XEROX

January 2003
701P22140

Xerox Document Services Platform

Generic MICR fundamentals guide

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Changes are periodically made to this document. Changes, technical inaccuracies, and typographic errors will be corrected in subsequent editions.

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Introduction

About this guide

The purpose of the *Generic MICR Fundamentals Guide* is to provide a reference for the various facets of the MICR environment within the context of the Xerox MICR printing products. This document does not contain specific information on individual Xerox MICR printers.

Since the printing of MICR documents involves application and operational considerations not normally associated with any of the standard Xerox printing systems, this document provides principles and guidelines to ensure successful MICR printing.

This document has been developed with the assumption that readers have knowledge of standard Xerox printing systems products, and the skills to develop applications and job source libraries.

The *Generic MICR Fundamentals Guide* contains the following chapters and appendices:

Chapter 1: Overview. Describes MICR, its historical background, and the printing and processing procedures for the MICR document.

Chapter 2: Environment. Examines the types of applications that use MICR, trends within the industry, and typical MICR printing methods and concerns.

Chapter 3: Paper facts. Identifies paper grades and properties required for MICR printing, and describes paper maintenance procedures.

Chapter 4: Document design. Describes the standard format, features, and requirements of a check document.

Chapter 5: Document processing. Examines the common types of reader sorter technology and the way these systems function.

Chapter 6: Quality control. Describes MICR document print quality specifications, the tools available to determine if a document is within specifications, and general operator maintenance procedures.

Chapter 7: Problem solving. Provides information on identifying MICR printer related problems and using rejection rate information to isolate the problem source.

Chapter 8: Security. Provides an overview of the security procedures used to control and audit access to a Xerox MICR printing system and to check printing functions.

Appendix A: MICR references. Lists the domestic and international standards documents that apply to MICR publications. Also contains a list of Xerox documents containing MICR information.

Glossary: Lists terms and definitions related to MICR printing and banking environments.

How to use this guide

- First, become thoroughly familiar with the operation of your own MICR system.
- Read through this guide to acquaint yourself with all of the topics.
- As needed, refer to sections of this guide that are pertinent to your work.

1. Overview

MICR (Magnetic Ink Character Recognition) is a process by which documents are printed using magnetic ink and special fonts to create machine readable information for quick document processing.

Although traditionally MICR has been used to print accounting and routing information on bank checks and other negotiable documents, the magnetic encoding lends itself to any form of document processing.

The following figure shows a check with a MICR line. This line contains block-shaped numbers running along the bottom of the check, and non-numeric characters called “symbols.” This entire string of numbers and symbols is printed using magnetic ink.

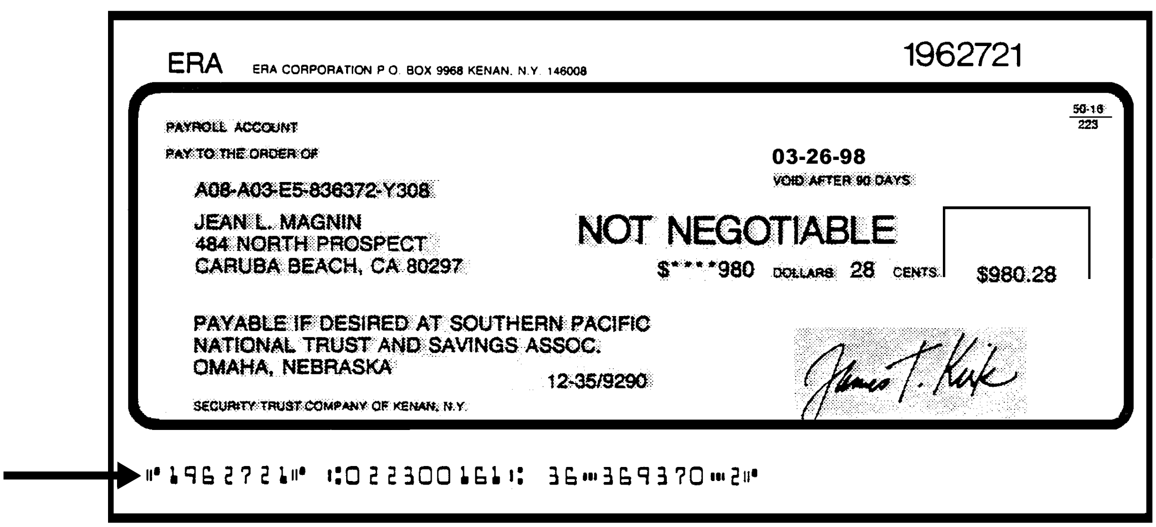


Figure 1-1. MICR line on a check

A brief history

Originally, checks were processed manually. However, by the mid-1940s the banking system became inundated with paper as society grew more mobile and affluent. Finding a means of handling the growing number of paper documents became vital to bankers. The banking and electronics industries searched for a standard process that could be used in all banks throughout the country.

In the mid-1950s, the first automated processing of checks was initiated. The system that is now known as MICR was developed by the Stanford Research Institute, using equipment designed by the General Electric Computer Laboratory. The E13B MICR font was also developed.

The specifications for producing the E13B font using magnetic ink were accepted as a standard by the American Bankers Association (ABA) in 1958. In April 1959, the ABA issued Publication 147, *The Common Machine Language for Mechanized Check Handling*.

Deluxe Check Printers had the task of translating the specifications into a working process. By the end of 1959, Deluxe successfully produced checks using magnetic ink.

In countries throughout the world there are groups that set standards and dictate the design specifications for document encoding, processing equipment, and quality criteria for MICR printing. Some of these are:

- American Banking Association (ABA)
- American National Standards Institute (ANSI)
- United Kingdom—Association for Payment Clearing Services (APACS)
- Canadian Payments Association (CPA)
- Australian Bankers Association (ABA)
- International Organization for Standardization (ISO)
- France—L'Association Francaise de Normalisation

In 1963, the American National Standards Institute (ANSI) accepted the ABA specifications, with minor revisions, as the American standard for MICR printing. The ANSI publication covering these standards is *Print Specifications for Magnetic Ink Character Recognition*, first issued in 1969. Although compliance with the standards is voluntary in the U. S., the banking industry considers them to be the definitive basis for determining acceptable quality of a MICR document.

Another MICR font, called CMC7, was developed by the French computer company Machines Bull and has been the official French standard since September 1964. The CMC7 font is also used in other countries, including Italy, Spain, and Brazil. Like the E13B font, CMC7 is a magnetically readable font, but with a different character design and recognition criteria.

Some countries also use OCR-A or OCR-B, which are optically read check processing fonts. These fonts do not need to be printed with magnetic ink in order to be processed. The following table shows which countries use the four check printing fonts.

Country	E13B	CMC7	OCR-A	OCR-B
North America:				
USA	X			
Canada	X			
Central America				
Bermuda	X			
Mexico	X			
Panama	X			
South America:				
Argentina		X		
Brazil		X		
Chile		X		
Columbia	X			
Ecuador		X		
Peru		X		
Uruguay		X		
Venezuela		X		
Europe:				
Austria				X
Belgium		X		X
Denmark		X		X
Finland		X		X
France		X		
Germany			X	
Holland		X		X
Italy		X		X
Norway		X		X
Spain		X		
Sweden		X		X
United Kingdom	X			X
Middle East and Africa:				
Israel		X		
South Africa	X			
Far East:				
Australia	X			
Hong Kong	X			
India	X			
Japan	X	X		
Kuala Lumur	X			
Malaysia	X			
New Zealand	X			
Philippines	X			
Singapore	X			
Taiwan	X			
Thailand	X			

Recognizing significant market value in combining the advantages of electronic laser xerography with MICR technology, Xerox initiated investigations in late 1979 and early 1980. Early efforts at the Xerox Webster Research Center concentrated on basic material physics. The objective was to provide a xerographic dry ink and developer that would produce high visual quality images that could be read using the standard banking reader sorter equipment.

Xerox's MICR printing products combine the following:

- A modified xerographic engine
- A unique magnetic materials package
- The standard ANSI and ISO MICR character sets

The Xerox MICR systems meet ANSI, CPA, and ISO specifications for automatic check handling.

Why MICR?

MICR was chosen by the ABA because it can be read accurately by machine, it uses existing printing technology, and the printed documents are durable to withstand mutilation.

A MICR encoded document can be read through overstamping, pen and pencil marks, oils and greases, and carbon smudges. However, MICR printing is one of the most quality-conscious application areas within the printing industry. It meets ABA security requirements for negotiable documents. MICR is the only system that produces reliable results at high processing speed.

Check printing capabilities

A Xerox MICR printing system with a magnetic material package and MICR fonts can print a character line at the bottom of a check form that is machine readable by standard banking reader sorter equipment. On blank security paper, the Xerox MICR printing system can produce the entire check image, including the form, all fixed and variable data, logos and signatures, and the MICR line, in a single pass.

The printing process is one small part of the total processing procedure for a MICR printing system user. Quality and accuracy of the check documents must be closely controlled during printing to prevent problems from occurring when the document is processed off-site.

Check processing procedure

All checks impact at least three parties:

- The person who writes the check
- The person to whom the check is being paid
- The bank at which the check writer has an account

Depending on where and by whom the check is deposited, how the check is processed, and how the check is handled for funds clearance, many different parties can handle the same check. Fraud can occur at any of the steps or access points in this process.

The following steps, illustrated in figure 1-2, trace a document through a series of corporate and banking system procedures typical of the MICR environment.

