to complete, even when the printed surface appears dry to the touch. Thick layers or large solid areas may increase cure time. Inks that dry but do not cure may re-melt or soften at the elevated temperatures in the fuser. Such inks might not cure even with extended time.

Hint: 72 hours to one week open to air is strongly recommended for full ink cure.

Pantones vs. Process Colors

Process colors are a subset of the pantone color series. However there are differences between a process color approach as compared to a pantone color approach.

Pantone colors. These are blends of pigments, which achieve a specific color. Since each pantone color is a unique ink formulation, some pantone colors may contain ingredients that are not compatible with the fuser or other electrophotographic components. A proven process color series may be more reliable than untested pantone colors.

Process Colors. A proven process color series may be more reliable than untested pantone colors. However, do not use multiple heavy lay-downs (such as a four color black). Four-color printing has the drawback of thick layers that more easily generate ink offset. For best results use pure colors and minimize color blends. Keep the total ink laydown to less than 30% dot coverage.

Soy Based Inks

Soy inks are important as renewable resource based inks. However a soy-based ink does not guarantee more reliable performance over petroleum or other oil based systems. Both soy and petroleum based inks can and must be formulated specifically as laser-safe to perform reliably in the imageRUNNER 110/110M/Pro 150+.

Varnish

Varnish overcoats vary in composition, and may impact the performance of the machine. At this time, there is insufficient data to accurately characterize the effects the electrophotographic process may have on varnish or aqueous surface overcoats.

Oil-based varnish. This is essentially ink without pigment. Thus all of the requirements for inks apply. Use a laser-safe varnish and make sure that the varnish does not interfere with the ink cure. Consult with your varnish or pre-printed media supplier to select a varnish that is laser-safe. The ink supplier may be able to assist in selecting a compatible varnish as well as in determining the appropriate time for application of the varnish that will not interfere with the laser-safe quality of the ink.

Water-based varnish. Typically water-based varnish does not cure like oil base oxidative cure inks, but it relies on evaporation of the compounds, which allow water solubility. It is critical that the supplier of the water-based varnish certifies it as laser-safe to the listed fuser temperatures since they will not cure over time.

Hint: Do not overcoat an area that is to be printed on by the imageRUNNER 110/110M/Pro 150+. Leave the area blank that is to be printed on. It is strongly recommended that test runs be conducted to determine the effects of the overcoat on the imageRUNNER 110/110M/Pro 150+.

Waterless vs. Water-based (conventional) Inks

Waterless inks have no known advantage or disadvantage compared with conventional water-based inks when used in the imageRUNNER 110/110M/Pro 150+. In both cases the inks must be certified as laser-safe by the ink manufacturer and allowed to fully cure for best performance.

Handling Pre-printed Media

Image Placement

The placement of both the ink and the toner on the sheet can have an impact on the performance of the imageRUNNER 110/110M/Pro 150+. Continuous in track bands of ink should be avoided. In practice, this means placing bands of ink cross-track to the fuser, so that the bands are perpendicular to the direction of the paper as it goes through the printer.

Keep the areas which are to be toned free of ink and varnish. Note that toning only a single small location on successive pages can lead to variation in stack height due to the finite thickness of the toner. Thicker stock, uncoated papers, and smaller stacks minimize this effect. Strategic placement of additional images also can even out the stack.

Imaging Over Ink

Avoid printing over inked areas. High gloss continuous ink coatings do not provide a good surface for toner adhesion. For best results, select an uncoated "xerographic" stock and limit ink area coverage to less than 30% dot coverage. Adhesion between ink and toner can vary with ink color, brand and manufacturer. Certain heavy coated papers reduce the quality of the toner-to-paper bond, and inks and varnish can aggravate this. Avoid printing over varnished areas unless the varnish is specifically designed to allow toner to adhere.

Ink Coverage

Use less than about 30% surface (dot) coverage of ink. Large solid areas and thick layers of ink will contribute to slower drying and increased ink contamination. When possible reduce the thickness of dark areas by using a true black instead of a multi-color process black. By using darker or more saturated colors the same "look" may be achieved but with a lower surface coverage of ink. If heavy coverage is desired, uncoated papers may perform better than high holdout papers such as coated or calendared stock. When possible, reduce solid areas by screening. For best results use less than about 30% surface (dot) coverage of ink.

Multi-pass Offset Printing

Multi-pass printing can introduce substantial moisture into the paper, which may result in wrinkling or deformity after electrophotographic printing. In addition, high levels of moisture in the paper may blister (see Potential Problems/Blistering) inks on pre-printed shells as they pass through the imageRUNNER 110/110M/Pro 150+. For best results minimize the amount of fountain solution application for multicolor printing.

Spray Powder

Spray powders will contribute to machine contamination. Minimize spray powder as much as possible. Use only what is required to prevent backside transfer of ink (set-off or blocking) and to allow proper cure of the ink.

Storage

Store re-printed shells following the same general guidelines as for all stock used in a digital printer. To prevent paper handling problems caused by changes in the ambient environment, stock should be stored in areas with controlled temperature and humidity; or alternatively, the paper should be wrapped with a moisture barrier such as plastic wrap, or paper-laminated wrap. However, tightly wrapping finished work may lengthen cure time and increase the possibility of curled or damaged sheets. Therefore, wrap only after the ink has cured -- 72 hours minimum. Ensure that the paper stock is not damaged during storage or by the storage process.

Potential Problems

Blistering

Heavy ink coverage, coated papers, and high paper moisture may result in a matting of the image, when the sheets are passed though the printer, caused by the formation of micro-blisters. These micro-blisters form when the elevated temperatures in the fuser turn paper moisture into steam that cannot escape through the ink or through the paper coating. Allowing the moisture to escape, either by screening the ink layer or by using a more porous paper may reduce this effect. The amount of moisture in the paper can be lowered by reducing the amount of fountain application or by storage in a drier environment.

Contamination

Printer contamination that results from pre-printed media generally comes from a combination of offset spray powder, uncured or non-curing inks, or waxy components in the media or ink.

Hint: Machine contamination may be reduced if plain paper jobs are intermixed with pre-printed jobs. It may also be beneficial to run 50 to 100 sheets of plain, unprinted paper through the imageRUNNER 110/110M/Pro 150+ to clean up contaminates.

Dust

White or colored dusts in the paper path may accumulate from the removal of offset powder from the pre-printed media. Reducing the amount of spray powder applied to the pre-printed media, and frequent vacuuming of the imageRUNNER 110/110M/Pro 150+, will help control this build-up. Cleaning the paper path in the imageRUNNER 110/110M/Pro 150+ once per 8 hour shift is usually sufficient. In most cases, only a clean dry cloth is needed.

Staining

Ink staining of the fuser roller and the wick may or may not necessarily be an indication of imminent part failure. Even high quality laser-safe inks will impart some stain to the fuser roller and to the fuser wick without compromising performance or part life. The wick can perform despite significant staining if toner is not accumulating on the fuser roller. The staining may be reduced by minimizing coverage, by minimizing in-track bands, by interspersing less stressful (plain paper) jobs, by minimizing offset spray powders, and by using oxidative cure laser-safe inks that have been allowed to fully cure.

Oil residue

Contamination that appears as the result of large duplex runs may be due to fuser oil entering into the system. Gloss coated stock and heavy ink coverage can prevent fuser oil from being fully absorbed into the paper. Oil contamination may be reduced by interspersing simplex; plain paper runs in with duplex runs; by using uncoated stock and by keeping ink coverage to less than 30% dot coverage. Consult your service representative about optimizing the fuser oil application rate.

