WHITEPAPER

A Brief Introduction to Media

DATAMAX®

What is Media?

"Media" is the general term used for the various paper, synthetic, adhesive, inking and other materials used to produce the labels needed in any bar code labeling application. In this sense "Media" is a rather broad term, encompassing a very large and diverse array of materials and technologies. However, we shall restrict ourselves to those labeling applications where labels are produced in house, typically at the site of their usage. "Media" then refers to the actual label materials used and the specific inking ribbons or inking chemistry used to generate images on the label materials.

The major benefit of printing on labels is flexibility. Labels can be printed one at a time or in batches to suit any application's particular needs. Printing labels in-house removes the need to plan well in advance of their usage and eliminates the need to carry any finished label inventory. There are several technologies available which are as follows:

> Impact printing, including line printers and serial printers.

> Toner-based printing, including laser, LED and Ion-Deposition.

> Thermal printing.

Impact Printing

Impact printers were very commonly used to print labels with bar codes and, unlike toner-based or thermal printers, impact printers can be used to print multi-part forms. Impact printers are typically used to create "batches" of labels, not one label at a time. Generally the printers are very durable but tend to be slow. Because of the way that impact printers create images, they cannot print very high density bar codes. Some line printers cannot produce bar codes with "X" dimensions smaller than 16 to 20 mils. and serial printers can produce bar codes with "X" dimensions as low as 11 to 14 mils. However, toner-based and thermal based printers can print bar codes with "X" dimensions smaller than 3 mils. Impact printers utilize an "inked ribbon" containing variable amounts of ink. Because of this, maintaining proper print contrast and the dimensional accuracy of the bars and spaces is a significant problem for impact printers. A new ribbon can transfer too much ink to the label surface, making the bars too wide and the spaces too narrow and also causing the images to smudge. An old ribbon can transfer too little ink, making the bars too narrow, the spaces too wide and not providing sufficient optical contrast between the bars and spaces. For these and other reasons, impact printers are not generally used today for bar code label printing.

Toner-based Printing

Several different types of printers use toner instead of ribbons for their inking technology. These include laser printers, LED printers and ion deposition printers. Typically these printers are used to print "batches" of labels, not one label at a time. Unlike desktop laser printers, industrial toner-based printers are designed to accept fan folded or rolled label media and also feature a very straight paper path. Laser printers can create very high quality labels with excellent bar codes. However, due to the toner based imaging technology, the images must be "fused" to the label material. Because "fusing" is accomplished by subjecting the toner and label to high temperatures and/or high pressures, the variety of label materials suitable for toner-based printing is limited and tends to be expensive.

Thermal Printing

Thermal printers are designed to print very high quality labels with or without bar codes. There are two general types of thermal printers, "Direct Thermal" and "Thermal Transfer". Each type utilizes a computer controlled print head that contains many hundreds, or even thousands, of tiny electric heating elements (called dots) that can be heated and cooled very rapidly. Like conventional FAX machines, direct thermal printers image the paper directly, using no ribbon, while thermal transfer printers use a temperature sensitive inked ribbon that transfers ink to the paper or synthetic label material when heated. Both types can print bar codes with "X" dimensions as small as 3 mils. Thermal printers are capable of producing very high quality labels and can be used to print as few as one label at a time or very large batches of labels. Additionally, since thermal printers directly image onto the label material, no "fusing" process is required and a very large variety of label material can be used.

Direct Thermal Printing

Direct thermal printers create high quality images on temperature sensitive label media without using a ribbon. FAX machines work in a similar fashion but direct thermal printers use a much higher quality of label material. The imaging process is called "dye melt reaction". An image is formed by selectively getting a special type of "dye" (coloring agent) to mix with a special type of "developer" (a material that when mixed with the dye, creates a permanent coloring to occur). A thin coating of a colorless "leuco dye" and an "acidic developer" resides on the label surface. The thermal print head selectively applies thermal heat energy to the label surface, melting the "leuco dye" and the "acidic developer" together. A chemical reaction occurs between the dye and developer forming the contrasting color visible image, typically black. The process is depicted by the diagram below. The label itself is composed of several layers of different materials. An array of resistive heating elements is mounted on a ceramic substrate and is held in contact with the top surface of the label material. Each resistive heating element is similar in principle to that found in your toaster but is very much smaller (from 5 mils and smaller!) This array of heating elements is called the "Thermal Print Head".