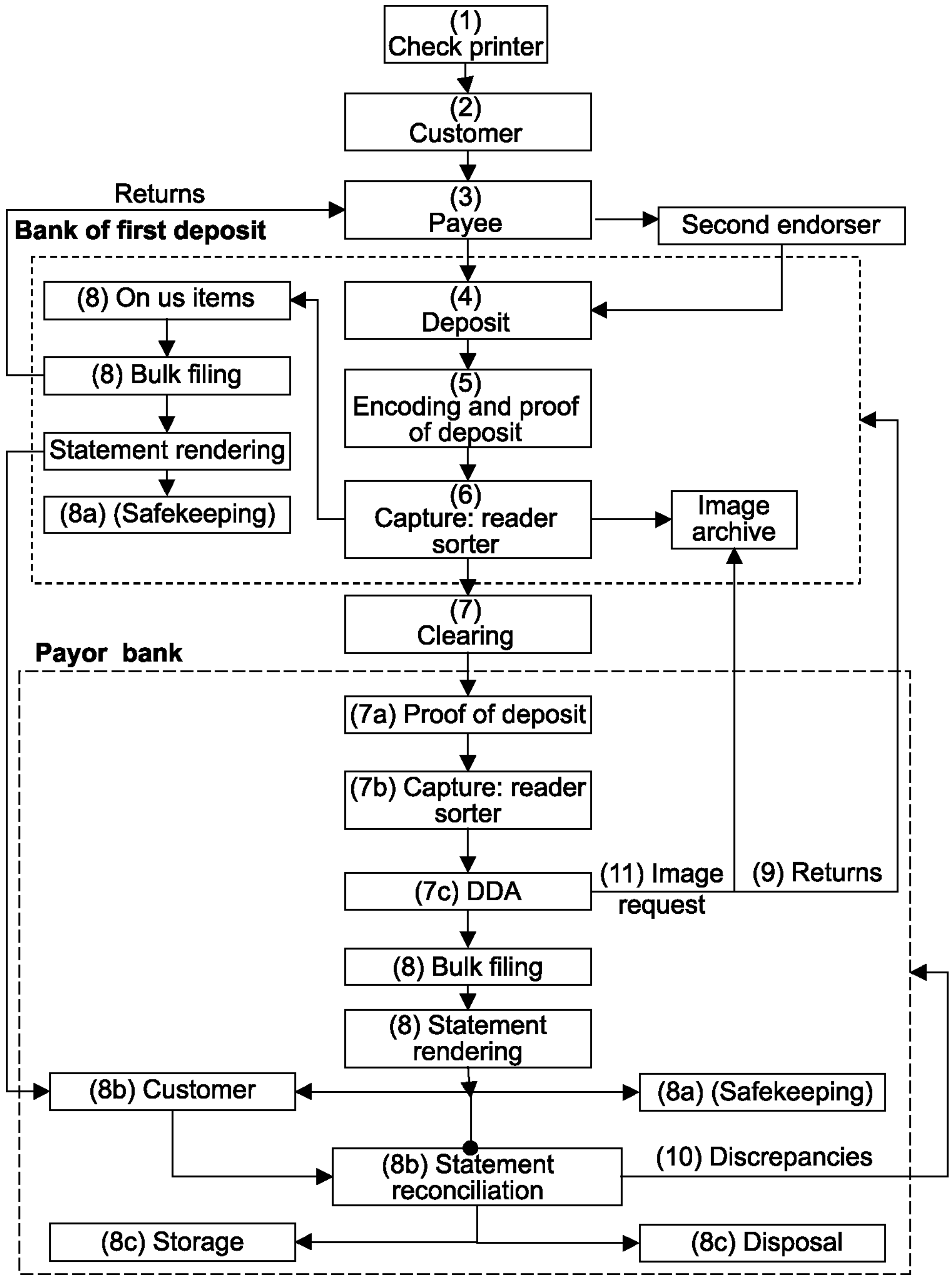


Figure 1-2. Life cycle of a check

1. The check printer (1) produces a blank check that will be completed later. This check includes the static data that is needed for a negotiable document:
   - Financial institution name and address, issuer name and address, check form, company logo, etc.
   - The MICR line, containing the account and routing information that is needed to process the check
   - Other audit, account, and report information as required by the customer
2. The customer (2) adds the transaction information—payee, amount, and date—and authorizes the funds transfer with a signature.

   NOTE: When using a MICR laser printer, steps 1 and 2 may happen simultaneously.
3. The completed check is transferred to the payee (3), who deposits it in the bank of first deposit (BOFD). The payee may receive the check in person, by mail, or through a third party. A third party check may require a second endorsement.
4. Deposits (4) are made in several ways: through a teller, using an automated teller machine (ATM), using a drop box, or through a postal lock box. Deposited items are accompanied by a deposit ticket that lists and totals the items and identifies the payee account.

   This is the entry point for the automated payment processing system.
5. The BOFD encodes the amount of the check in the MICR line (5) and balances the check against the deposit ticket to verify that the correct amount is being credited to the payee account (proof of deposit).
6. MICR documents that are printed on a Xerox MICR printing system are usually corporate paychecks, stock dividend checks, etc. After printing, these type of documents require additional processing using a high-speed device called a “reader sorter.” The reader sorter identifies each magnetized character and symbol of the MICR line using logical analysis algorithms of the electronic wave patterns that the characters produce.

   In the “capture pass,” checks are read in a reader sorter for the first time (6). At this time, they are sorted into checks drawn on the BOFD, known as “On-us items” (8), and checks drawn on other banks.

7. Checks drawn on other banks are sent to the payor bank through a clearing (7) arrangement. The check may be cleared through the Federal Reserve, a correspondent bank, a clearing house, or directly by the issuing bank.

   The payor bank also balances the check against the deposit ticket (proof of deposit) (7a) to verify the check amount, and performs its capture pass (7b) on the reader sorter in order to identify the issuer account (7c). (Refer to the “Proofing checks” section of chapter 5 for more information on this part of the process.)

8. In most cases, the check is debited from the issuer account and moved to bulk filing (8), where it is stored until time for monthly statement rendering.

   From this point forward, an On-Us item is treated the same as one that was cleared to another bank.

   Two exceptions may occur:

   - If the payor bank does not honor the check, it is returned (9) through the BOFD to the payee. The amount is then deducted from the payee account.
   - During reconciliation, the account holder may discover a discrepancy (10) between its records and those of the bank. Their bank then researches any discrepancies.

NOTE: Account holders may contract with their banks to perform reconciliation before clearing the check.

Production cycle of a check

The check production process starts as soon as the need is identified. Design requirements should comprehend purchasing, distribution, warehousing, manufacturing, internal and external processing requirements, and the needs of the check issuer. Banks frequently require new corporate accounts to submit checks for approval before the banks approve the account.

The following steps, illustrated in figure 1-4, describe the typical process that is required before the first negotiable checks are delivered to the payee.

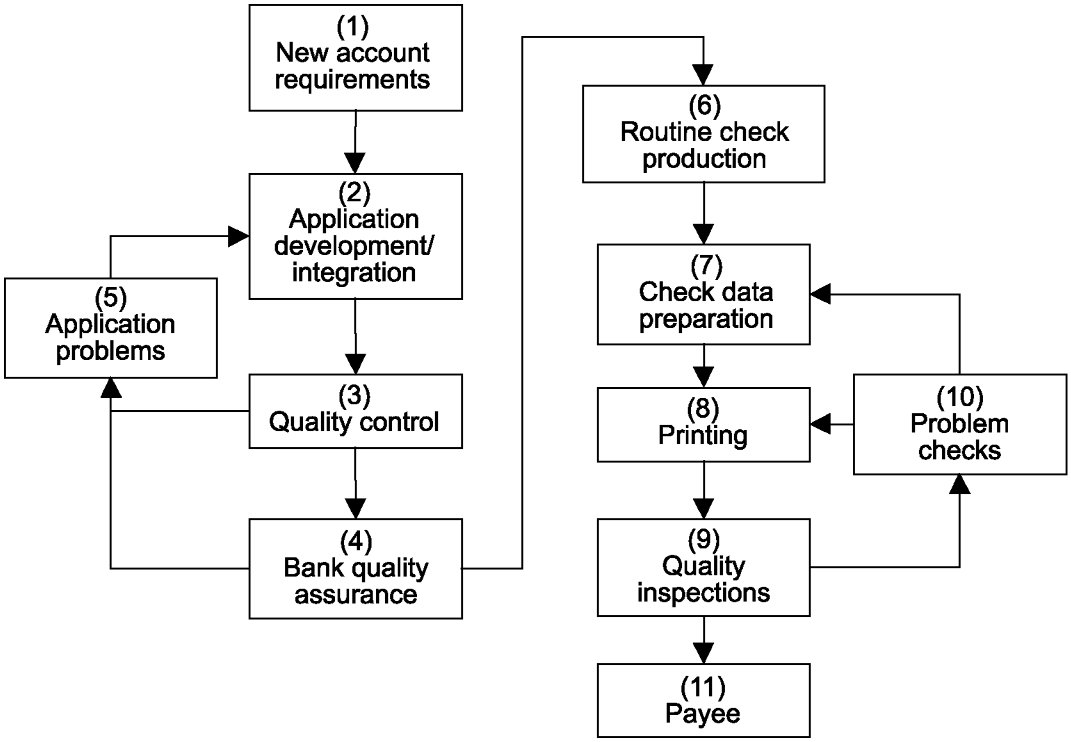


Figure 1-3. Check ordering and production cycle

1. Design requirements are defined for a new account.
2. Requirements are passed to application development.
3. Samples pass internal quality checks.
4. Samples are forwarded to the bank for approval.
5. Any problems are referred to application developers, who ensure that the problems cannot occur in production.
6. After approval by the bank, the check design becomes available for routine production.
7. Variable check data is prepared for incorporation.
8. The checks are printed.
9. The printed checks are inspected.
10. Any problems are reported to the source for correction and reprinting.
11. When they have passed bank validation and quality inspection by the issuer, the checks are issued to the payee.

Changes in check creation role

In the past, the roles of manufacturer and check issuer were distinct. Because the technical requirements of doing MICR printing were fairly difficult, the manufacturer usually did all of the process steps that involved the generation of the check, except for entering the amount, date, and payee.

The introduction of MICR impact printers allowed the check issuer to sometimes take over printing the MICR line. With further technological advances, such as the Xerox MICR printing systems, the check issuer has assumed still more responsibilities that previously belonged to the manufacturer.

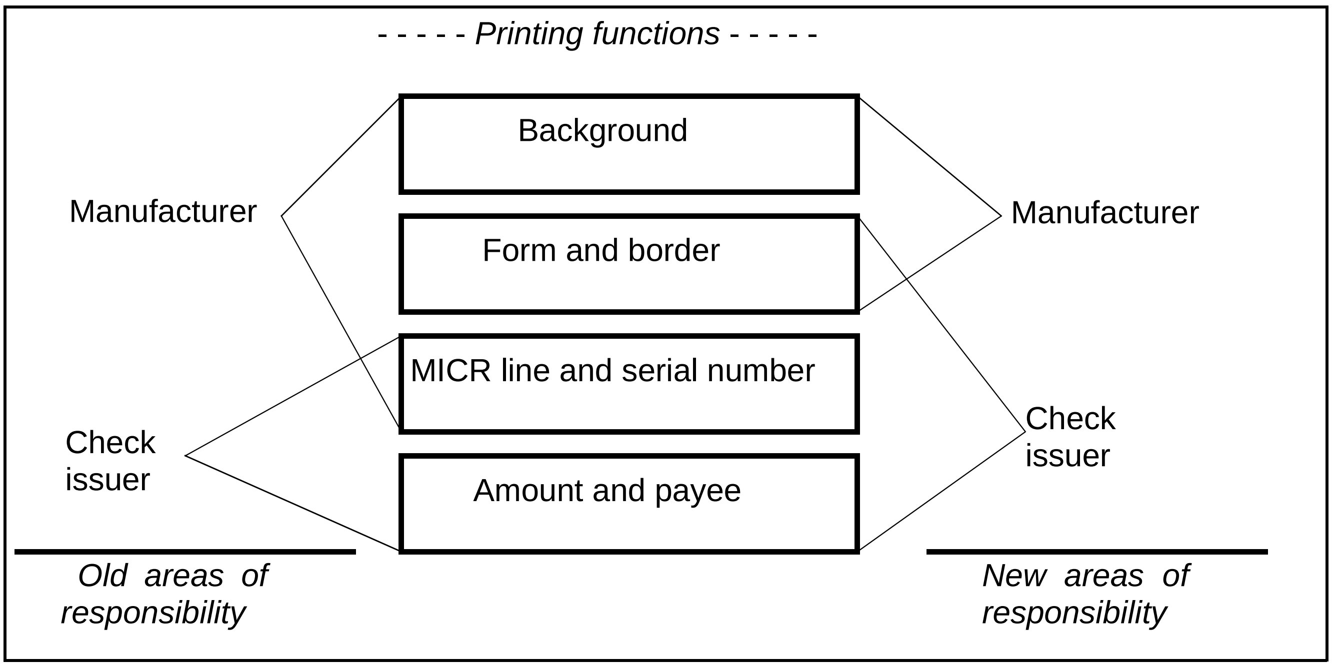


Figure 1-4. Changes in check creation roles

Because MICR documents are typically negotiable documents, every possible measure must be taken to ensure successful processing. With a less clear division between check manufacturer and check issuer responsibilities, the check issuer becomes more involved in the development of a new check issuance application.