Hint: If oil contamination is observed, run approximately 50 to 100 sheets of plain, 8½" x14" (or ISO B4) 20 lb. bond paper through the imageRUNNER 110/110M/Pro 150+ in simplex mode without any image. In most cases, this will clean up any excess oil.

Cleaning

Frequent vacuuming or wiping with a clean cotton cloth is recommended to minimize spray powder contamination. Note that cleaning toner or ink from contaminated parts by using solvents or mechanical means is not recommended; this may damage the machine components. Call service for suggestions and for replacement parts.

Paper Primer

Experience has shown that when offset printed media is to be imaged a second time in an electrophotographic process, customers typically choose a paper suitable for the offset press. Though similar in appearance and physical properties, offset papers can differ significantly from xerographic papers in both performance and chemistry. There are however, some papers that will provide satisfactory performance for both applications.

Hint: Pre-printed materials intended for use with the imageRUNNER 110/110M/Pro 150+ should be printed with papers and inks that are compatible with the electrophotographic process. Papers designated by the manufacturer as laser, dual-purpose, multi-purpose, xerographic, etc. are strongly recommended. The following information will provide background information relative to these papers, their properties and their use.

The Technical Association of the Pulp and Paper Industry (TAPPI) is a good reference for paper related information:

- www.tappi.org
- 1.800.332.8686 (US)
- 1.800.446.9431 (Canada)

The Paper Manufacturing Process

The first step in the paper manufacturing process is the extraction of cellulose fibers from the plant material (usually wood). Two common methods are used are mechanical and chemical pulping.

Mechanical pulping retains lignin, the substance in wood that holds the fibers tightly together. This is a physical process in which large logs, after the bark has been removed, are ground into small cellulose fibers. The fibers are diluted with water and used directly in the paper manufacturing process. Because of the presence of lignin, mechanically pulped wood products turn yellow and photo-chemically degrade when subjected to light. This degradation process limits the effective life of a mechanically pulped wood product. Mechanically processed wood fibers produce a weaker paper and are commonly used for newsprint and coated magazine papers.

Chemical pulping removes the lignin by a chemical cooking process. This process separates the lignin and cellulose fibers from wood chips by using chemicals, pressure and heat. More costly than mechanical pulping, the chemical process yields longer cellulose fibers, which produce a stronger paper. The absence of lignin provides a very white durable pulp that is desirable for quality printing papers.

In addition to cellulose fiber, fillers are also added to the pulp mix to enhance surface smoothness, to increase brightness and opacity and to reduce porosity. The most common fillers and brighteners are clay, calcium carbonate and titanium dioxide. Uncoated alkaline-based papers contain a higher percentage of filler than comparable acid based papers.

To impart water repellency and ink holdout properties to the paper, sizing (in the form of rosin, gelatins, glues, starch, etc.) is added to both the pulp (internal sizing) and to the surface of the finished paper (external sizing) prior to final drying and finishing.

Paper is made when the refined pulp is applied in a controlled manner to a moving screen or wire. The wire allows the water to drain while capturing the fibers to form a paper “web”. Additional water removal is accomplished by pressing the wet web against an absorbent felt. Paper made on a traditional (horizontal) Fourdrinier machine will have a distinct two-sidedness known as "wire side and felt side". Papers made on newer high-volume production machines such as gap formers or hybrid twin-wire machines exhibit little or no two-sidedness.

The speed of the moving wire orients the cellulose fibers in the direction of the paper making process. This creates a grain direction within the sheet. Close examination of the finished sheet in the “X - Y” directions reveals this fiber orientation. Grain direction has a direct impact on the physical properties of the finished sheet.

Finished paper comes off the paper machine in the form of large “reels”, typically 10 or more feet wide (depending upon the size of the paper machine) and thousands of feet long. For "cut sheet sizes", the reels are then cut into smaller “rolls” which are then "sheeted" (slit) into smaller widths via slitter knives and cut to the desired length via chopper knives. Four to 6 rolls are usually run on a sheeter at one time. The 4 to 6 sheet set is called a “clip”. A typical 500-sheet ream will contain from 84 to 125 "clips" or groups of sheets from separate rolls.

Standard trimming tolerances for cut size U.S. papers is +/- 1/32 inch (.031") to 1/16 inch (.062"). For folio size papers the tolerance is +/- 1/16 inch (.062") to 1/32 inch (.031"). Standard cutting tolerances for European papers is +/- 2mm.

To keep first and second side duplex image placement in agreement, squareness of cut size sheets should be kept to within 1/32 inch. Commercially manufactured "cut size" sheets are usually guaranteed to this tolerance.

Weight tolerances are generally kept to within 5% of the nominal weight.

Individual reams of copy paper are wrapped in a material that is resistant to the transmission of water vapor. The wrapper serves to keep changes in the moisture content of the paper from occurring inside the wrapper and it also keeps the paper clean until ready for use.

Paper Types, Sizes and Terminology

Each paper type or family has evolved to fill a specific need or purpose:

Uses of paper

Book, offset and text papers are generally equivalent in weight (grams/square meter). Other physical properties such as caliper, surface smoothness, stiffness, moisture content, sheet brightness, and opacity can vary widely.

Book. Book papers are used for trade and textbooks as well as for general printing. They are less expensive than text papers and are made in a variety of colors and surface finishes. Book papers have a wider range of weights and bulk than text papers have, so it is possible to secure almost any desired bulking.

Offset. Offset papers are similar to the coated and uncoated book papers used for letterpress printing except that sizing is added to resist the moisture which is present in offset printing and the surface is treated to resist picking (lifting of fibers and small pieces of coating from the paper surface during the printing process).

Text. Text papers are noted for their interesting textures and attractive colors. They are frequently used for announcements, booklets and brochures. Most text papers are treated with a sizing to make them more resistant to water penetration and easier to print.

Bond. Bond papers are commonly used for letters and business forms. They have surfaces that accept ink easily from a pen or typewriter and can be easily erased. Copy or xerographic papers are included in the Bond family.

Cover. Cover papers (often coated) are made in heavier weights and matching colors for use as covers on booklets, etc. Within this family, many special surface textures are available with finishes ranging from antique to smooth. Special characteristics of cover papers include dimensional stability, durability, uniform printing surface, good scoring, folding embossing and die-cutting qualities. It is a useful rule of thumb that a cover stock of the same basis weight as text paper has about twice the thickness of the text paper.

Bristol. A “board” grade, Bristol has a softer surface than index or tab, making it ideal for high speed folding, embossing or stamping. It is an economical substitute for cotton fiber stocks. It is very receptive to ink and has good snap and resilience. Business cards are often printed on Bristol.

Index. A stiff, hard-surfaced paper used for file folders and file separators. Commonly used whenever an inexpensive stiff paper is required, it is available in both smooth and vellum finishes. Two outstanding characteristics are stiffness and receptivity to writing ink.

Tag. A tag is a utility sheet ranging in weight from 100 to 250 pounds for manufacturing tags. It may be made from sulfite, sulfate or mechanical pulp, and various types of waste papers. Tag board is sometimes tinted and colored on one or both sides. Tag stock has good bending or folding qualities, suitable bursting and tensile strength, good tear and water resistance, and a surface adaptable to printing, stamping or writing.

Hint: An equivalent weight chart can be found at the following website:
http://home.inter.net/eds/paper/grammage.html#bweightequiv

As the table of Equivalent Weights indicates, different types or "families" characterize paper. These are listed across the top and along the left side of the table. Book (also called Text and Offset), Bond, Cover, Bristol, Index and Tag are common. Notice that each type of paper has its own unique size. This is called the “basis” or “parent” size. The basis size for Book paper is 25 x 38”. The Bond basis size is 17 x 22” and so on for each paper type. The basis weight of any given paper is determined by the weight of 500 sheets (one ream) at its basis size. For example, 20# Bond means that 500 sheets of bond paper measuring

17 x 22" would weigh 20 pounds. For each family there is a weight range within which each paper can be purchased. The differences in family weight ranges reflect the physical differences between papers as well as the different basis sizes.