When an image is to be formed, electricity is sent through the tiny resistive heating elements causing the electrical energy to be converted to thermal heat energy. This thermal heat energy in turn flows into the label surface and causes the temperature of the thermally sensitive coating to rise dramatically. Once the surface temperature passes the melting point of the "leuco dye" and the "acidic developer", the dye and developer melt, chemically react and form the visible image.

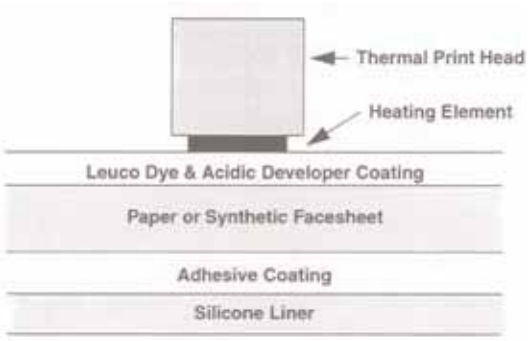

Figure 1 - Direct Thermal Printing

Many different types of direct thermal stock are available. The less expensive grades are more sensitive to light and may not be readable by infrared bar code readers. The more expensive grades are less sensitive to bright light and can be read with infrared based readers. As a general rule, direct thermal printing is not recommended for applications in which the label needs to last longer than 1 year or where the label can be exposed to bright lights and/or high temperatures. However, direct thermal printing can be used for many applications where the label doesn't need to last very long, is typically used indoors and where the benefits of low maintenance and no ribbon consumption are desired. Examples are airline baggage tags, deli labels and bakery labels.

Thermal transfer printers create a very high quality bar code label, very quickly and in small or large quantities. Unlike direct thermal printers, thermal transfer printers use a specially formulated inking ribbon and can print on a very large variety of paper and synthetic materials, satisfying a wide variety of labeling applications. The imaging process is technically known as "resistive heating element material transfer", in which a thermal print head is used as a thermal energy source to selectively cause the transfer of a colored inking material from a carrier surface onto the label material. The combination of the colored inking material and the carrier is known as the "thermal transfer ribbon". The tiny resistive heating elements within the thermal print head provide the heat energy that softens and melts the colorant material which is then transferred to the label material. The diagram below depicts the basic thermal transfer process.

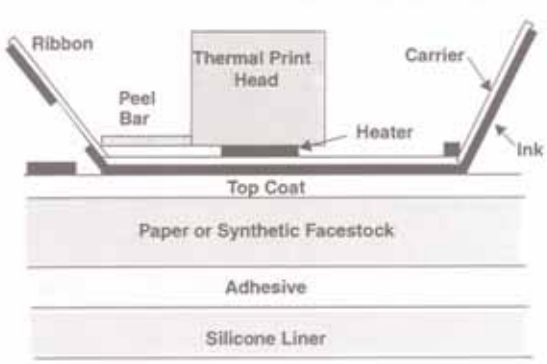

Figure 2- Thermal Transfer Printing

Heat energy, selectively supplied by the thermal print head, flows through the ribbons carrier material and into the colorant ink and the top surface of the label material. When the temperature of the inking material exceeds the melting temperature, the inking material begins to soften and melt. Once the temperature rises past the transfer temperature, the softened inking material flows onto the label' surface. Once the label and ribbon move away from the thermal print head, the inking material and label surface cools, allowing the inking material to re-solidify on the label surface. The mechanical bonds between the now solidified ink and the label surface now exceed the bonds between the ink and the ribbon carrier, so the ink transfers to the label surface as the ribbon is separated from the label.

Now that you have a basic understanding of the direct thermal and thermal transfer printing processes, we can begin to discuss in more depth the "media" used with these printing methods in generating printed labels.

Thermal Transfer Ribbons

Thermal transfer ribbons are constructed using a high strength carrier material onto which several "coatings", including the colorant ink, are applied. Typically from two to four separate material coatings on both sides of the carrier material are performed. The diagram below depicts the construction of a typical thermal transfer ribbon.

Figure 3 - Thermal Transfer Ribbon Construction

Back Coating

Every good quality thermal transfer ribbon has a material layer coated on the back side of the ribbon, the side that directly contacts the thermal print head. This back coating layer serves several functions:

> It provides a smooth, non-abrasive surface to the thermal print head, minimizing wear and tear on the heating elements.