2. Environment

Checks and other bank forms constitute the most frequent uses of MICR printing. All businesses issue checks to meet payroll and accounts payable obligations. In addition, all profitable publicly owned businesses make periodic stock dividend distributions by check.

Most medium and small companies buy check production services from a service bureau or a bank. Individuals who once obtained personal checks through their banks can now buy checks through the mail from check printers.

A major trend in the banking industry is check truncation. Truncation refers to the ability of the bank of first deposit to process MICR documents, both theirs and those belonging to other banks, without further transfers of the paper document (check). The check is processed electronically. This reduces cost and improves check clearance.

Types of MICR applications

A MICR system need not be dedicated to check printing or to any other MICR-specific application. A MICR system operates no differently from an identical system that does not have MICR. MICR and non-MICR systems may be mixed at a site and do not impact scheduling of jobs that do not require MICR magnetic materials.

MICR printing is most frequently used for the following types of applications.

Manufacturing checks

Check manufacturing refers to the process of converting milled paper into finished check and deposit books, computer stationery, etc. This is usually done by a small group of specialty or security printers, mail order check printers, and others. MICR printing systems are becoming more popular in this market.

Issuing checks

The most common use of MICR printing systems is the process of obtaining check stationery from the manufacturer and encoding it with MICR information. Most businesses regularly issue checks in at least two of the following categories.

- Payroll checks
- Accounts payable checks
- Dividend checks
- Benefit checks
- Drafts
- Warrants
- Negotiable orders of withdrawal

Issuing turnaround documents

Turnaround documents refer to any type of volume transaction, whether negotiable or not, that requires data capture. Familiar examples of turnaround documents are:

- Credit card invoices
- Insurance payment booklets
- Instant rebate coupons

Turnaround documents are also used in remittance processing, which is a procedure for handling items returned with a payment. MICR encoded turnaround documents enable organizations to cut their resource and equipment costs. For example:

1. A bank card company MICR encodes an account number on the bill and remittance slip that is sent to the customer.
2. The payment is returned with the remittance slip. When the bank card company receives the check and payment slip, the two documents are visually checked to see that the amounts are the same on both.
3. The documents are processed by a MICR reader sorter, which reads magnetic ink characters.

Printing financial forms

MICR is also used for printing a variety of financial forms. Examples of MICR financial forms include:

- Personal checkbooks
- Limited transaction checks, such as money market checks
- Direct mail promotional coupons
- Credit remittance instruments
- Internal bank control documents, such as batch tickets

Xerox MICR printing systems

The Xerox MICR printing systems are a unique range of products that combine speed, intelligence, and high print quality. They also provide great flexibility in font selectivity, graphics capability, and dynamic page formatting.

An advantage to Xerox printing systems is their ability to print a document in a single pass, as shown in the following figure. The form design, variable data, logos, and signatures can all be printed together. With MICR enablement, the MICR line can be included.

Additional benefits include:

- The elimination of expensive production and inventory of pre-printed forms
- The ability to produce multiple checks on one physical page
- Reduced handling steps by using cut sheet rather than fanfold paper
- The reduction of additional equipment, such as bursters, decollators, trimmers, and signature machines
- Reduced turnaround time
- Ability to print checks against multiple accounts

With the introduction of the latest MICR printing systems, Xerox has expanded its application base, using more paper sizes and multiple paper stocks.

MICR printing technologies

The following basic printing techniques are capable of generating magnetic characters:

- **Letterpress**

  Letterpress is based upon a raised typeface that sits above the plane of the image carrier. The typeface is inked with special magnetic ink and applied to the paper under pressure. Common forms of letterpress are: hot metal type, sequential number machines, and ribbon encoders.

- **Offset lithography**

  Large offset devices are typically used to produce check stationery. The lithographic process uses magnetic ink and water to shape the image on a plate. The image is transferred to a rubber sheet called a blanket. The image is then "offset" to the paper.

- **Impact ribbon encoding**

  Ribbon encoding, also called "direct printing," is a letterpress technology with a different delivery method. Instead of the ink being applied to the typeface and then to the paper, the ink is suspended on a thin sheet of backing (usually a polymer base) called a ribbon.

  The ribbon is held between the typeface medium (drum, daisy wheel, or hammer) and the paper, so that when the typeface is struck against the paper, the components on the ribbon are trapped and pressed onto the document to be printed.

- **Non-impact (xerography and ionography**)

  Non-impact printing technologies have been growing in market penetration. They require highly sophisticated and consistent equipment utilizing magnetic materials.

- **Thermal ribbon encoding**

  A non-impact, thermal transfer version of ribbon encoding combines some of the characteristics of the conventional ribbon encoding with those of non-impact technology.

Printer technical optimization

The Xerox MICR systems use the same operating software as their standard configuration counterparts. In addition, the MICR systems have been enhanced to include the following features:

- Optimized print engine
- MICR materials package
- Optimized paper handling system
- Digitized MICR font

Optimization of the MICR print engines subsystem is required by the physical properties of the dry ink. As a result of these changes, dry ink and developer are not interchangeable between MICR and non-MICR printers, unless specifically designed to accept more than one type of materials.

The Xerox MICR systems have a paper handling system designed for the highly accurate registration. This is required for precise placement of the MICR line to maximize readability during check processing.

Typical MICR printing concerns

The following areas of MICR user concerns have made banks want to increase reliability of the MICR document generating process:

- **Security:** This can be addressed by providing high security within the document creation process. In addition, counterfeiting can be reduced by the use of various design and production techniques.
- **Quality:** Sensitive to the banking industry demands, printing businesses maintain tight quality control procedures.
- **Production speed**
- **Cost**

In addition to their need to adhere to required print quality standards, they have the following concerns about the printing operation:

- Traditional MICR printing devices are labor intensive.

- High security measures are needed in any environment that uses check stationery. These measures affect physical access restrictions and staff supervision.
- Check printing usually requires frequent starting and stopping, which is time-consuming and degrades print speed.
- Storing hundreds of different preprinted check and deposit forms can be costly.
- Short print runs of continuous forms can waste materials.
- Check production requires short lead times.

Xerox MICR printing systems reduce many of these concerns. There is no need to store different types of preprinted forms, and single pass printing eliminates many time constraints.

3. Paper facts

MICR applications have special paper, print, and finishing requirements. Refer to your printer operator guide for a complete list of supplies and options.

Refer to *Helpful Facts about Paper* for information on solving printer problems relating to paper.

Paper guidelines

The paper that you use to print MICR documents must meet the criteria for the Xerox MICR laser printer and the specifications imposed by MICR industry standards. In addition, papers must resist alteration and prevent duplication of negotiable documents. They must support high print quality and feed through the printers properly.

NOTE: Some banking authorities specify the type and weight of paper that should be used for check printing in that country. It is essential that only the specified paper be used.

Follow these guidelines for best results:

- Understand check stock security requirements, and use security features that do not degrade printer performance.
- Do not accept delivery of paper or forms that are not ream-wrapped in a moisture barrier.
- Do not open paper reams until you are ready to load the paper into the printer.
- Store paper in the printer room for at least 24 hours before using it. This allows the paper to stabilize to the temperature and relative humidity of the room.
- Do not allow the printer room to become excessively humid or dry. This can cause a difference in moisture content between the edges and center of each sheet of paper, and result in feeding, image permanence, or image deletion problems.

- Do not use cut-sheet check paper that was converted from fanfold by the paper distributor. This conversion process can result in dimensional inaccuracy, poorly cut edges, and unacceptable paper curl.

MICR paper requirements

The following table summarizes Xerox's recommendations for papers that are used for MICR printing. Papers with the following characteristics perform best in Xerox MICR printers.

Table 3-1. **Xerox paper recommendations**

Paper characteristics	**Recommended for optimal printer and reader/sorter performance**
Basis weight	24-pound/90 gsm
Sheffield smoothness	80 to 150
Grain direction	Parallel to the long edge of check or MICR document. Short grain direction may be acceptable for personal, 6 inch/152 mm checks.
Moisture content	3.9 to 5.e per cent
Reflectance	60 percent minimum
Curl	Refer to instructions in your MICR printing system operator guide
Perforations	60 to 80 ties per inch
Metallic content	No ferromagnetic materials can be present in the paper.
Stiffness	For recommendations, refer to "Paper stiffness," later in this chapter.
Cutting precision	+/- 0.030 inch/0.762 mm length +/- 0.030 inch/0.762 mm width
Coating	Do not use paper containing clay or resin coatings.
Lamination	Do not use stock that is a combination of paper and plastic.
Preprinting ink	Must be heat resistant to approximately 400 degrees F/204 degrees C for laser printing. Heat resistance varies according to manufacturer.
Size	Refer to instructions in your MICR printing system operator guide

Basis weight

Basis weight is an industry term for expressing the weight per unit area of paper. Paper weight is generally expressed as grams per square meter (gsm), a measure that makes it easy to compare any two pieces of paper, even if the papers are of different types, such as offset and index.

In the United States, paper weights are given as the weight of 500 sheets of paper of a particular size. The size of the basis sheet, however, varies with the type of paper. This makes difficult any comparison of weight between different types of paper. For example, 50 pound xerographic bond is not the same as a 50 pound offset paper, and both are different from a 50 pound index stock.

Xerox MICR printing systems produce the best quality and highest throughput using the Xerox recommended 24 pound (U.S. market) or 90 gsm xerographic paper. Lighter papers often cause misfeeds, and heavier papers are more subject to jams (although most Xerox printing systems can handle a wide range of paper weights).

In multi-pass reader sorter processing, lighter weight papers subject to frequent misfeeds and mechanical stresses, and are not as reliable as 24 pound paper.

Sheffield smoothness scale

The smoothness of your paper can impact image quality. With increasing roughness, the print quality of solids and halftones degrades. Extremely rough paper does not properly accept fused dry ink, which rubs or flakes off.

Rough papers require a higher density setting and more ink than smooth papers to achieve the desired level of image darkness, because surface irregularities must be filled in with ink.

Papers must measure 50 to 200 when they are measured by a Sheffield smoothness instrument, in order to meet ANSI standards. Higher numbers indicate rougher paper.

Xerox has conducted extensive image quality testing on xerographic, bond, and offset papers. The smoother xerographic and bond grade papers provide the best image quality. Xerox recommends a Sheffield smoothness of 80 to 150.

If you use preprinted forms, check with your forms supplier for the smoothness quality of the form before you make a bulk purchase.

Grain direction

Paper properties are related to the grain direction. The grain of a paper is the direction in which most of its fibers lie, as shown in the following figure. Long grain papers are cut so that the fibers are aligned with the long dimension of the cut sheet. Short grain papers have the fibers aligned with the short dimension of the sheet.

You can use 24 pound paper in either grain direction. If your paper is lighter than 24 pound, use it only for documents in which the grain is in the long dimension of the finished document. For long grain MICR-processed documents, the minimum paper weight is 20 pounds.

NOTE: 24 pound, long grain paper is recommended for MICR printing.