Within each paper type or family, there are different family members, papers belonging to the same family but made for different purposes. For instance, members of the Bond family include xerographic, laser, ledger, dual purpose (DP), and carbonless form papers. Each of these types has commonly available weights. Paper grade usually refers to quality and brightness level. For example, laser paper can be purchased in a number "1", "2" or "3" grade. A low-grade number indicates higher quality and brightness.

Despite these family differences, there are some commonalties. Reading across the table allows comparison of papers from different families and sizes. Again, looking at the 20# Bond example, the table shows that an equivalent weight in the Book paper family is 50#, or in the Cover family, 28#. Since the minimum weight of Cover paper is 50#, the 28# weight equivalent should serve as an example only. The easiest way to compare paper weights from different families is to use the grammage column on the right side of the table. Here it can be seen that a 20# Bond weighs the same as a 50# book paper. Both weigh 75 grams per square meter.

The European and the Japanese markets have their own systems to identify different paper sizes. In Europe, papers commonly weigh in the 70 to 90 grams per square meter (g/m2) range, with common sizes being ISO A4 (8.27 x 11.69" or 210 x 297mm) and ISO A3 (11.69 x 16.54" or 297 x 420mm). In Japan, weights range from 56 to 68 g/m2 and are commonly available in 3 sizes: JIS A4 (8.27 x 11.69" or 210 x 297mm), JIS B4 (10.12 x 14.33" or 257 x 364) and JIS A3 (11.69 x 16.54 or 297 x 420).

Brand Types

Papers can generally be purchased under the following three name brands schemes:

Mill Brands. Papers that carry the label of the paper manufacturer. Examples include Hammermill, Mohawk, Domtar, MeadWestvaco, etc.

Equipment Manufacturers. Brands that reflect printing equipment manufacturers brand names. Paper manufacturers will sometimes contract with equipment manufacturers to display their names on the ream and carton labels. Canon and HP are examples

Private or Merchant label. Papers generally bear the name of a supplier or paper distributor. These papers may be manufactured by a large manufacturer in the US or imported from other countries.

Ream / Carton Terminology

Paper labels differ by design from manufacturer to manufacturer. In addition, the same name-brand paper can be produced at multiple mills. As such, a given paper's characteristics may vary from lot number to lot number. This may effect how the paper performs in the printer.

The following consumer information is generally printed on each ream and carton label.

Brand name. This is the name that the paper manufacturer, equipment manufacturer, paper merchant or distributor has given to the product. Hammermill Tidal DP, Mohawk Options are examples.

Manufacturer name. This is the name of the company that manufactured the paper. Hammermill, Domtar, MeadWestvaco are examples.

Size of paper. US papers are listed in inches; European paper sizes are listed in millimeters

Color. Examples include white, off-white, blue, pink, yellow, etc. Usually pastels are used for office papers.

Number of sheets. Paper is generally packaged in reams (500 sheets). However, some heavy weight and specialty papers are packaged in reams containing fewer sheets.

Basis weight. This is the weight of 500 sheets of paper in its basis size. Basis weights are listed in pounds, while grams per square meter list most European and Japanese papers.

Thousand sheet weight. This is also called “M” weight. This is the weight of 1,000 sheets in its cut size. Used mostly by printers (who often purchase paper by weight) this description allows for a direct comparison of paper weights across all families. Since European papers use the g/m2 designation, they do not use the M weight comparison.

Direction of grain. This is the direction of the grain of the paper relative to the cut dimensions. "Grain long" means that the grain direction runs parallel to the length (long edge) of the sheet; "grain short" means that the grain direction runs perpendicular to the length (long edge).

Recommended use. Labels will sometimes list the equipment for which the paper is intended. Xerographic papers will often say “for high speed copiers and printers”, “Laser Compatible”, or simply “Xerographic”.

Suggested side for digital printing. Paper will print on both sides, but due to the inherent curl tendency built into the sheet, one side often is preferred for first-side printing. This is important when both sides of the sheet will be printed. Usually an arrow on the label indicates which side to print first. Note: when paper is loaded into the imageRUNNER 110/110M/Pro 150+ paper supplies, the side of the paper indicated by the arrow should be "down" in the paper supplies.

Item number. This is a product identification number used by the manufacturer. Sometimes accompanied by a bar code, it is used to identify this specific paper usually for re-ordering purposes.

Run, lot or batch number. Stamped on each ream and carton, this number identifies the manufactured lot of paper from which the ream or the carton came. It also identifies the mill, shift, finishing operation and personnel involved with the production of the paper. Should problems occur, this identification allows the mill to track manufacturing specifics about this paper.

Finishing Characteristics

The individual ream wrapper is typically a polyethylene laminate or wax coated sheet used to inhibit moisture penetration.

Deformation of the paper (indicating physical damage within the ream) can be determined by feeling the surface of the ream. A good ream of paper will be flat across the surfaces and at the edges.

During the finishing operation, the slitter knives cut several sheets of paper at one time (usually six). If the knives are dull, the slit edge of the top sheet will fold over the bottom sheet creating a “hook”. This deformed edge will impede the separation of individual sheets. Hole-punched paper can also exhibit this problem around the hole-punched areas.

Dull knives can also cause edge fray by leaving a ragged edge cut. Exposed and frayed paper fibers contribute to dusting and contamination of internal machine parts.

Sheet Appearance

Paper brightness is usually determined by grade, but it will vary by manufacturer and brand name. Higher quality papers usually mean brighter sheets at a higher cost.

Opacity is the resistance of a paper to image show-through. Increasing the amount of short fibers and filler level within the sheet can increase opacity.

Color is determined by dye additives, and must be rigidly controlled lot to lot.

A “natural” product at times can contain dirt, even in the best paper. Dirt can take the form of wood fibers, oil, black spots or other contaminants. Also, higher contamination levels are often found in recycled paper.

Paper Storage and Handling

The temperature and humidity of the area where paper is stored and used can have a definite influence on how the paper performs during any given imaging process. The following guidelines are recommended:

- Paper should be stored in the original carton and ream wrappers.
- The optimum paper storage and imaging operating conditions are:
    - 68 to 76 degrees F (20 - 24 degrees C)
    - 35 to 55% relative humidity
- Paper should not be stored directly on the floor, since storage in this manner increases the possibility of moisture absorption.
    - Store paper on shelves off the floor
    - If storage on the floor is necessary, stack on a wood pallet
- In areas of high humidity, store any partially used reams or cartons of paper in plastic wraps or bags.
- If paper is moved from a storage area to a location with a different temperature and humidity, the paper should be conditioned to the new location before use.

To determine how long paper should stand before unwrapping, first find the difference in temperature between the paper and the place it is to be used. Next, determine the cubic volume of the skid, or carton (for paper on skids or in cartons, the formula is: length (in.) x width (in.) x height (in.) = cubic volume). Using the temperature differential and chart, consult the chart for the correct time to acclimate.

Conditioning Chart for Paper (hours paper should be acclimated to pressroom temperature).