> It prevents the polyester base film carrier from sticking to the thermal print head and tearing.

> It helps to lower friction that in turn reduces the buildup of static electricity. Excessive buildup of static electricity can cause poor print quality and in certain situations may even damage the thermal print head.

> It aids in minimizing ribbon wrinkle and ribbon slippage.

Although seemingly innocuous, the back coating is a very important component of any good quality thermal transfer ribbon. Inferior back coatings can:

> Cause dirt and debris to build up on the thermal print head, increasing the cleaning frequency and increasing the potential for premature thermal print head failure due to abrasive damage.

> Increase the thermal heat energy requirements for good quality printing by acting as an insulator.

> Increase the potential of experiencing ribbon wrinkle.

> Generate static electricity that attracts dirt and foreign particles as well as potentially damaging the thermal print head.

Polyester Base Film Carrier

The carrier is an important component of any thermal transfer ribbon and must exhibit several characteristics. The carrier must be thin in order to conduct heat fairly well! The thermal heat energy must travel through the carrier (as well as through any intervening layers) in order to reach the ink layer. If the carrier is not thin enough and if it does not conduct heat well enough, sufficient heat energy will not reach the ink layer and will cause poor printing. The carrier must also be strong and resist tearing and must withstand high temperatures without distorting.

Thermal transfer ribbon carriers are almost exclusively constructed from polyester films that are only from 2.5 to 8 microns (millionth of an inch!) thick with the standard thickness being 4.6 microns. All polyester base film carriers are not the same! Thicker polyester films tend to be stronger and better resist wrinkling (ribbon wrinkling causes poor printing of bar codes) but also tend to generate lower quality images and support slower printing speeds. Very thin polyester films can support high print speeds but tend to wrinkle and tear easily. The major material costs of most thermal transfer ribbons reside in the cost of its polyester base film. Since good quality polyester film carrier is essential to good quality printing, always be wary of very inexpensive ribbons since they may utilize inferior grades of polyester base films.

Primer Layer

Some thermal transfer ribbons employ a coating of material directly onto the inked side of the polyester base film that serves a couple of purposes. First, the primer helps to "bind" the ink layer to the base film, ensuring even ink coatings. The primer coating also serves as a logical "separation point" for the ink layer. When the primer coating gets hot, it typically exhibits a very "weak bond" to the ink layer, thus allowing the ink layer to easily transfer itself to the label surface. Again, not all thermal transfer ribbons utilize or require a "primer layer", but its use depends upon the inking material formulation and the coating methods used in the construction of the ink layer.

Ink Layer

This is where the rubber meets the road, so to speak. The ink layer contains the actual material that is transferred to the label to form the image. A wide variety of thermal transfer ribbons are available and it is very important to match your ribbon selection to your application. There are three basic formulations of ink used in thermal transfer ribbons which are:

> **Wax-based inks** are the lowest in cost and are suitable for most applications. Label images may be scratched in use or smear if the temperature is too high.

> **Resin-based inks** produce label images that are much more resistant to wear and extreme conditions. Some resin inks used on certain facestocks can withstand temperatures over 1000 degrees. However, resin-based inks tend to be rather expensive. Wax-resin inks" produce label images with higher durability than wax-based inks but are lower in cost than pure resin-based inks.

The melting points of each type of ink varies and determines the amount of heat energy required to transfer the ink to the label. Wax inks tend to require the least amount of heat while the pure resin inks generally require the most. The thickness of the ink layer also affects the amount of heat energy required. The ink formulation and how it is actually coated onto the carrier determines, to a very large part, how the ink separates from the ribbon carrier and how it transfers and adheres to the surface of the label. These characteristics in turn determine the edge definition and density (darkness) of the printed image. High resolution printing (250 DPI and higher) typically requires a more sophisticated ink formulation and coating method than do moderate to low print resolution applications (203 DPI and below). There are many ink formulations and coating methods employed today to support thermal transfer printing on an enormous array of different label materials and for label applications that subject their printed images to high temperatures.

Top Coating

Some thermal transfer ribbons include a coating of material over the ink layer called a "Top Coating". The "Ink Layer" should have a rather high coefficient of friction between itself and the surface of the label. If not, then slippage between the label surface and the ribbon will result, creating poor printing and smudges. Some label materials are fairly "glossy" and most inks have a difficult time generating any friction with them. In these cases a "top coating" placed over the ink layer provides the necessary coefficient of friction in order for the ribbon to operate properly with the label material.