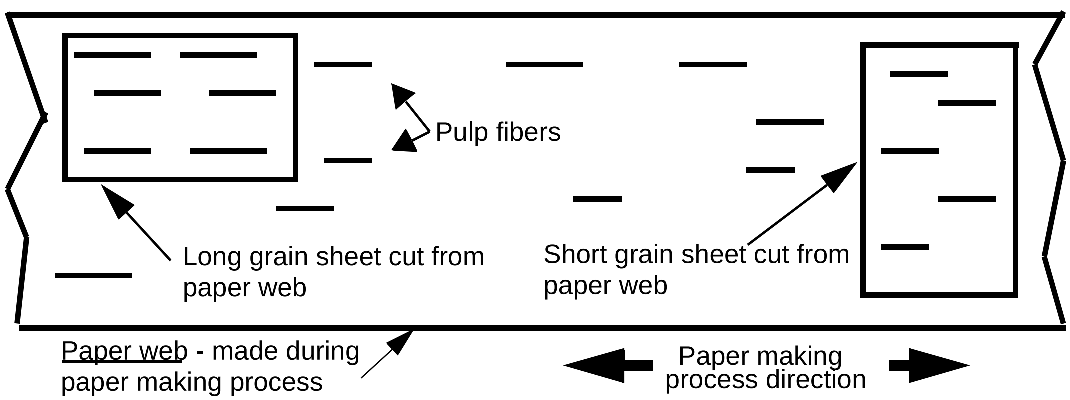


Figure 3-1. Long and short grain

The following figure shows the relationship between long and short grain documents and the MICR processing direction. The shaded areas represent typical documents that would be cut from these sheets for MICR processing.

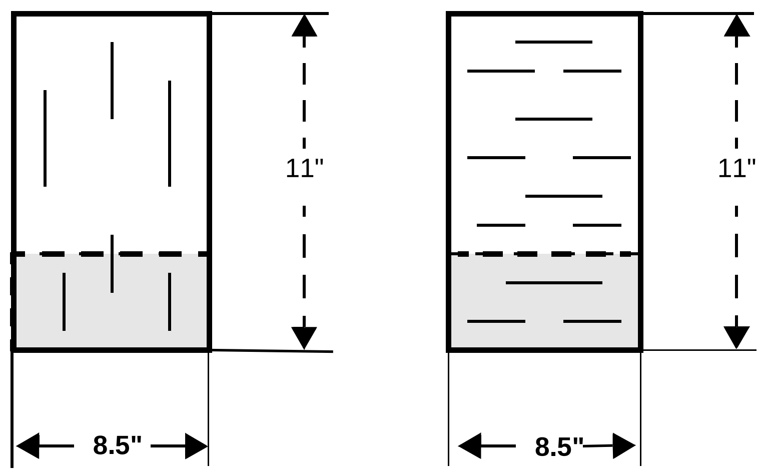


Figure 3-2. Long and short grain documents

Moisture content

Too much moisture in paper causes excessive curl, jams, degraded image permanence, and print quality problems. Too little moisture causes static problems, which can lead to jams, misfeeds, and difficulties in post-processing paper handling.

Papers with a nominal moisture content of 4.7 per cent perform best in Xerox MICR laser printers. Offset and bond papers may have a higher moisture content than xerographic papers.

Xerox brand papers have a maximum moisture content of 5.3 percent, with an average of 4.7 per cent. Several other MICR bond papers have moisture content of less than 5.3 percent.

Preprinted papers must have a moisture content within these limits *after* preprinting.

Reflectance

All MICR materials must meet a background reflectance standard of 60 per cent minimum, as measured by equipment having a CIE Photopic Spectral Response. Backgrounds containing patterns, designs, logos, or scenes must meet additional limits on the contrast of the preprinted areas. These background reflectance standards were developed to permit machines to read information on the check, such as the convenience amount field.

Requirements for background reflectance are discussed in chapter 4, “Document design.”

Curl

All papers curl to some degree. Excessive curl is one of the most common causes of paper jams. Selecting a low-curl paper with the proper moisture content makes a significant difference in the productivity of your system. Refer to the operator guide for your printer for paper curl recommendations specific to your printer.

Because the front and back surfaces of the paper, as determined during the paper making process, differ slightly in their makeup, one side is preferred as the side to image first. If you are using a quality 24 pound/90 gsm paper intended for xerographic purposes, the ream wrapper is marked with an arrow that indicates the preferred printing side. Print on this side for one-sided printing. For two-sided printing, print on this side first (unless instructed otherwise in the operator guide for your laser printer).

How you load preprinted paper is determined by the preprinting. Preprinted forms should be produced so that their curl is compatible with the requirements in your MICR printer operator guide.

Perforation

When you use perforated paper, your objective is to have a smooth, free-feeding sheet that retains sufficient beam strength to prevent sheet fold-over, buckling, or jams.

If you use preperforated forms, consider the following factors:

- Use 24 pound/90 gsm paper.
- Use a perforation that lets the sheets retain as much stiffness as possible. Reduced stiffness may result in jamming and paper mutilation.
- Perforations should be nine per inch.
- All holes should be the same size.
- The ratio of holes to paper (tie size) should be less than or equal to 1:1. In other words, the tie size should be at least as large as the hole size.

- If you are using micro-perforations, be sure to have more than 60 ties to the inch.
- Make sure that the perforation line is rolled sufficiently to eliminate the underside bulge (debossment). Otherwise, feeding and stacking may be unreliable and print deletions may occur.
- When paper is perforated, a ridge or dimple forms around the holes. Make sure that the design and placement of the perforation does not cause document edge irregularities.
- Do not use puncture-type perforations that are not ironed smooth. They prevent the stack from lying flat, which can cause feeding problems and deletions. Use rolled perforations instead.
- Make sure that the perforation design and placement do not cause document edge irregularities.
- Make sure that die-cut perforated papers are free of paper dust and chaff.
- Avoid printing any text or forms data within 1/8 inch/3.2 mm of any perforation.
- For printers that use edge registration: Full-length perforation that is parallel to the registration edge should not be closer than 1.5 inches/37.5 mm to that edge.

Metallic content

Paper stock materials for MICR applications cannot contain ferromagnetic particles.

Stiffness

Stiffness refers to the rigidity or bending resistance of the paper. Thicker papers are usually stiffer. In general, 16 pound/60 gsm and lighter papers are not as stiff as heavier stocks. They may bunch up or wrinkle in the printer, causing jams and misfeeds. Heavier papers, such as cover and index stock, may jam more frequently and have more print quality defects (skips, blurs, and deletions) due to their reduced ability to bend.

24 pound/90 gsm paper usually provides stiffness levels in the range needed by the Xerox MICR laser printer and the proofing, reader sorter, and remittance-processing systems used in banking environments.

Stiffness is lower across the grain direction than in the grain direction. Documents having the grain running parallel to the short dimension of the paper require special consideration to ensure adequate stiffness. Short grain MICR documents are restricted to papers with a basis weight of 24 pound/90 gsm or higher.

Cutting precision

Paper for MICR printing applications should be free of all defects that could interfere with reliable feeding, such as edge-padding and folded or bent sheets.

NOTE: Fan all paper before loading it.

The squareness of each sheet must be precisely controlled to ensure optimum MICR band registration. The dimensions must be controlled to ±.030 inch/0.762 mm.

Papers that have been converted from continuous form paper present a risk of jams and poorly registered forms in a Xerox MICR laser printer.

Xerox paper

To ensure reliability, Xerox has developed paper with the optimum characteristics for xerographic printing. Every lot of Xerox paper is tested at least three times:

1. At the mill by the manufacturer
2. In Xerox quality-assurance laboratories
3. In Xerox laser printing systems prior to shipment

Xerox 4024 Dual Purpose 24 pound paper is recommended for MICR printing in the U. S. and Canada. This paper has been extensively run on Xerox MICR laser printing systems. It closely complies with all MICR paper specifications and is suitable for printing MICR encoded documents that will be processed through high-speed reader sorters.

Paper maintenance

The physical condition of your MICR paper is extremely important. In addition to being free from holes, wrinkles, tears, damaged edges, and foreign material, MICR paper must be carefully maintained, both before and after printing.

Wrapping factors

Paper with a moisture content below 5.5 per cent is best for a Xerox MICR laser printer. The moisture content must be uniform within the ream, which should not be allowed to lose or gain moisture during storage.

To best preserve paper and preprinted forms, use moisture-proof ream wrappers, which maintain critical moisture balance.

Xerox paper is covered with a polyethylene laminate ream wrapper. This material is the most effective in resisting the transfer of moisture from the environment. Unlike wax laminate wrappers, polyethylene does not bleed through the paper covers when exposed to heat. Wax bleed-through can cause feeding problems. Discard the top and bottom sheets if you suspect wax contamination.

Storage factors

Xerox paper are packaged in protective heavyweight cartons, which you can reuse for storage. These cartons are transported on a wooden pallet that provides uniform support and protection to the bottom layer of cartons. The cartons are protected with a moisture barrier of plastic shrink-wrapping.

Temperature and humidity conditions

The temperature and humidity in the printer environment can affect runability and print quality. Use the following guidelines for the best MICR printing performance:

- Optimum temperature and humidity range
  - 68 to 76 degrees F / 20 to 14 degrees C
  - 35 to 55 percent humidity.

  Store all paper on a wooden pallet. Placing paper directly on the floor increases moisture absorption.
- If you move paper from a storage area to a location with a different temperature and humidity, condition the paper to the new environment before using it. The time you should wait between paper storage and use is listed in the following table.

Table 3-2. **Temperature conditioning chart**

Temperature difference	**10° F**	**15° F**	**20° F**	**25° F**	**30° F**	**40° F**	**50° F**
Number of boxes	**Hours**	**Hours**	**Hours**	**Hours**	**Hours**	**Hours**	**Hours**
1	4	8	11	14	17	24	34
5	5	9	12	15	18	25	35
10	8	14	18	22	27	38	51
20	11	16	23	28	35	38	67
40	14	19	26	32	38	54	75

  For example, if you want to move 10 cartons (boxes) from your storage area at 55 degrees F to your printing room at 75 degrees F, (a change of 20 degrees), you should let the cartons stand unopened in your printing room for at least 18 hours before use.
- Store paper inside the original carton and ream wrappers until shortly before use.
- Reduce excessive curl by storing the paper in a dry environment for several days.

Paper runability criteria

Use the following criteria to avoid paper jams and to assure high image quality:

- Use 24 pound/90 gsm xerographic or dual purpose MICR bond paper. The paper should have the following characteristics:
  - Low moisture content (below 5.3 per cent)
  - Built-in curl control
  - Smooth surface (smoother than most offset or bond papers)
  - No mechanical defects
  - Moisture-proof wrapping
- Correct temperature and humidity are also important. Refer to the “Temperature and humidity conditions,” earlier in this chapter.

Your service representative can verify that the MICR printing system is adjusted within design tolerances. If a paper runability problem persists, consider changing:

- The ream, carton, or request paper from a different lot
- Your type, weight, or brand of paper
- The conditions under which the paper is stored
- The temperature or humidity of the printer environment
- The time elapsed between unwrapping and printing

The following table is a troubleshooting guide for paper runability issues.