Temperature difference between storage and pressroom (degrees F)

Volume of Paper	10	15	20	25	30	40	50	60
96 cu Ft.	15	20	27	34	41	57	79	115
48 cu Ft.	14	19	26	32	39	54	75	109
24 cu Ft.	11	16	23	28	35	48	67	100
12 cu Ft.	8	14	18	22	27	38	51	78

Coated Papers

Coating improves the appearance qualities of the sheet and also provides some measure of chemical resistance and other functional properties. A coating is applied to paper to even out the irregularities of the sheet surface; enhancing smoothness Coatings consist mainly of pigments such as Kaolinite clay (most widely used), which has tiny platelet shaped particles. Calcium carbonate, ground natural limestone or precipitated from a manufacturing process, is also used and imparts brightness and opacity to matte or dull surfaced papers. The final dried coating is not a continuous film, but rather a porous structure of pigment particles.

Coated papers are available in a variety of different surface finishes, which vary according to gloss level. Some of the most popular finishes are:

- Gloss. High gloss is obtained by passing the paper between steel and fabric rollers of a super-calendar under pressure.
- Dull. Dull surfaced papers are passed through the super-calendar at low pressure, imparting a lower level of gloss to the surface
- Matte coated. Matte coated papers are fully coated but not super-calendared. This produces a finish similar to uncoated sheets but with the advantage of a uniform, fully sealed surface.
- Cast Coated. The coated surfaces of these sheets are cast against a smooth, chrome-plated drum producing a mirror-like reflectance, the highest gloss available.
- Coated-one-side (C1S). Lighter weight C1S sheets are widely used for labels. Heavier cover and board grades are often used for packaging.

Hint: Care should be taken when choosing coated papers. They must be designated for use with both the offset printing and electrophotographic imaging (i.e.: pre-printed shells). Consult with the paper manufacturer for specific recommendations.

Recycled Paper

Recycled paper is manufactured the same way as virgin paper. Recycled pulp is added to the manufacturing process along with the virgin pulp. However, recycling and de-inking processes reduce fiber length. Due to the shorter fiber lengths, softwood virgin fiber may be added to improve the stiffness and to stabilize other physical properties of the finished sheet.

In the United States (as of 1/1/99), the Environmental Protection Agency has defined recycled paper as a having a minimum of 30% Post Consumer Waste (PCW) content.

PCW is the primary raw material for the manufacture of recycled pulp. PCW is collected from diverse sources, sorted into separate different paper types and de-inked to remove printing inks and other contaminants. As a result, the quality and consistency of recycled pulp is more variable than virgin pulp. However, in recent years manufacturers have been able to significantly improve the quality of recycled papers. Although some differences remain, the performance of recycled papers has improved and can be expected to be similar to that of virgin papers.

Hint: Before using recycled papers, they should be tested for machine compatibility.

Alternate Fiber Materials

There are other papers that are manufactured from alternate fibers or are "tree-free". The fiber content of treeless papers may include kenaf, bamboo, banana, sugar cane, cotton, straw and a number of grasses.

Customers should be aware that these products also have a down side. Non-wood fiber is often expensive due to higher fiber extraction costs and the seasonal nature of some plant material. Higher pulping costs can drive up the cost of alternate fiber paper to the range of premium wood fiber papers.

Hint: Papers containing non-wood fiber may have different physical properties than those produced from traditional wood fiber sheets, and as such should be evaluated for machine compatibility.

Paper Properties

The physical properties of a paper such as weight, caliper, etc. are designed into the sheet during the manufacturing process to meet the needs for which the sheet was intended. Although some physical properties may be common to both electrophotographic and offset printing applications, some properties may be unique to each process. For example, a xerographic paper is designed to perform within a specific range of electrical resistivity, while a paper intended for an offset printing application may be designed with little or no consideration concerning electrical properties.

Paper interacts with almost every subsystem in the electrophotographic process. Properties of paper, such as stiffness, surface smoothness, etc., determine how the paper interacts with handling subsystems (feeder, mainframe and accessory paper paths), and with detack from the image loop and fuser. Electrical properties such as resistivity / conductivity impact the charging, transfer and paper handling subsystems. Paper properties can also impact the quality of the image.

Physical paper properties can impact any of the three areas of the electrophotographic process: 1) mechanical (handling), 2) electrostatic (toner/image transfer), and 3) image quality. The following list of measurable properties (bolded) will serve to define these values and to summarize, where relevant, their potential impacts with the electrophotographic process:

Basic Sheet Size. This is the size that is used to determine paper substance weight. Size varies depending upon the type of sheet; for instance, for bond papers, basic sheet size is 17 x 22 inches.

Basis Weight. Basis weight defines the weight of a fixed number of sheets per unit area of any type of paper. It is expressed as the weight in pounds of a ream (generally 500 sheets) of paper cut to a given standard size for that grade (basic sheet size). Because of variations of ream sizes specified for various grades of paper, a table of equivalent weights is sometimes necessary to correlate sheets of different grades.

Hint: A conversion chart for comparing paper weights can be found at the following website: http://home.inter.net/eds/paper/grammage.html#bweightequiv

Gram Weight. An alternative metric weight description used mostly outside the United States, gram weight (grammage) is the general equivalent of basis weight (pounds per ream) expressed in grams per square meter (g/m2 for a single sheet). Also see the section on Caliper for additional descriptions.

Caliper. Caliper refers to the thickness of an individual sheet measured under specified conditions, usually expressed in thousandths of an inch (mils). Some papers are specified in terms of "points". For example, 8-point stock is 8 mils thick. (0.008").

In general, as the caliper or thickness of a paper is increased, the stiffness or bending resistance is also increased. Paper caliper must be considered relative to paper supply capacity. Thicker sheets will occupy more space and therefore reduce the number of sheets in the supply. For example, 20-pound bond paper is approximately .004" (4mils) in thickness. One thousand sheets of 20-pound bond paper will be approximately 4 inches in thickness. Similarly, 110-pound index paper is approximately .0085" (8.0mils) in thickness. One thousand sheets will be 8.5 inches in thickness. In the imageRUNNER 110/110M/Pro 150+ Product Family, paper supply capacities are specified in terms of 20-pound bond paper. Given the difference in paper caliper, the paper supplies will hold ½ the number of 110 index sheets as 20 pound bond sheets.

Papers with a common basis weight but having different surface smoothness characteristics can also differ in caliper. Thicker paper will create more disturbances as it enters roller nips, particularly at the fuser. This disturbance can cause irregularities in drive speed, which may result in a cross-track image artifact.

Paper caliper can affect the toner transfer process. When the transfer process deviates from the ideal “constant current” situation to a “constant voltage” situation, the electric fields seen by the toner in the transfer process will approach an inverse dependency on the thickness of the sheet: Electric Field = voltage / caliper. In other words, the thicker the paper, the less electrical field the toner will see and the less toner will be transferred.

Image quality is also affected by caliper. Thicker sheets have higher opacity and reduce image “show-through” on duplex prints. Thicker papers can also reduce toner adhesion by acting as a heat-sink, leaching heat away from the toner-to-paper fusing process.

Hint: In some cases, the Field Engineer can adjust the fuser to compensate for the heat loss in thicker papers. However, these changes can also induce a phenomenon called "bricking" where the fused output sheets stick together when stacked in the delivery. High fusing temperatures can also induce "blisters" in coated papers.

Smoothness. This is the surface property of paper related to its degree of uniform evenness and flatness, which generally determines the crispness of the printed image. One commonly used measurement for smoothness is the Sheffield smoothness scale. It is a measure of the airflow at a specified pressure that escapes from under a specified disk, which is held against the sheet with a given weight.