In other cases, the label material may have a surface that is not smooth. A "top coating" can be applied over the inking layer that, during the transfer process, acts as a "filler", filling in the voids on the labels surface and greatly increasing the print quality. "Top Coatings" are generally used only on specialty formulations of thermal transfer ribbons and are typically tailored to specific label applications.

Table 1 depicts the typical characteristics of the three general types of thermal transfer ribbons available today. Please note that this table depicts merely the typical characteristics.

	Wax	Wax/Resin	Resin
Heat Energy	Low	Medium	High
Print Speed	2 - 12 IPS	2 - 8 IPS	1 - 6 IPS
Durability	Low	Medium	High
Static Elect	Low	Low/Medium	Medium/High
Facesheets	Coated Paper Uncoated Paper Some Synthetics Tag Stock Some Films	Coated Paper Glossy Paper Some Synthetics Tag Stock Films	Synthetics Films

Table 1 - Typical Ribbon Type Characteristics

Labels for Thermal Printing

Typical label stocks used for most bar code labeling applications are constructed using a combination of several different material layers or coatings, all laminated into a single sheet. The diagram below depicts the construction of a typical label.

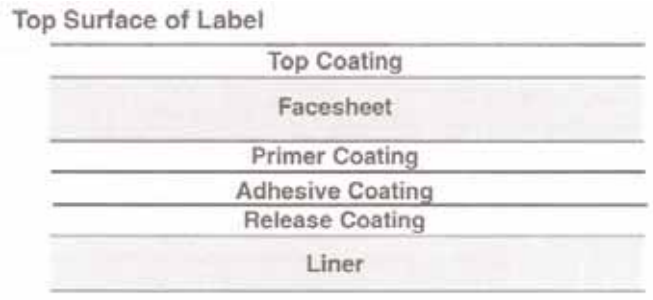

Figure 4: Typical Label Construction

Top Coatings

"Top coatings" are materials applied to the top of the facesheet (the side of the facesheet that will be printed upon) mainly to either allow printing to occur or to increase the print performance. "Direct Thermal' label stock is fabricated by applying a specific type of "leuco dye" and "acidic developer" mixture onto the surface of raw facesheet material. The chemical formulation of the "leuco dye" and "acidic developer" mixture, as well as its thickness (also known as "coating weight") determine the labels printing characteristics, print performance and environmental performance.

For labels destined for use with thermal transfer ribbons, top coatings are applied to enhance the facesheets print performance. Many facesheets by themselves exhibit moderate to poor print performance using thermal transfer ribbons. Thermal transfer printing requires a rather smooth surface and a surface that bonds well to the ink formulation that is to be used. "Clay" is a common top coating applied to facesheets that significantly improves the facesheets print performance. Resin accepting top coatings are often applied to facesheets when printing with resin ink formulations is intended. These resin top coatings improve the bonding between the label and the resin ink and provide an indelible image.

Facesheets

"Facesheets" are the actual base material that makes up the label itself. All the other components are "laminated" or are coatings that are applied to the "facesheet". There are literally hundreds upon hundreds of different combinations available. Facesheets are chosen based upon the properties they exhibit and the needs of the particular label application. Some facesheets are "naturals" for thermal transfer printing while others are not. Facesheets can be manufactured from either paper or synthetic raw materials.

> Paper

Paper is the most commonly used facesheet and is usually the lowest in cost. It is available in many types, thickness', colors and sizes. However, paper can be damaged by light, water, dirt and chemicals and may be torn or scraped. Paper labels perform best in controlled environments and in applications such as product labeling, pricing and shipping.

> Synthetics

Synthetic facesheets include, but are not limited to, polyester, polypropylene, polyolefin, vinyl and mylar. These stocks can provide very high print quality and are more likely to perform better than paper for labels exposed to harsh environments or subject to hard use. Polypropylene facestocks are available in many forms for a wide array of applications. Polyester is used in applications subjecting labels to very hard use and to extreme environmental conditions. Vinyl facestocks are also very durable, especially on curved or irregular surfaces

Primer Coatings

"Primer Coatings" are applied to the BACK SIDE of the facesheet and serve three primary functions:

> Increase Label Opacity

"Opacity" measures the amount of light a material blocks out (or absorbs) and can be thought of as the opposite of "transparency". A facesheet with a low opacity allows whatever is located behind the label to "show though". To lessen or eliminate this tendency, primer coatings with high opacities can be used.