Table 3-3. **Paper runability issues**

Malfunction	Possible causes
Repeated processor jams	• Excessive curl • High moisture content in paper • Excessive paper smoothness • Bent corners • Predrilled paper plugs • Excessive moisture in printer or paper storage environment • Paper not acclimated to printer environment
Paper multi-feeds or skew feeds	• Poorly cut paper • Wrapper wax or glue on sheets • Low humidity in printer environment • Poorly drilled paper • Paper too porous
Paper misfeeds	• Poorly cut paper • Excessive curl
Jams in stacker bin	• Excessive curl • High moisture content in paper • Excessive moisture in printer or paper storage environment
Sheets stick together in stacker	• Low humidity • Paper dust on static eliminator
Poor copy quality	• Rough paper • Incorrect paper conductivity
Leading edge of the paper tears	• Poorly cut paper • Paper too lightweight • Excessive curl
Spots on copy	• Wrapper wax or glue on sheets • Excessive paper dust • Dust from poor perforations • Wax or soap used on drill

Preprinted forms considerations

The combination of consistent data format and element location makes preprinted forms useful in MICR applications. Additional requirements for security features, either in the base paper stock or in the preprinted form, come from the need to protect a financially negotiable document.

You need to consider several factors related to ink and paper when selecting a preprinted form for any type of laser printer. Preprinted check stock must not offset (transfer from a printed sheet onto other surfaces). Work closely with the forms vendor to ensure that requirements are understood and met. Always test the application on the appropriate printer before production printing.

Inks

Choosing the correct ink is the first step in designing forms that function well in Xerox printers. Inks for these forms must cure well, must not be tacky, and must not offset. In choosing an ink, you must consider the amount of heat and pressure to which the forms will be exposed while passing through the printer. You must also consider the *dwell time*–the amount of time that the preprinted paper is subjected to those conditions.

Good performance has been reported with the following ink types:

- **Oxidative inks:** The following qualities are desirable in oxidative inks:
  - Non-volatile, cross-linkable vehicles
  - Internal and surface-curing driers
  - Minimal use of antioxidants
  - No slip agents
  - pH in the press fountain high enough to permit curing

  NOTE: Oxidative inks can require several days to harden satisfactorily.

- **UV cured inks:** Inks that are cured using UV (ultraviolet) light change immediately from liquid to solid upon exposure to an intense UV light source.

- **Laser inks:** Inks that are formulated specifically for use on forms that will pass through laser printers are a recent development that holds considerable promise. These inks cure promptly (usually within 24 hours) and are formulated with laser printer conditions as a design criterion. They can be expected to reduce offsetting and other problems encountered with other types of inks.

  Laser inks may be oxidative, UV, or heat set types.

Another option is to use Xerox forms, whose performance is guaranteed. The same guarantee should be expected of the forms vendor chosen by the customer.

Security features

Checks and other negotiable require protection against fraudulent use. Security features can be incorporated into the base stock when the paper is made, or they can be part of the preprinted form. These features should be chosen to achieve sufficient document security without negative effects on printer operation.

A secure document is protected against both duplication and alteration. Security features should be selected to address each of these aspects effectively when they are used in a MICR laser printing system.

A detailed discussion of check security is contained in chapter 8, “Security.”

Duplication detection

The most common security features for detecting duplication of forms include:

- **Microprint:** Extremely small type used to print a message or phrase that is readable under magnification
- **VOID pantograph:** A pattern of varying halftone screen frequencies in the check background that causes the word *VOID* to appear in the background of a copied check
- **Split fountain backgrounds:** Continuous fade from one color to another across the document
- **Microfibers:** Tiny colored or UV treated fibers that are incorporated into the base paper stock and are easily visible under normal or UV illumination.

- **Watermark:** A variation that is made in the opacity of the paper during manufacturing. An artificial watermark is typically a white ink image that is printed on the back of the check.
- **Drop-out ink:** Very low density ink that is used to print a message, usually on the back of the check
- **Thermochromic ink:** An ink that is used to create an image that changes color when warmed by a finger

Alteration prevention

The most common security features for detecting alteration of forms include:

- **Security backgrounds:** Patterns printed in the check background that show any attempt to alter the image. Regular patterns are preferable; irregular patterns may merge with altered areas.
- **Fugitive inks:** Inks that run when they come in contact with liquids

Application design

Intelligent application design can provide additional protection against alteration.

- In left- and right-fill fields, pad any open space with additional characters. Asterisks (*) are recommended to fill in the convenience amount field (the amount written in numerals).
- Redundant data—duplicate information, such as the amount written in both numbers and words—makes altering the valid check data more difficult.
- Fonts with large, wide-stroke characters are more difficult to alter than small, narrow type faces.

Numbered stocks

Preprinting sequential numbers on the sheets of MICR stock is a useful tool for tracking stock usage. Numbered stock is helpful for determining the number of sheets that were used for a check printing job, reconciling against the size of the job and the number of sheets that were used but not issued as checks.

Following are some points to note for using numbered stocks:

- To achieve reconciliation without substantial waste, always use the stock sheets in the same order—lowest to highest—so that the sequence remains intact.
- Avoid gaps in the sequence.
- Storing unused stock without wrapping may cause runability problems the next time it is used.
- The numbering order depends on how the paper is loaded in the feeder tray. If the paper is loaded face up, the lowest numbers must be at the top of the stack. If the paper is loaded face down, the lowest numbers must be at the bottom of the stack. For face down printing, either the paper must be boxed face down or the paper boxes must be inverted before the paper is used.
- Synchronizing the sequential numbers with the check serial numbers is not recommended because of the complexity it adds to the production process. Operators are required to input the starting sequence number, and the job must be restarted any time a jam occurs.

Features to avoid

Some security features may either be ineffective or cause damage to the printer. Before making a major forms investment, always test new preprinted forms to verify that security claims are delivered without printer impact.

- Some security papers contain chemical indicators that produce vivid dye images in areas where erasers, bleaches, or chemical eradicators have been applied. These indicators are intended for wet ink images and do not effectively protect dry ink images. They may degrade image quality, reduce document security, and severely impact printer reliability.
- Another type of chemical treatment of the base stock attempts to reduce the risk of alteration through improved image performance. Some, but not all, of these treatments improve permanence. There remains a risk of printer contamination, with associated degradation in image quality, reduction in image permanence, and potential printer reliability impacts.

- Many security features must be located in areas of the document where the printer places critical information, such as the payee name and the check amount fields. However, if the feature interferes with the bonding of dry ink to paper, poor image permanence results. This negates the value of the feature and makes alteration harder to detect. If the feature covers less than 20% of the paper surface, this risk is reduced.

4. Document design

Although other applications are possible, a MICR document is typically a negotiable document, very often a check. However, all types of MICR documents must be produced in accordance with the standards and methods that have been established for checks, in order for the automated payment systems to process them.

Check document content

A check is an unconditional order in writing that:

- Is addressed by a person or legal entity to another person or legal entity.
- Is signed by the person giving it.
- Requires the bank to pay, on demand, a sum of money, after a specific date.

The design of a check should enable anyone to quickly and easily enter and extract the necessary information.

A blank check normally has the characteristics that are described in the following sections. An issued check has the same characteristics, plus the variable data: payee, date, amounts, and signature.

Security features

Security should be present on all *negotiable* documents to protect against tampering and duplication. They may be incorporated at the time the paper is manufactured or can be part of the preprinted form, and a given sheet may include features from both sources. Form production considerations are discussed in chapter 3, “Paper facts.” Issues related to document design are discussed in the next section.

For additional information on security paper and tampering methods, refer to “Security” chapter.

Background printing

While MICR documents may be printed on white or pastel colored paper, negotiable documents nearly always have some sort of background—a scenic image, a logo, or a pattern. Fixed form and variable information should print darker than this background.

The background printing must not interfere with extraction of the information that is required to process the completed check. Industry standards have defined requirements for the following areas that contain the necessary variable information:

- MICR line
- Convenience amount
- Amount in words
- Date
- Payee
- Signatures

In these areas, additional background printing limitations and measurements apply. Tighter limits are placed on reflectance, and contrast is defined in a localized manner that is more in keeping with the way automated equipment detects check data. New scanner-based test equipment is now required to evaluate how a check design conforms to the new specifications.

Check issuers who do not print their own forms must require their forms suppliers and application developers to adhere to check background specifications.

Fixed information

The fixed data that appears on the face of either a personal or business check is necessary for the proper processing of the check.

Date line

The date is a required element on a check. It is written by the issuer and represents the day on or after which the amount of the check may be transferred. The date line should be in the upper right corner of the check.

If the application produces a completed check, the date should still be located in this area, but the actual line may be omitted.

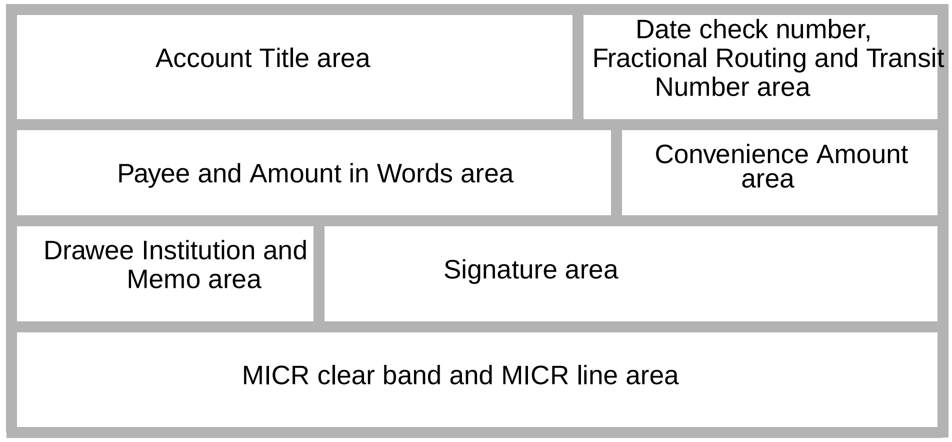


Figure 4-1. Typical U. S. personal check document design layout

Amount lines

The amount of the check is also required. In order to prevent tampering, the amount should appear twice on the check. The amount that is written in numerals is called the “Convenience Amount,” while the amount that is entered as text is the “Amount in Words.”

ANSI standards specify the location of the Convenience Amount for all styles of checks, and this standard is followed throughout the world. The area may be highlighted by the use of preprinted boxes and must include a dollar symbol ($). For completed checks, the box around the Convenience Amount field should be retained to aid in locating this data.

NOTE: The Xerox MICR fonts contain a dollar symbol, which is acceptable for all applications.

The area for the Amount in Words is normally located left of the Convenience Amount, but may be above it or below it. For completed checks, the line for entering the Amount in Words may be omitted.

Payee line

The payee area of the check provides a line for the purpose of entering the name of the payee. The line is often preceded by the words “PAY TO THE ORDER OF.” For completed checks, this line may be omitted, because the payee information is already present.

Signature lines

The signature line or lines are located in the bottom right portion of the check, above the MICR line. The signature area should be located no lower than 8½ inches/216 mm from the bottom edge of the check to avoid interference with the MICR information in the clear band area.

The minimum clear band dimension for Xerox MICR printers is ¾ inch/19 mm, because the line printed by a Xerox MICR printer is magnetic and therefore must be kept out of the MICR clear band over the entire allowable registration range.