Surface smoothness can affect paper feeding and handling. Smoother paper increases sheet-to-sheet contact between sequential sheets in a stack. To separate individual sheets from the stack, air must be introduced between the top sheet and the rest of the stack. Smooth surfaced papers make the air introduction process more difficult. Further, high sheet-to-sheet contact also increases friction between sheets. With increased friction, there is a greater possibility of misfeeds, multi-feeds and feed skew.

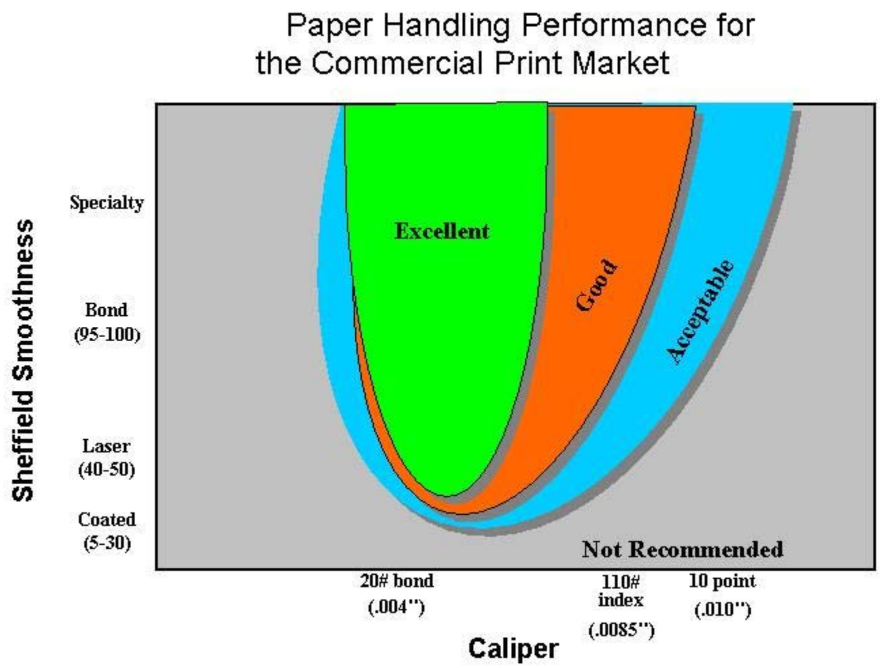
The electrostatic effects of smoother papers can affect toner transfer and detack of the paper from the photoconductor. Smoother papers provide a high level of contact with the film and toner. This minimizes gaps between the paper and the toner, increasing the efficiency of the toner transfer process. However, this increased contact, along with the electrostatic forces holding the paper to the film, makes a smoother paper much more difficult to detack from the photoconductor. This may result in an increased jam rate in the detack area.

Image quality issues such as toner adhesion, image density and background are also affected by paper smoothness. On a microscopic scale, the toner on a smooth paper will sit higher on the surface than on a rougher surfaced sheet. This effectively increases the efficiency of heat transfer to the toner, thus allowing the toner to fuse into the paper better.

Smoothness can also affect the density and sharpness of the toned image. Good density with little or no mottle is obtained with smoother papers. Rougher surfaced papers will often exhibit a loss of print density (mottle) edge and image sharpness.

Smooth surfaced papers can also increase the visibility of undesirable image background. Background particles are produced when stray toner particles are deposited in non-image areas of prints during the transfer process. When fused, background toner can spread uniformly on a smooth surface paper to create a larger spot. Rougher surfaced papers generally produce less visible background.

Hint: See Chart below for general paper handling performance relating smoothness and caliper.



Stiffness. This is the degree of resistance a paper has to the stress of bending.

Paper stiffness is geometrically related to sheet caliper. As sheet thickness increases, bend resistance is also increased substantially. Stiffness can also be affected by paper grain direction. In general, papers are twice as stiff in the cross-grain direction as the in-grain direction.

Mechanically, paper stiffness affects the way paper feeds and transports. Low stiffness papers do not have the beam-strength to support themselves across areas where they may not be physically supported by a paper handling mechanism. The gap between the paper handling subsystem and fusing subsystem is one example. Further, there is a minimum sheet stiffness required to enable a feed mechanism to reliably remove and feed one sheet at a time from a stack of paper.

Conversely, high stiffness papers are difficult to transport around bends in printer paper paths. The imageRUNNER 110/110M/Pro 150+ has a distinct advantage in this area with its short, straight paper path.

Stiffness properties also affect the paper's ability to release from the film after image transfer and from the fuser rollers after fusing. In the case of detack from the film; paper stiffness and sharp angle bends can be leveraged to break the electrostatic attraction of the paper and film. The design of the fusing subsystem also balances the stiffness of the paper and the release characteristics of the fuser rollers to promote detack. Lower stiffness papers are generally more difficult to detack from either the film or fuser rollers.

Sheet stiffness can also impact image quality. High stiffness papers can damage the photoconductor causing image artifacts. Stiffer papers offer less conformity to the transfer and fusing nips and thereby effectively reduce the efficiency of the transfer and fusing processes. This can result in lower toner adhesion and other image artifacts.

Hint: If thick, stiff paper is used, a sheet that is cut such that the grain direction is perpendicular to the direction of feed in the imageRUNNER 110/110M/Pro 150+ may perform better than one where the grain is parallel to the direction of travel.

Moisture Content. Moisture content is a measure of the percentage of water, by weight, contained in paper (pulp, paperboard, chips, etc.) that will vary according to atmospheric conditions.

High moisture content in the paper will affect handling performance by increasing the propensity of the paper to curl and by lowering sheet stiffness. High curl will occur in the paper supply if high moisture papers are subjected to low relative humidity (RH) conditions. Paper with high moisture content will also exhibit a high level of post-fuser curl as the moisture is driven out of the paper by the fusing process. Finished copies will generally curl toward the heated side of the paper.

Papers with low moisture content will cause static in the transport and fusing systems that can cause transport and feed problems. They may also wrinkle in environments with high relative humidity.

Paper will also expand as it absorbs moisture. The magnitude of expansion and shrinkage will be much greater in the cross-grain direction and will be dependent on paper type, caliper and composition. Papers that are coated on one side only (C1S) have a high propensity to curl toward the coated side as the uncoated side absorbs moisture and expands. In dry conditions, C1S papers will curl toward the uncoated side as the sheet looses moisture. In addition, papers with high moisture content will exhibit noticeable shrinkage when heated and dried during the fusing process. This will affect the dimensional stability of the sheet and also have a direct impact on front side to back side image registration.

Papers recommended for use with an electrophotographic process are closely controlled for moisture content (about 5%). Offset printing papers will generally have a higher moisture percentage, and the printing process itself can also add moisture to a sheet.

Hint: If pre-printed offset sheets are to be run on the imageRUNNER 110/110M/Pro 150+ they should be stored, un-wrapped in a temperature and humidity controlled environment during the ink cure time (70 degrees F and 40-60% RH for 72 hrs minimum is strongly recommended).

Coated papers with high moisture content or with an incompatible coating material can blister and jam when exposed to the heat and pressure of an electrophotographic fusing system.

Resistivity. Resistivity is a measure of how well the paper will conduct or hold an electrical charge.