> Provide Anchorage for Adhesive Coating

The primer coating also provides a firm anchorage for the subsequent coating of adhesive material, ensuring a secure and reliable bond between the facesheet and the adhesive.

> Prevent Adhesive Migration

Adhesives tend to have a nasty habit of "migrating". With labels this is exhibited by the leaking of adhesive from the sides of the label and can be a very troublesome problem if not dealt with. Properly formulated and applied primer coatings drastically reduce or eliminate adhesive migration problems.

Adhesive Coating

What good is a label if it doesn't stick? The adhesive coatings function is to provide the right type and amount of "stick" for the labels. Many combinations of adhesive materials are available. Some applications require permanent labels that resist exposure to temperature extremes, high humidity, chemicals or outdoor use and be tamper-resistant or tamper-evident. These applications require a "permanent adhesive". Other labels must be easily removed without tearing, damaging the item or leaving a residue. These labels may also need to be removed and perhaps even re-applied. These label applications require a "removable adhesive" or a "repositionable adhesive". Many surfaces are difficult to label (like porous surfaces) and may require specific adhesive formulations and/or custom thickness, or coat weights. There are two common types of adhesive materials used today which are:

> Rubber based Adhesives

These adhesives are useful for quick sticking applications but may weaken when exposed to cleaning solvents, chemicals or ultraviolet light.

> Acrylic based Adhesives

These adhesives come in a wide range of properties. Some allow clean, easy removal without leaving residues. Others may require some time period in which to set completely but hold permanently in a wide variety of conditions. Others can be used in label applications where the labels will not come off in one piece.

Release Coating

The "release coating" is typically a silicone based material that is applied to the liner material to prevent the adhesive coating of the facesheet from bonding to the liner itself. The "release coating" allows you to "peel' the label away from the liner.

Liner

The "liner" is usually a paper based material that provides a covering protection for the adhesive coating and also provides support for the facesheet during any die cutting operations. An added bonus is the stability it provides to the facesheet while the facesheet is being run through an applicator or printing system. The liner is the "leftover" piece after the label has been peeled off and applied.

Label Pre-Printing and Converting

The labels you are used to dealing with come in many different lengths and widths, can have various shapes and may have pre-printed images already applied to them. How do they get that way?

Raw Material Suppliers

Raw material suppliers are companies that specialize in the manufacture of one or more of the components used to make a label. These manufacturers produce and ship raw materials in huge quantities. For instance, raw facesheet is typically provided in rolls of over 3 feet in diameter and over 20 feet in width and in 5,000 or 10,000 foot lengths. Some example of raw material suppliers are:

Facesheet		Adhesive	Liner
- Consolidated	- BXL	- National Starch	- National Starch
- DuPont	- Appleton	- Monsanto	- Monsanto
- VanLeer	- Kanzon	- DuPont	- International
- Mobile			

Secondary Converters

This is where "Datamax Pioneer" comes in, as a "secondary converter". Secondary converters purchase the slit rolls of laminated label materials from the primary converters and "convert" them into the finished label products you are familiar with.
Secondary label converting, or simply label converting, may entail several steps and processes. Slit raw label stock can be "die cut to form the repeating label pattern of the length, width and shape desired. The die cut labels are then "slit down" and "wound" to the label roll widths and diameters desired by the end use applications. Additional top coatings can also be applied along with pre-printing of the finished labels. Not all secondary converters can perform all these tasks so make sure that the label converter you select can indeed fulfill your requirements.

Here are some of the terms you will commonly encounter:

Web Width
The distance from the left edge of the liner to the right edge of the liner, regardless of the number of labels across the liner.

Die
A cutting tool designed to cut a repeating label pattern into a continuous roll of slit raw label stock. Datamax/Pioneer has over 4000 dies in stock covering multiple press widths. If your label application requires a unique die tool, one can be developed with typical costs ranging between $400 and $4,000.

Die Cut
A special shape cut into the facesheet of the label, leaving a space all around and between labels. The cut does not protrude into the liner.

Butt Cut
A slit, or cut, across the web of the facesheet, specified as the top of the label. No wasted label material is removed nor is there any space left between or around the labels.