The signature lines may be omitted when a completed, signed check is issued; however, the ¾ inch/19 mm clear area must be retained. This clear area is measured from the lowest descending stroke of the signature, because any incursion into the MICR clear band can cause rejects or misreads.

Name of financial institution

The institution where the account is located is referred to as the “payor institution.” The payor institution name and address is generally printed in the lower-left section of the check, directly below the Payee and Amount in Words area. If it is adjacent to the MICR clear band, the institution name must be more than ½ inch/13 mm above the bottom of the check in a preprinted form, or ¾ inch/19 mm above the bottom if the check is printed by a Xerox MICR printer.

Memo line

A line is generally printed in the lower-left corner of the check, below the payor institution name. This information also must be positioned at least ½ inch/13 mm above the bottom of the check on a preprinted form, or ¾ inch/19 mm above the bottom of a check printed by a Xerox MICR printer.

Account title

The title of the account is normally printed in the upper-left corner of the check, directly above the payee line. This area provides the customer information, which could include address and telephone number.

Check serial number

This number is usually printed in the upper-right corner of the check. It is not a required element of the check, and is provided as a convenience to the account holder. In most cases, the check serial number appears a second time in the MICR line.

Fractional routing number

This number in fractional format is printed in the upper-right corner of the check. It identifies the payor institution and is used in routing the check through the banking system. A portion of the routing number is also in the MICR line.

MICR line

The MICR line is the line of machine readable information that is printed at the bottom of each check. Financial institutions are dependent on the accuracy and integrity of the data in this line. Unlike the fixed elements of the form, the MICR line must be printed using magnetic ink and a special MICR font, such as E13B or CMC7.

MICR line (clear band) format requirements

The format of the MICR line must conform to the standards set by ANSI specifications. The MICR line is contained within the clear band area, which is located at the bottom of the check.

By ANSI standards, the minimum size of the clear band is defined as the bottom 5/8 inch/16 mm of the check document.

The clear band must not contain any magnetic material other than MICR characters. Because the entire Xerox MICR document uses the magnetic dry ink, make sure that no marks of any kind (cut lines, signature letters, etc.), other than the MICR line font characters, are printed in the clear band on either side of the paper.

All MICR characters must be in a single line within the clear band. In accordance with ANSI standards, the MICR line must be positioned as follows.

- Between 3/16 inch/4.8 mm and 7/16 inch/11.1 mm from the bottom edge of the check

- 5/16 inch/7.9 mm from the right edge of the check, ± 1/16 inch/1.6 mm
- Minimum of 1/8 inch/3.2 mm from the left edge of the check

The following figure illustrates the clear band dimensions for the E13B and CMC7 fonts.

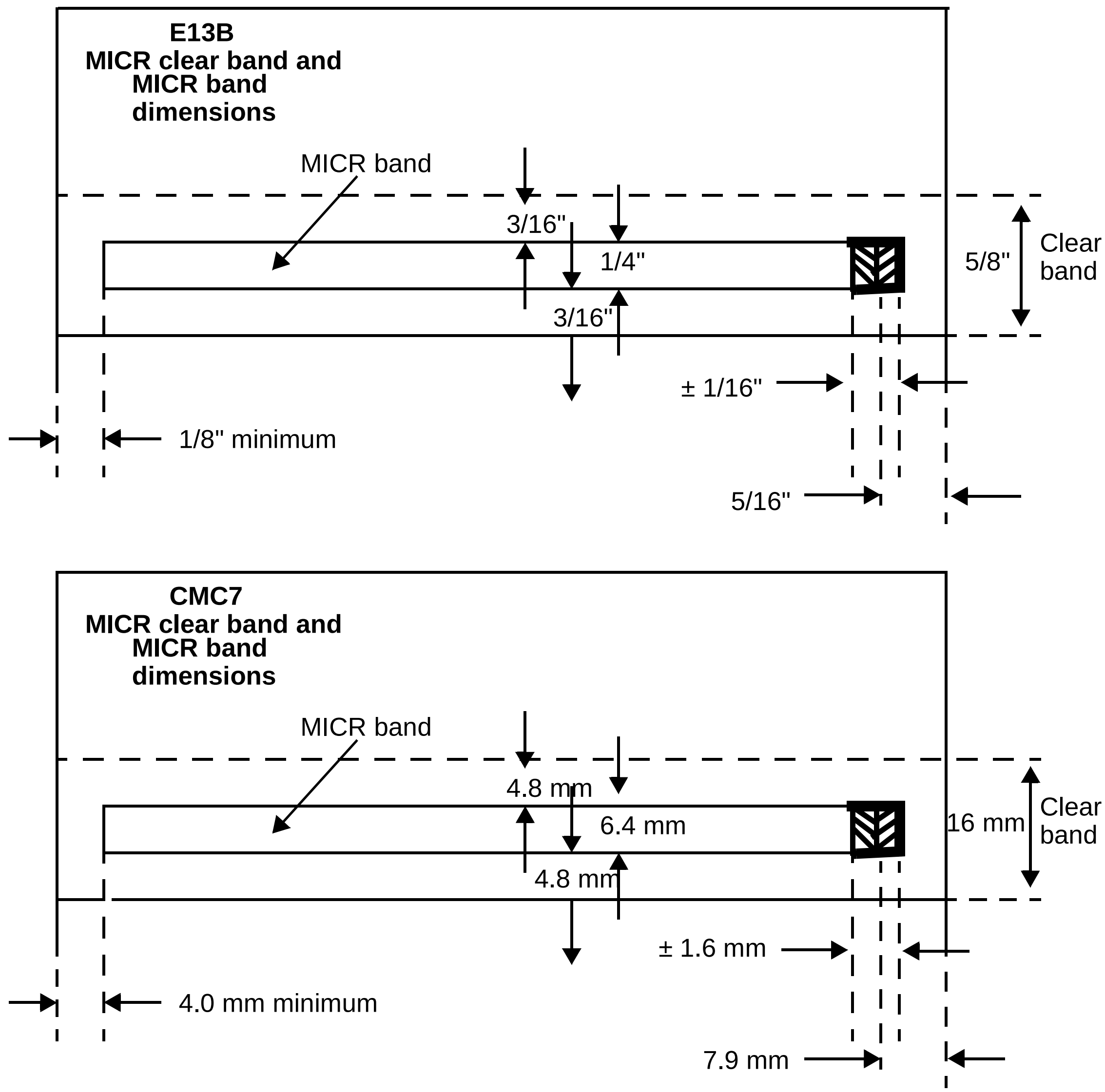


Figure 4-2. MICR clear band dimensions

Format specifications using E13B

The recommended clear band dimension for Xerox MICR printers using the E13B font is 3/4 inch/19 mm, to provide for tolerances of the printing and finishing systems, and to allow an extra margin of safety between the clear band and the magnetic ink on the rest of the check. If the clear band is not at the bottom of the sheet, keep 1/8 inch/4 mm below the clear band free of printing.

E13B character set

There are two types of characters in the E13B font: numbers and symbols.

E13B numbers

The E13B font numbers are illustrated below:

E13B symbols

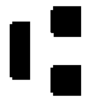
The E13B font has the following four symbols.

On-Us symbol

This symbol tells the reader sorter that the next few numbers identify the account. Because the issuing institution determines the content of the On-Us field, the bank branch on which the check is drawn may also be indicated.

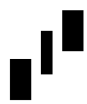
On larger business size checks, the On-Us symbol is also used to define a field on the left end of the check. This optional field, called the Auxiliary On-Us field, frequently contains a multiple digit serial number.

Transit symbol



The two Transit symbols tell the reader sorter that the numerals between these symbols are the routing number that identifies the institution on which the check is drawn and where the document should be sent for processing. Checks are not processed in branch offices, but in central processing locations, which ensures that documents take the shortest route and the shortest processing time.

Amount symbol



The two Amount symbols tell the reader sorter that the numbers between the symbols are the amount of the check in cents. You seldom see this symbol or the Amount field when you are developing an application, printing a MICR job, or servicing the MICR printer. The amount is normally added later by the bank. However, some customer applications may add the Amount field while printing checks.

Dash symbol

The Dash symbol is sometimes used as a separator within the On-Us Field, although reader sorter manufacturers discourage its use because of detection problems. Some banks use the Dash symbol to separate the bank branch number from the account number.

E13B character design

All of the E13B characters are designed on a 7 by 9 matrix of 0.013 inch/0.33 mm squares (see figure 4-5.). The minimum character width is four squares (or 0.052 inch/1.3 mm) for the numbers 1 and 2. The maximum width is 0.091 inch/2.3 mm for the number 8, 0, and four special symbols. All characters except the On-Us and Dash symbols have a height of 0.117 inch/3 mm. This does not correspond to an exact point size usually specified for fonts, but is between 8 and 9 points.

The height of the On-Us symbol is 0.091inch/2.3 mm, and the dash is 0.052 inch/1.3 mm. Both heights are multiples of the basic 0.013 inch/0.33 mm unit.

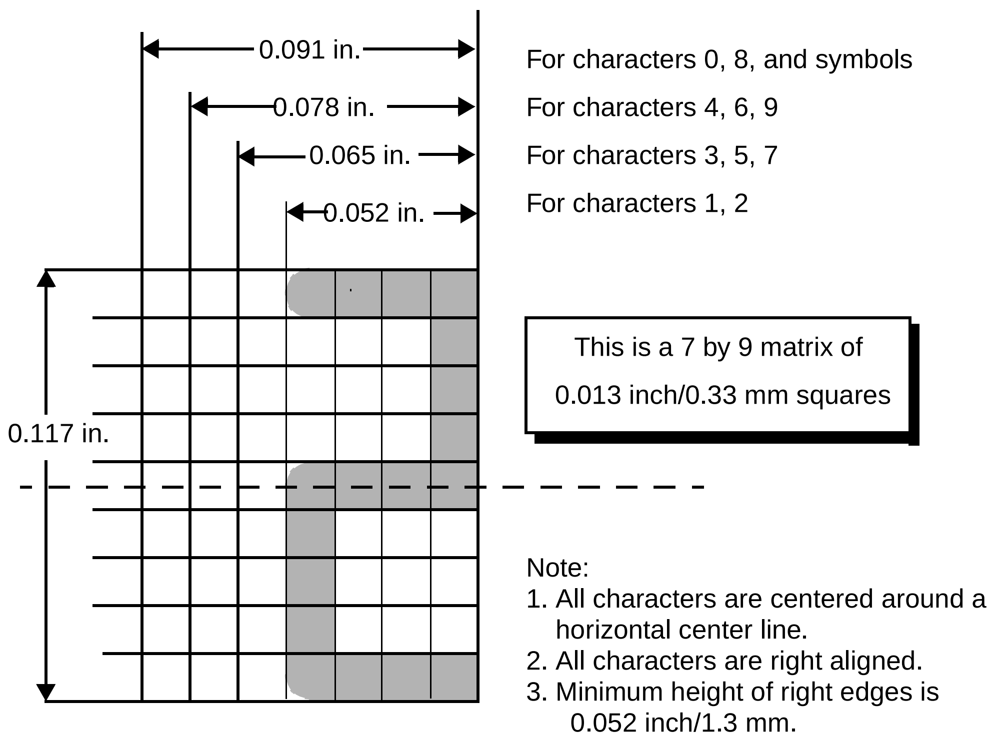


Figure 4-3. E13B character matrix design

Field formats—E13B font

The MICR line contains up to 65 character positions. These positions are numbered and grouped into five fields, which are read from right to left.