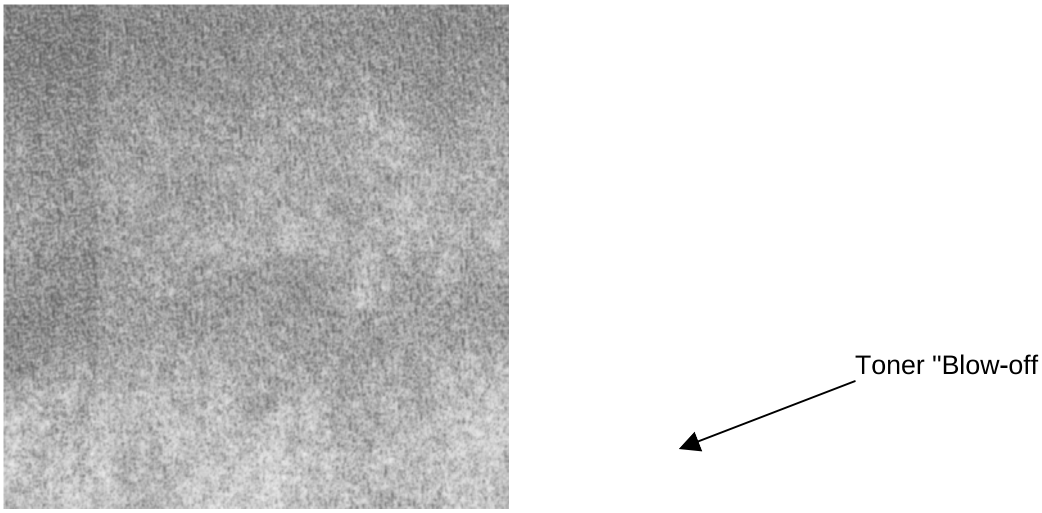
In an electrophotographic imaging process, moisture content has a direct impact on the electrical resistivity of paper. A sheet with high moisture content will have a lower resistivity (high conductivity). Conversely, low moisture content will produce high resistivity (low conductivity).

The formation of a static electrical charge within the sheet is of concern from a paper-handling standpoint. Sheets with high resistivity will inhibit the release of static charges that form during the paper handling process. This can lead to a high number of jams.

Hint: In colder climates in the winter, the relative humidity in heated buildings can drop as low as 10-15%. Storing open stacks of paper in this environment can dry the paper around the edges of the stack. Raising the humidity level of the storage and operation areas to 40-50% RH may improve paper handling and imaging performance.

Paper must also be able to sustain an electrical charge for efficient toner transfer and be able to dissipate that charge for separation from the image loop after imaging. Paper with low resistivity will not be able to sustain the constant charge density necessary for efficient transfer of toner. High resistivity papers will produce a localized breakdown of the transfer fields that disturb toner laydown, possibly producing image artifacts.

Papers with high resistivity can directly affect the toner transfer process and subsequent image quality. High resistivity can cause localized electrical field breakdowns and disturb toner transfer, which in turn can cause poor image continuity and a phenomenon called "toner blow-off."



Example of Toner Blow-off on a Grayscale image.

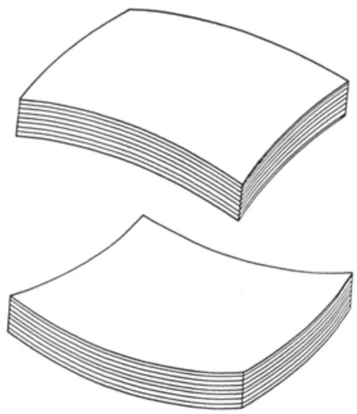
Sheet Flatness (curl and cockle). Sheet flatness refers to the quality of a sheet of paper, that which makes it resistant to curling and distortion.

Inherently, paper is manufactured with a built-in curl. Papers generally curl toward the last side dried when the paper is manufactured. This amount of curl (called out-of-ream curl) is controllable during the manufacturing process.

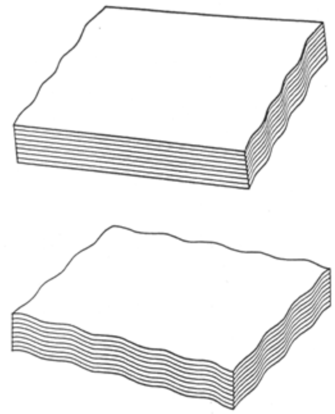
In a high humidity environment, some papers may exhibit a defect known as cockle, a small-scale physical distortion of the surface of the sheet that imparts a rippled appearance to the paper surface. Cockle is caused by non-uniform shrinkage and expansion of high and low densities of fibers within the sheet. The expansion and shrinkage of these areas can be accentuated by changes in ambient relative humidity conditions.

Cockle prevents a uniform surface-to-surface contact between the paper and the film and will impact both electrostatic performance and image quality. This non-uniform contact is the result of air gaps caused by the deformed areas of the paper. This leads to non-uniform transfer, which results in image voids. The imageRUNNER 110/110M/Pro 150+ uses a roller transfer system to minimize this artifact.

When paper is exposed to fluctuations in environment, curl and cockle can be accentuated. In a dry environment, paper will curl generally parallel to the grain direction. Stacked sheets will exhibit "tight edges" due to moisture loss at edge of the stack. In a humid environment, paper will expand resulting in cockle or curl. If sheets are stacked, wavy edges will occur at the exposed edges due to the increased moisture absorption. These irregularities can result in an increase in feeding errors and in image quality artifacts.



Curl results when moist paper is exposed to dry environment



Wavy edges result from paper being exposed to a moist environment

Hint: Paper should be protected from extreme environments as much as possible, especially after any protective wrapping has been removed. This is especially important with recycled paper.

Hint: If feed errors occur, check the curl direction of the paper in the supply. Generally, paper feed can be improved by orienting the paper in so that the curl is in the "down" direction. Whenever new paper is added to the paper supply, any remaining paper should be removed and placed on top. It is also a good idea to remove any sheets with bent or folded corners. Remove the top 5 to 10 sheets from the supply before starting up after an extended period of non-use.

Paper stacking is also influenced by curl. Tray capacities for paper stacks can be negatively affected by curl whether it is in the paper drawers**,** paper path, or accessories. Curl will decrease tray capacity and must be planned for in equipment operation. Curl can also have a significant impact on the number of jams that occur in the imageRUNNER 110/110M/Pro 150+.

In an electrophotographic process, curl can also impact the mechanics of how well the paper will detack from the film and release from the fuser rollers. Curl in the direction of the film during detack or in the direction of the fuser roller during release will impede the release of the paper.

Hint: Note the axis of the curl. Paper will generally curl along the grain direction of the sheet. A diagonal curl should never be present and is most often the cause of excessive jams.

Hint: The imageRUNNER 110/110M/Pro 150+ has a Post-Fuser Decurler unit that can be adjusted to compensate for sheet curl caused by fusing.

Porosity. Porosity is the degree to which a paper will allow the permeation of air, gas, or liquid, determined by the compactness of its fibers.

In general, paper porosity has minimal impact on the imageRUNNER 110/110M/Pro 150+.

Coefficient of Friction. A characteristic determined by measuring the sliding resistance of sheets from one another, after they have been pressed together.

The imageRUNNER 110/110M/Pro 150+ uses an air assisted vacuum feed that is relatively insensitive to coefficient of friction. However, high friction coefficients between sheets in a stack can result in feeding or stacking difficulties.

Formation. This is the uniformity of a paper's fibrous structure and distribution.

Variations in formation can result in un-even moisture distribution throughout the sheet. Un-even moisture distribution can create cockle and non-uniform electrical resistivity within the sheet. Cockle can result in poor paper-to-film surface contact, and uneven resistivity will contribute to non-uniform toner transfer and poor image continuity on finished prints.

The imageRUNNER 110/110M/Pro 150+ uses a roller transfer system to minimize these effects.

Edge Cut. Poor edge cut can cause hooking or padding of sheets within a ream, resulting in misfeeds and multi-feeds.

Poor edge cuts can also result in high dust contamination levels. Contamination of the electrophotographic process can lead to premature wear of parts, image artifacts, image loop (scumming), and charger contamination.