Matrix Stripping
Performed on press, after die cutting operations, "matrix stripping" is the removal of the label waste left between and all around the labels. This term is also referred to as "ladder stripping".

Perforation
The "cut & tie" pattern cut into the label to allow for fan-folding or separation of label sections.

Label Width
The measured distance across the label from left to right. When label sizes are specified as 4 x 6, the label width is always the first number.

Label Length or Height
The measured distance from the top of the label to the bottom. When label sizes are specified as 4 x 6, the label length or height is always the second number.

Label Repeat
The measured distance from the top of one label to the top of the very next label.

Fold Length
For fan-folded label stock (not rolled), it is the measured distance from the top of one fold to the top of the next fold. If the label repeat is specified, this measurement may be expressed as the number of "labels down on a fold".

Number Across
The total number of labels side to side across the width of the web or liner.

Label Pre-Printing

Some secondary converters, such as Datamax/Pioneer, have the capability to add "pre-printed" fields and graphics to blank label stock, often in multiple or process colors. Pre-printing is the process of applying ink to a blank label in order to:

> Provide consistent label nomenclature for all text and graphics that never or rarely change.

> Improve your company and/or product image.

> Announce new products or services.

> Allow for quick product identification.

> Integration of the label with product packaging.

> Provide visual identification and differentiation for your products. There are three basic types of pre-printing:

> Floodcoating

Complete ink coverage of the entire label surface. For instance, if you need all blue or all red labels, you would floodcoat them with blue or red ink.

> Spot Printing

Application of ink in specific areas on the label, in one or more colors, but not more than 5 or 6 colors. For instance, you may require your company name, logo and address to appear on the label in one color and perhaps the general product name in another color. One or more printing plates is created from artwork provided by the customer, designating the custom information to print.

> Process Color Printing

Process printing is the application of ink from a series of two or more halftone plates to produce intermediate colors or shades. Process color is usually performed using a 4 color printing process where the primary colors are yellow, magenta, cyan and black. Process color printing is generally more expensive that either floodcoat or spot color printing.

Assessing Your Bar Code Media Needs

You begin to determine your labeling application media requirements by determining what your labels must accomplish. Only then should you decide upon what media is best suited for your application.

What your labels must accomplish...

> Do your customers have compliance labeling requirements? For example, customers and their industries often specify label size, configuration, content, print quality and the various symbologies (bar code types) to be used in printing the labels. Customers may also assess penalties if the labels are not provided or if they are improperly printed.

> How many different types of labels are required? Determine whether both product and shipping labels are required and if so, then how many labels are needed for each item or package.

> Where on the product or package will the label be placed? Onto what kinds of materials will the labels be affixed? Also determine the type of surface involved. Is it smooth, hard, rough, porous or curved?

> What is the size, shape, and color for each label?

> Does the label application require any particular characteristics such as high label strength or high temperature resistance?

> In what environments will the labels be used or exposed? Determine how long the label will be used or needs to last. Will the label be exposed to sun, bright light, water, chemicals or temperature extremes? Will the bar code reading device rub up against the label?

> Does the label have a security function? Determine whether the label should be removable, permanent, tamper resistant or covered by a protective coating.

Once you have answered these questions, a good bar code & media printing specialist can determine what media would best suit your label applications. In many cases there are several different media combinations that can fulfill the requirements of a particular labeling application, each having different, sometimes significantly different, cost profiles. The best specialists can not only determine the specific media your application requires but can also determine the best COST FIT that can save you and your company considerable money.

In Closing

As you now see, there is quite a lot to consider and decide upon in order to determine the right types of media for your labeling applications. We hope this brief article has been somewhat helpful but we understand that, at best, it most likely answers only some of your most basic questions. However, Datamax Pioneer is a premiere, worldwide supplier of thermal printing media and can supply your labeling applications with superb quality media, great prices and top notch service.

Please visit www.datamaxcorp.com for more information on Datamax products and solutions.

Datamax specializes in the design, manufacture, and marketing of products for bar code and RFID labeling including thermal demand printers, label, ticket and tag materials, and thermal transfer ribbons. Headquartered in Orlando, Florida, Datamax has sales representative offices in Singapore, China, and Harlow, England, as well as label converting and preprinting facilities in Robinson, Illinois. Datamax markets its products exclusively through a network of resellers in more than 100 countries worldwide.

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Rev. 05/04