1. Amount
2. On-Us
3. Transit
4. External processing code (optional)
5. Auxiliary On-Us (optional)

All checks have at least three of the fields (Amount, On-Us, and Transit). Commercial checks may also have an Auxiliary On-Us field, located on the left of the check. Some checks also have an External Processing Code (EPC) digit, located between the Transit and Auxiliary On-Us fields.

The Amount and Transit fields have a standardized content, while the contents of the On-Us and Auxiliary On-Us fields can vary to meet the individual bank requirements. The following figure illustrates the placement of the four fields on a check in the U. S.

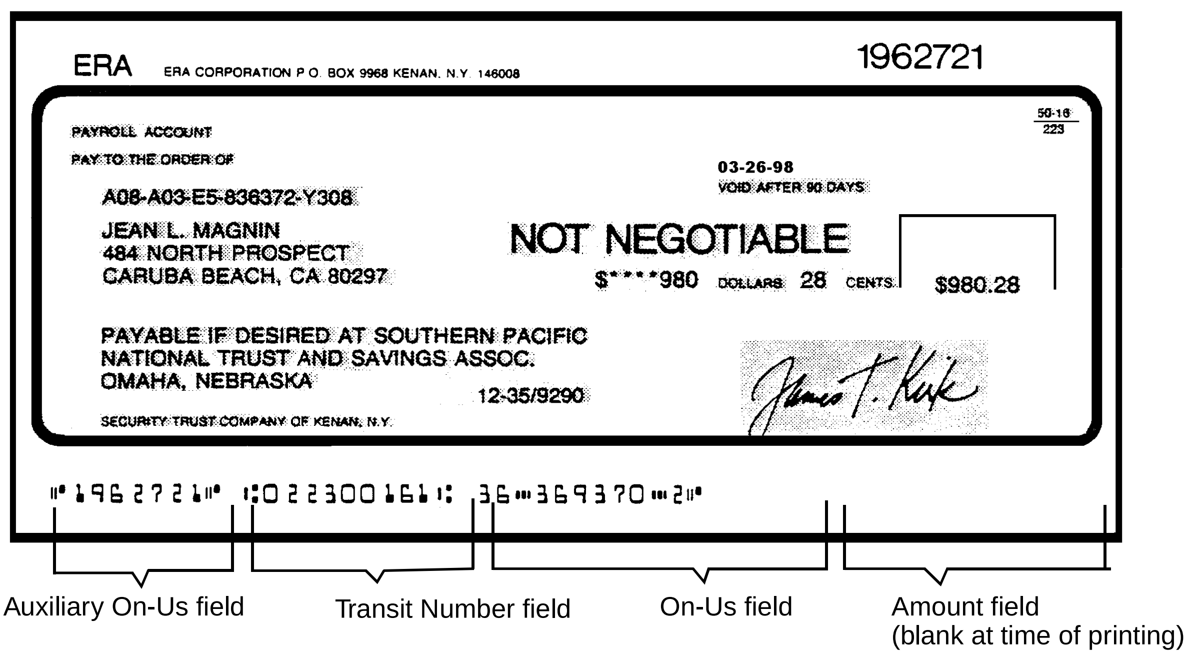


Figure 4-4. MICR line fields

Document Specifications form

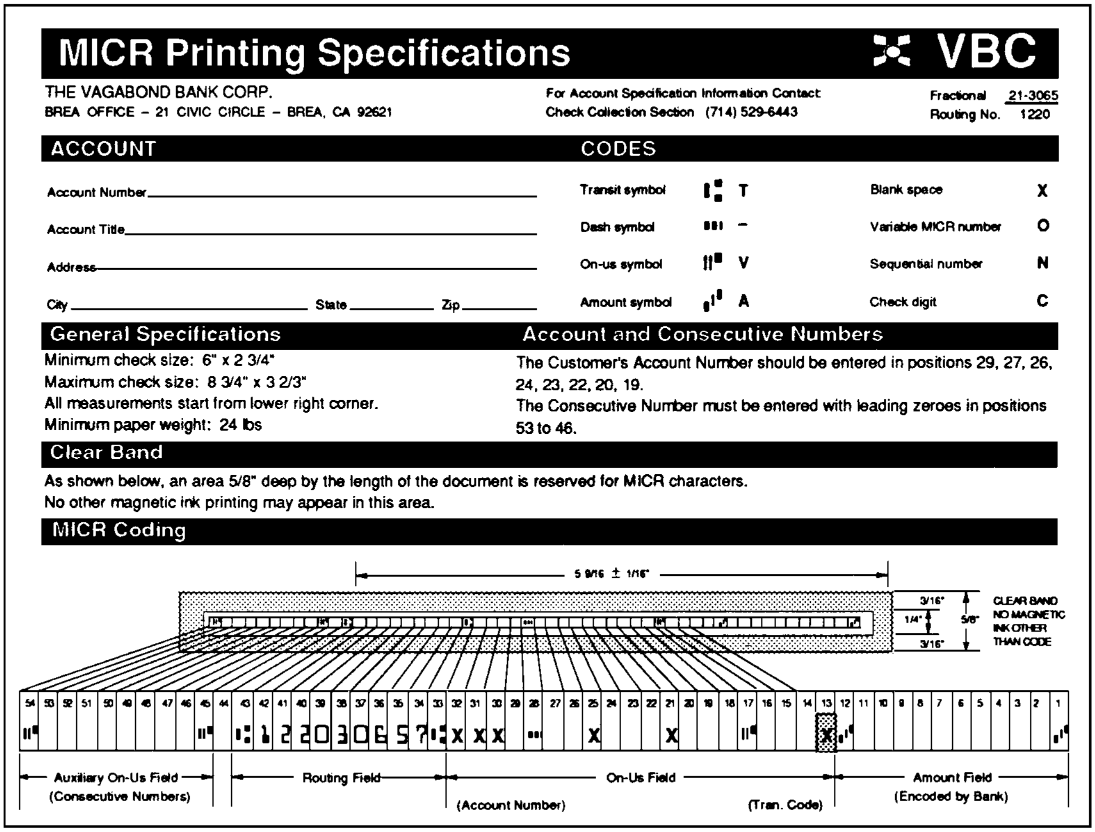
For accurate formatting of the entire MICR line, each bank should provide a MICR Document Specifications form to identify the proper contents of the various character positions. (Refer to figure 4-4). The MICR Document Specifications form includes:

- The account number, title, and address
- General specifications regarding check size and format
- The position of the control characters and digits that will be entered into the routing field
- The structure of the On-Us and Auxiliary On-Us symbols
- General specifications regarding the quality control procedures of the bank

Each MICR symbol, and the numbers or spaces between those symbols, must be properly registered so that the fields do not flow into one another.

The exact field structure depends on the national standards. Field lengths may vary as a function of the national requirements and even the detail usage of the symbols may be different. For example, although Australia uses the same length and bracketing structure for the Amount field as the U. S., their “starts” are equivalent to the Transit field with a Transit symbol, but they “close” with an On-Us symbol.

Even within the national standards, variation can exist within fields. It is always best to identify the required field structure through the use of the bank's MICR Document Specifications form for a specific account.



MICR Printing Specifications

VBC

THE VAGABOND BANK CORP.
BREA OFFICE – 21 CIVIC CIRCLE – BREA, CA 92621

For Account Specification Information Contact:
Check Collection Section (714) 529-6443

Fractional Routing No. 21-3065 / 1220

ACCOUNT

Account Number ______
Account Title ______
Address ______
City ______ State ______ Zip ______

CODES

Transit symbol	⑆	T	Blank space		X
Dash symbol	⑉	–	Variable MICR number		O
On-us symbol	⑈	V	Sequential number		N
Amount symbol	⑇	A	Check digit		C

General Specifications

Minimum check size: 6" x 2 3/4"
Maximum check size: 8 3/4" x 3 2/3"
All measurements start from lower right corner.
Minimum paper weight: 24 lbs

Account and Consecutive Numbers

The Customer's Account Number should be entered in positions 29, 27, 26, 24, 23, 22, 20, 19.
The Consecutive Number must be entered with leading zeroes in positions 53 to 46.

Clear Band

As shown below, an area 5/8" deep by the length of the document is reserved for MICR characters.
No other magnetic ink printing may appear in this area.

MICR Coding

Figure 4-5. MICR Document Specifications form (U. S. example)

NOTE: In this example, X denotes blank spaces required by the issuing bank.

Amount field

The Amount is the first field on the right, located between character boxes 1 and 12. When this field is used, position 12 contains the Amount field symbol, and positions 2 through 11 contain the actual amount. The amount is right-justified, and all unused positions to the left are filled in with zeros.

The Amount field is usually empty when the document is printed; the amount is added later by the bank. However, some applications may add the Amount field while printing checks.

On-Us field

The second field from the right is the On-Us field, located between character boxes 14 and 31. It follows a blank space at position 13, which is a separator from the Amount field.

The On-Us field includes variable information from the banking institution, including the account number. It contains the On-Us symbol, at position 14 and 31 or 32.

To the left of the On-Us symbol, reading right to left as the reader sorter does, are the account number, the bank branch number, and the check number. The check serial number is typically to the right of the On-Us symbol. Since the issuing institution determines the content of the On-Us field, the bank branch on which the check is drawn on may also be indicated. The last position is usually followed by a blank in position 32.

The Dash symbol is sometimes used as a separator within the On-Us field. This is not recommended, however, because the dash is difficult to detect.

Transit field

The Transit field is located between character boxes 33 and 43. The Transit symbol is located at positions 33 and 43. On a check having four fields, like the one in figure 4-3, this field is second from the left. However, shorter checks (such as personal checks) do not have an Auxiliary On-Us field. In this case, the Transit field is the farthest left of the three fields. The Transit field, like the Amount field, is right-justified, with all unused positions to the left filled with zeros.

External processing code (EPC) field

The External Processing Code (EPC) field is an optional field between the Transit and Auxiliary On-Us fields at position 44 or 45. When present, this field indicates that the document is eligible for special processing.

Auxiliary On-Us field

The Auxiliary On-Us field is an optional field that is sometimes used by the banks for additional processing information or high value serial numbers. When it is present, it is the farthest left on the check, between positions 45 or 46 through 65.

This field is not present on personal checks because of space limitations. On business checks, it usually contains the check serial number or accounting control information specific to that account.

Field formats summary

The following table provides a summary of the MICR field formats and character positions using the E13B font.