Hint: It may be important to monitor edge cut quality, especially if sheets are cut on customer equipment. Ragged edges may indicate a dull or damaged cutting blade. Also, riffling the stack of paper aggressively when loading the paper supplies may help to loosen any interlocked edges.

Surface Abrasion Resistance. This is the degree to which paper can withstand repeated scuffing, rubbing or scratching, as measured by weight loss of the sample.

Mechanically, paper-handling subsystems can disturb the paper surface, resulting in the release of fillers and other contaminants. These can find their way into other areas of the imageRUNNER 110/110M/Pro 150+ and result in performance degradation.

Electrically, dust generated during paper handling can contaminate chargers and film, leading to non-uniform charging. Non-uniform charge levels will produce image voids and artifacts.

Canon

Issues Regarding Pre-printed Media

imageRUNNER 110/110M/Pro 150+ Product Family Paper Supplies & Main Print Engine

Material	What runs well	What can run with limitations	What will not run or will cause problems
Papers	Papers within the imageRUNNER 110/110M/Pro 150+ specification range; xerographic papers; toned imageRUNNER 110/110M/Pro 150+ images onto xerographic papers that are uncoated and pre-printed using laser safe inks. Uncoated papers with a Sheffield smoothness > 95 and a caliper greater than 0.004" and less than 0.006". Refer to Smoothness / Caliper chart	Some types of 80# (216 g/m2); cover stock (outside imageRUNNER 110/110M/Pro 150+ weight range); offset (printing) paper; heavy stack weight papers (paper supply lift problem: >20 # in upper drawer, >35# in middle drawer & >45# in lower drawer); toned imageRUNNER 110/110M/Pro 150+ images onto low ink dot density (</= 30%) pre-printed, coated papers that are within the specified weight. range. Uncoated papers with a Sheffield Smoothness > 50 and a Caliper greater than 0.004" and less than ~0.010". Refer to Smoothness / Caliper Chart	Some 80# cover stock (especially coated); heavy weight gloss coated papers (registration & paper feed problem); toned imageRUNNER 110/110M/Pro 150+ images onto high ink dot density (>30%) pre-printed, coated papers that are within the specified weight range. Refer to Smoothness / Caliper Chart

Material	What runs well	What can run with limitations	What will not run or will cause problems
Ink	"Xerographic", laser safe or high temperature rated inks that have been well cured. Consult ink manufacturer for specific recommendations	Some "xerographic", laser safe or high temperature rated inks that have not cured well	Rubber based inks; quick-set or cold-set inks; metallic inks; scuff resistant inks (high wax content)
Spray Powders	Minimal amounts of spray powders over short run lengths coupled with regular imageRUNNER 110/110M/Pro 150+ cleaning & maintenance	Heavy application of spray powder is not recommended as it causes machine contamination; heavy amounts of spray powders over long run lengths coupled with regular imageRUNNER 110/110M/Pro 150+ cleaning & maintenance	Heavy amounts of spray powders over long run lengths without imageRUNNER 110/110M/Pro 150+ cleaning & maintenance
Printing Process	Standard Speedmaster & Quickmaster process set-ups.		Heavy transfer of moisture to the paper can cause curl problems
Ink and paper combinations **Note:** Ink and paper combinations were tested under tightly controlled laboratory conditions with engineered test target documents. This is not to be considered an endorsement of these materials by Canon L.L.C. for use in the imageRUNNER 110/110M/Pro 150+ Product Family	Superior Special Laser Safe Ink on Domtar Plainfield Opaque 80 lb. Text (Cured for >2 weeks) * Superior Product Nos. are: YB5082 MRB8724 MBD6551 AC3034 K&E Novavit F908 Bio on Mead Westvaco Sterling Ultra Gloss 80 lb. Text. (Cured for >2	K&E Novavit F908 Bio on Domtar Plainfield Opaque 80 lb. Text - Cured for >2 weeks * Superior Special Laser Safe Ink on Mead Westvaco Sterling Ultra Gloss 80 lb. Text-Cured for >2 weeks * Superior Product Nos. are: YB5082 MRB8724 MBD6551	Non-laser safe inks Uncured laser safe Inks (Cured less than 72 hours)

Product Family.	weeks) *	AC3034	

imageRUNNER 110/110M/Pro 150+ Finishing Accessories

Material	What runs well	What can run with limitations	What will not run or will cause problems
Papers	Papers within the imageRUNNER 110/110M/Pro 150+ specification range; xerographic papers; uncoated papers with a Sheffield smoothness > 100 and a caliper greater than 0.004" and less than 0.006". See chart on Smoothness and Caliper	Some types of 80# (216 g/m2); cover stock (outside imageRUNNER 110/110M/Pro 150+ weight range); offset (printing) paper; uncoated papers with a Sheffield smoothness > 50 and a caliper greater than 0.004" and less than ~0.010". See chart on Smoothness and Caliper	Some 80# cover stock (esp. coated); heavy weight gloss coated papers (registration problem); booklet maker may need to be adjusted for satisfactory booklet results. See chart on Smoothness and Caliper
Pre-Printed Media	Pre-printed sheets within the imageRUNNER 110/110M/Pro 150+ specified weight range (sheet weight & stack weight); pre-printed xerographic papers; pre-printed media that is properly dried (>72 hours). See chart on Smoothness and Caliper	Certain types of overcoats and varnishes; there is no recommended overcoat at this time; some types of 80# (216 g/m2); cover stock (outside imageRUNNER 110/110M/Pro 150+ weight range); offset (printing) paper; See chart on Smoothness and Caliper	Some 80# cover stock (esp. coated); heavy weight gloss coated papers (registration problem); booklet maker may need to be adjusted for satisfactory booklet results. See chart on Smoothness and Caliper

Corrective Action for Pre-Printed Media:
Hints, Tips & Troubleshooting

Print Engine and Fuser

Issue	Cause	Corrective Action
Rapid contamination	Non- laser-safe ink	Contact ink or media supplier to obtain proper laser-safe ink
Rapid contamination with laser-safe ink	Wet ink	Allow 72 hours to 1 week for complete curing. Avoid sealing stack in plastic before completion of ink cure. Allow pre-printed media to cure, un-wrapped, in a temperature and humidity controlled environment.
Contamination	Laser-safe ink not sufficient	Contact ink or media supplier, request reformulation for improved heat resistance
	Excess offset (spray) powder on prints	Reduce offset powder to minimum required to prevent backside marking of prints. Conduct regular maintenance with thorough cleaning of imageRUNNER 110/110M/Pro 150+ System.
	Heavy coverage on coated stock	Use 30% or less ink coverage. Substitute uncoated stock. Mix in less stressful (plain paper) jobs when possible. Shift continuous in-track inked areas to cross track.
Contamination with varnished stock	Non- laser-safe varnish or suppression of ink cure	Contact ink or media supplier. Select a laser-safe varnish, apply after ink has cured
Working ink suddenly contaminates	Change in printing process	Check for change in: - ink coverage / laydown - in-track ink image - fountain pH - use of varnish - dry time (unsealed) - quantity of spray powder
	Change in job stream	Check for change in: - length of duplex run - mix of stressful pre-print jobs - ink / oil hold-out of paper

Issue	Cause	Corrective Action
Toner adhesion to inked images	High percentage (>40%) dot coverage	Keep dot coverage in the range of 30% or lower.
	High gloss coated stock	For highest adhesion properties uncoated papers are recommended
Matting of gloss overcoat	Micro-blistering due to heat and pressure	Avoid overcoats on heavy ink coverage or coated stock. Try alternate paper stock.
Uneven paper stack	Localized image on thin smooth stock	Distribute image around sheet or process smaller stacks. Coarser (i.e. uncoated) or thicker stock may also help.
Objectionable Odors	Non-laser-safe materials	Use only laser-safe inks and papers. Contact ink and paper manufacturers.
Back side marking	Duplex oil contamination	Intersperse simplex and duplex jobs. Replace coated stock with more absorbent paper. Screen solid ink areas to 30% or lower dot coverage. Discuss optimizing oil rate with service technician.
Gloss over coat matting	Aqueous over coat surface changes due to heat & fuser surface finish	Avoid using aqueous over coats.
Ink image ghosting	Uncured ink	Use only laser safe inks; Allow pre-printed media to dry a **minimum** of 72 hours
Toner Adhesion to Inked Images	High percentage (>40%) dot coverage	Keep dot coverage in the range of 30% or lower
Toner Adhesion to Inked Images	High gloss coated papers can cause degradation in toner adhesion. Paper is too smooth	For highest adhesion properties uncoated papers are recommended. Use a paper with a Sheffield Smoothness > 50
Contamination	High rates of printer's dust in combination with low maintenance & general lack of cleaning	Use low to moderate amounts of printer's dust. Regular maintenance with thorough cleaning of print engine.
Image Disruption (pre-fuser toner smearing	Thermal build-up in pre-fuser paper transport hardware	Keep basis weight <200 g/m2 & use caution in selecting high gloss coated papers

Paper Supplies & Registration

Issue	Cause	Corrective Action
Mis-feeds & poor paper transport	Paper Stiffness	Keep Basis weight <200 g/m2; Caliper < 10 mils for uncoated. < 6 mils for coated papers
	Paper is too smooth	Use paper with a Sheffield Smoothness > 50. See Smoothness & Caliper Chart
Mis-feeds & poor paper transport	High paper moisture content resulting in curl, cockle & paper edge inconsistencies.	Fountain solution application should be kept at a minimum;
	Paper is too smooth	Use paper with a Sheffield Smoothness > 50 In some cases, increasing vacuum levels in the Paper Supplies may help. See Smoothness & Caliper Chart
Mis-feeds	Gloss Coated Paper sticking together.	Proper printing dust application can help; load paper with curl down.
	Paper is too smooth	Use a paper with a Sheffield Smoothness > 50. See Smoothness & Caliper Chart
Mis-feeds	Poor paper cut quality	Use sharp well maintained paper cutter equipment; avoid small lot sizes in final cutting process; fan sheets on all four edges before loading.
Mis-registration	Paper Stiffness	Keep basis weight <200 g/m2 & use caution in selecting high gloss coated papers. Caliper for coated stocks < 6 mils.
	Paper is too smooth	Use a paper with a Sheffield Smoothness > 50. See Smoothness & Caliper Chart

Mis-registration	Inadequate coefficient of friction. Paper is too smooth	Fuser oil from side 1. Keep basis weight <200 g/m2 & use caution in selecting high gloss coated papers; fan sheets on all four edges before loading in the paper supplies Install FRU #J0337 (heavier springs) to increase drive force. Use a paper with a Sheffield Smoothness > 50. See Smoothness & Caliper Chart
Paper Lift Overload	High density coated papers (typically 2x that of bond)	Limit the stack height of heavy weight, coated, large format papers (A3, 11x17, 12x18, 14x17, 14x18). <20 # in upper drawer, <45# in middle drawer and lower drawer)
Cover & page marking	Uncured ink & low scuff resistance ink	Allow ink to cure for a minimum of 72 hours**,** and use high scuff resistant inks

Stapler

Issue	Cause	Corrective Action
Stapling alignment & performance	Heavy weight cover and insert papers	Keep basis weight <200 g/m2 and use caution when selecting heavily coated papers. Caliper < 10 mils for uncoated; caliper < 6 mils for coated
Contamination	High rates of printer's dust in combination with low maintenance and general lack of cleaning	Use low to moderate amounts of printer's dust. Regular maintenance with thorough cleaning of Print Engine
Cover & page marking	Uncured ink and low scuff resistance ink	Allow ink to cure for a min. of 72 hours and use high scuff resistant inks

Stacker

Issue	Cause	Corrective Action
Stacking alignment	Heavy weight, high gloss covers on thick booklets	Keep basis weight <200 g/m2 and select matte or dull cover finish
Paper throughput	Paper path structural deformation due to thermal buildup	Keep basis weight <200 g/m2 and use caution in selection of coated papers – recommend uncoated papers
Contamination	High rates of printer's dust combined with low maintenance and general lack of cleaning	Use low to moderate amounts of printer's dust. Regular maintenance with thorough cleaning of accessories.
Cover & page marking	Uncured ink & low scuff resistance ink	Allow ink to cure for a minimum of 72 hours and use high scuff resistant inks
Paper Bricking	Excessive heat retention in the stacked paper	Keep basis weight <200 g/m2 and use caution in selecting coated papers. Uncoated papers recommended. Remove paper from stacker more frequently.
Paper Marking	Marking on paper from paper path hardware that is deflecting due to thermal build-up	Keep basis weight <200 g/m2 and use caution in selection of coated papers. Uncoated papers recommended.

Booklet Maker

Issue	Cause	Corrective Action
Cover marking	High gloss, cover paper in conjunction with thick booklet production	Use caution when selecting coated cover papers – recommend uncoated covers
Booklet registration & alignment	High gloss, heavy weight papers	Keep basis weight <200 g/m2 and use caution in selection of coated papers - recommend uncoated covers
Contamination	High rates of printer's dust in combination with low maintenance and general lack of cleaning	Use low to moderate amounts of printer's dust and routine maintenance with thorough cleaning of print engine
Cover & page marking	Uncured ink & low scuff resistance ink	Allow ink to cure for a minimum of 72 hours and use high scuff resistant inks
Semi-Bricking	Toner transfer and offset due to thermal build-up in paper	Keep basis weight <200 g/m2 and use caution in section of coated papers - recommend uncoated covers; Remove paper more frequently.

Appendix A

Ink and Coating Recommendations

Offset Inks <u>to be avoided</u> when you want to overprint B&W variable data

- Rubber based inks
- Quick-Set or Cold-Set inks
- Metallic inks
- Scuff resistant inks, because of their high wax content

For color covers that will be inserted into a document without going through the fusing process, high scuff resistant inks are recommended.

Offset Inks that have shown good results when overprinting B&W variable data

- **<u>Laser compatible</u>**, because they dry quickly and cure within 72 hours. Must be able to resist the effect of the fusing process. The imageRUNNER 110/110M/Pro 150+ fusing temperature is 350 to 375 degrees F. (depending on model – imageRUNNER 110 or imageRUNNER 110M)
- When possible, suggest that the design process include a non-inked area where the B&W variable overprint is to go. Printing directly on paper instead of on offset ink in general results in better toner adhesion.

Ink Tips for the Offset Printer

- Ink density should be kept to a maximum of 30% dot coverage and the amount of fountain solution should be kept to a minimum.
- Printed sheets should be kept in a controlled environment (temperature and humidity)
- Use of offset powder - 23-micron particle size at the minimum application rate was found to be acceptable. Overuse will contaminate the imageRUNNER 110/110M/Pro 150+.
- **Use papers designated for digital printing or dual use.** Many offset printing papers contain high amounts of moisture and will blister when run through the Fuser.

Varnish and Aqueous Coating

These coating are generally not compatible with the effects of the fusing process - The coating can melt and contaminate the imageRUNNER

110/110M/Pro 150+. Toner will not adhere well to these coatings. Use only when the paper will not be exposed to the fusing process.