Table 4-1. **MICR field formats—E13B**

Field	Position	Description
Amount	1 to 12	Fixed field signifying the dollar value of the check. **Position:** • **1** Opening amount symbol • **2 to 3** Cents • **4 to 11** Dollars (zero-fill to left) • **12** Closing amount symbol • **13** Space
On-Us	14 to 31 or 32	Content is determined by each institution; generally contains the account number. May optionally extend to include position 32. May also contain the serial number, the transaction code, or both. The symbol located nearest to the left edge of the document, must end more than ¼ inch/6.35 mm from the left edge of the document. **Position:** • **14** On-Us symbol • **15 to 31 or 32** Generally contains the account number, and may also contain the serial number, transaction code, or both. • **31** On-Us symbol if not used to extend the field • **32** Space, or On-Us symbol if the field was extended
Transit	33 to 43	Fixed field identifying the institution upon which the check is drawn. **Position:** • **33** Opening transit symbol. • **34** Check digit. This number combined with the first eight digits verifies the accuracy of the routing number in computer processing. • **35 to 38** Institutional identifier (a four-digit check routing symbol). • **39 to 42** Check routing symbol. The first two digits are the federal reserve district for the institution. The third digit identifies the federal reserve office (the head office or branch) or a special collection arrangement. The fourth digit shows the state for the institution, or a special collection arrangement. • **43** Closing transit symbol.
External Processing Code (EPC)	44 or 45	External Processing code (EPC) field. If present, represents participation in an authorized program that requires special handling or processing in the collection system.
Auxiliary On-Us (optional)	45 or 46 to 65	Content determined by each institution. Contains numbering, transaction codes, and internal controls. Used only for checks longer than 6 inches/152 mm). The right most symbol must start within ¼ inch/ 6.35 mm of the Transit symbol farthest to the left.

Character alignment

The bottom edges of adjacent E13B MICR characters within the same field are in alignment within:

- ± .007 inch/0.18 mm (CPA—Canada)
- ± .015 inch/0.38 mm (ISO—International)
- ± .030 inch/0.76 mm (ANSI—U. S. only)

Although this is a concern for impact printing, MICR characters printed on laser systems are always properly aligned.

NOTE: The Amount field of the MICR line is not normally printed by the laser printer, but is added by a proof machine at the bank of first deposit. The proof machine, being an impact device, may cause alignment errors.

CMC7 font

The CMC7 font is an alternative MICR font that has been adopted in various countries throughout the world.

CMC7 numbers and symbols

The usage of the CMC7 special symbols generally parallels the usage of the E13B special symbols. There are, however, significant differences.

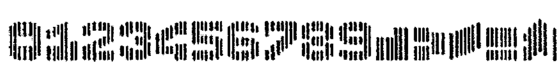


Figure 4-6. CMC7 MICR font character set

The CMC-7 font consists of 10 numeric characters (0-9), five special symbols, and 26 alphabetic characters (A-Z). The five special symbols are illustrated in the following figure:

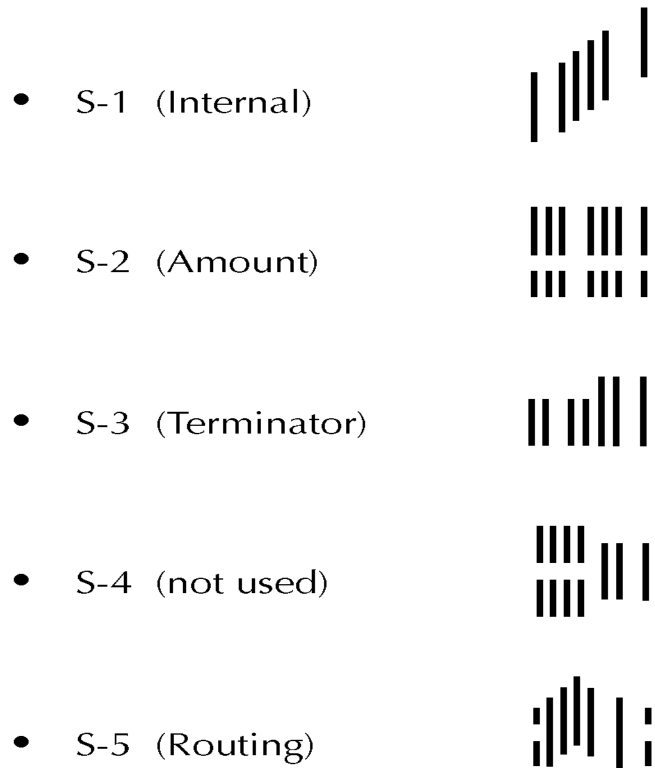


Figure 4-7. CMC7 special symbols

S-1: Indicates the start of the bank's internal information (account number, etc.). Although it serves a purpose similar to the E13B On-Us symbol, it is not used in the CMC7's equivalent to the E13B Auxiliary On-Us field.

S-2: Identifies the start of the Amount field. Unlike the E13B structure, this symbol is not used to terminate the Amount field. The CMC7 Amount field terminates when the appropriate number of digits (minimum 10, maximum 12, followed by a blank) have been detected.

S-3: Used as the terminator for the bank routing information. It also functions as the terminator of the check number field (following a minimum of four digits, maximum of seven digits).

S-4: Not used. Although its structure is defined, this symbol usually does not appear in the structure of the MICR line.

S-5: Indicates the routing number that identifies the institution on which the check is drawn and where the document should be sent for processing. This symbol is the equivalent of the E13B Transit symbol. However, it is not used to terminate the bank routing identification.

Character design

The CMC7 font differs from the E13B font in character height and width. The height of all of the numeric characters is 0.112 inch/2.85 mm. Special symbols are 0.106 inch/2.70 mm. Unlike the E13B font, the CMC7 characters all have the same width. Each CMC7 character format consist of seven vertical strokes separated by six spaces of 0.3 or 0.5 mm (referred to as short and long intervals). Each character contains two long intervals and four short intervals. Different permutations of the long and short intervals identify each character.

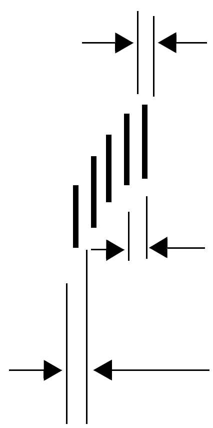


Figure 4-8. CMC7 stroke and interval dimensions

The fonts are optimized for each product. They are not interchangeable between products.

MICR character spacing requirements

Reader sorters have timing limits that prevent them from handling extreme variations in character spacing. The average spacing requirement for MICR characters is 0.125 inch/6.4 mm per character (8 characters per inch).

The MICR specifications have a tolerance on the 0.125 inch/6.4 mm spacing requirement of ± 0.010 inch/.3 mm. Specifications also state that the accumulated error must not exceed field boundaries, shown in table 4-1. MICR characters are right justified and the numbers are read from right to left. This means that you might need to pad the MICR line with leading blanks so that the numbers start in the correct position.

Character spacing algorithm for 300 dpi

MICR printing systems print at 600 or 300 dots per inch. At 600 dpi, there are no issues with character spacing. 600 dpi can be divided evenly by 8 characters per inch, resulting in 75 dots per character.

However, 300 dpi, when divided by 8 characters per inch, results in 37.5 dots per character. The system cannot print half a dot, so it cannot print each character at exactly 8 characters per inch.

You can achieve an average of 37.5 dots per character by using a proportional spaced font with a spacing algorithm that places a space of one dot after every second character. In other words, two characters of 37 dots are printed, followed by a one-dot space, then the sequence is repeated. This algorithm is used extensively in high volume printing installations.

Fixed pitch and proportional font spacing

The relationship between the input character and the output character or space is shown for proportional spaced fonts in table 4-3, and for fixed pitch fonts in table 4-4.

NOTE: The relationship between the input character and the output character may differ slightly from these tables for some Xerox MICR products. These differences are primarily found with the revision control character (?) and the special symbols.

The following HP PCL escape sequences must be entered exactly as shown to select the Xerox MICR fonts:

- E13B:

  <ESC>&100<ESC>(0U<ESC>(s0p8.00h9.00v0s0b0T

- CMC7:

  <ESC>&100<ESC>(1U<ESC>(s0p8.00h9.06v0s0b0T

NOTE: The PCL 5 font rotation commands are used to rotate the E13B and CMC7 portrait fonts for landscape applications.

Table 4-2. **PCL fixed pitch MICR font characteristics**

File name	**E13B-P.FNT**	**CMC7-P.FNT**
Orientation	Portrait	Portrait
Symbol set	OU	1U
Pitch	Fixed	Fixed
HMI	8.00 CPI	8.00 CPI
Point	9.00	9.06
Style	Upright	Upright
Stroke weight	0	0
Type face	Line printer	Line printer

Table 4-3. **Character conversion and spacing of proportionally spaced MICR fonts (LCDS printing only)**

Input character	**Input code**	**E13B font**		**CMC7 font**	
ASCII symbol	Hex Value	Printed result	Dot width	Printed result	Dot width
(space)	20	(space)	37	(space)	37
!	21	(space)	1	dollar symbol	37
$		dollar symbol	37	dollar symbol	37
0	30	0	37	0	37
1	31	1	37	1	37
2	32	2	37	2	37
3	33	3	37	3	37
4	34	4	37	4	37
5	35	5	37	5	37
6	36	6	37	6	37
7	37	7	37	7	37
8	38	8	37	8	37
9	39	9	37	9	37
:	3A	Transit symbol	37	S-1 symbol	37
;	3B	Amount symbol	37	S-2 symbol	37
<	3C	On-Us symbol	37	S-3 symbol	37
=	3D	Dash symbol	37	S-4 symbol	37
>	3E	(not used)	--	S-5 symbol	37
A	41	(space)	1	(space)	1
B	42	(space)	2	(space)	2
C	43	(space)	4	(space)	4
D	44	(space)	8	(space)	8
E	45	(space)	16	(space)	16
F	46	(space)	32	(space)	32
G	47	(space)	64	(space)	64
X		(space)	37	(space)	37
Y		(space)	38	(space)	38
a		Amount symbol	37	(not used)	--
d		Dash symbol	37	(not used)	--
o		On-Us symbol	37	(not used)	--
t		Transit symbol	37	(not used)	--
z		On-Us symbol	37	On-Us symbol	37
?		revision control character	37	revision control character	37

Table 4-4. **Character conversion and spacing of fixed pitch MICR fonts at 300 dpi**

	E13B font			**CMC7 font**		
Input character	Printed result	Dot width @300 dpi	Dot width @600 dpi	Printed result	Dot width @300 dpi	Dot width @600 dpi
space	(space)	37.5	75	(space)	37.5	75
$	dollar symbol	37.5	75	dollar symbol	37.5	75
0	0	37.5	75	0	37.5	75
1	1	37.5	75	1	37.5	75
2	2	37.5	75	2	37.5	75
3	3	37.5	75	3	37.5	75
4	4	37.5	75	4	37.5	75
5	5	37.5	75	5	37.5	75
6	6	37.5	75	6	37.5	75
7	7	37.5	75	7	37.5	75
8	8	37.5	75	8	37.5	75
9	9	37.5	75	9	37.5	75
:	Transit symbol	37.5	75	S-1 symbol	37.5	75
;	Amount symbol	37.5	75	S-2 symbol	37.5	75
<	On-Us symbol	37.5	75	S-3 symbol	37.5	75
=	Dash symbol	37.5	75	S-4 symbol	37.5	75
>	(not used)	--	--	S-5 symbol	37.5	75
a	Amount symbol	37.5	75	(not used)	--	--
d	Dash symbol	37.5	75	(not used)	--	--
o	On-Us symbol	37.5	75	(not used)	--	--
t	Transit symbol	37.5	75	(not used)	--	--
z	On-Us symbol	37.5	75	On-Us symbol	37.5	75
?	revision control character	37.5	75	revision control character	37.5	75

Check size

The ANSI specified size limits for a check are shown in the following figure.

Length:	6 inches/152 mm minimum 8.75 inches/222 mm maximum
Height:	2.75 inches/70 mm minimum 3.67 inches/93 mm maximum

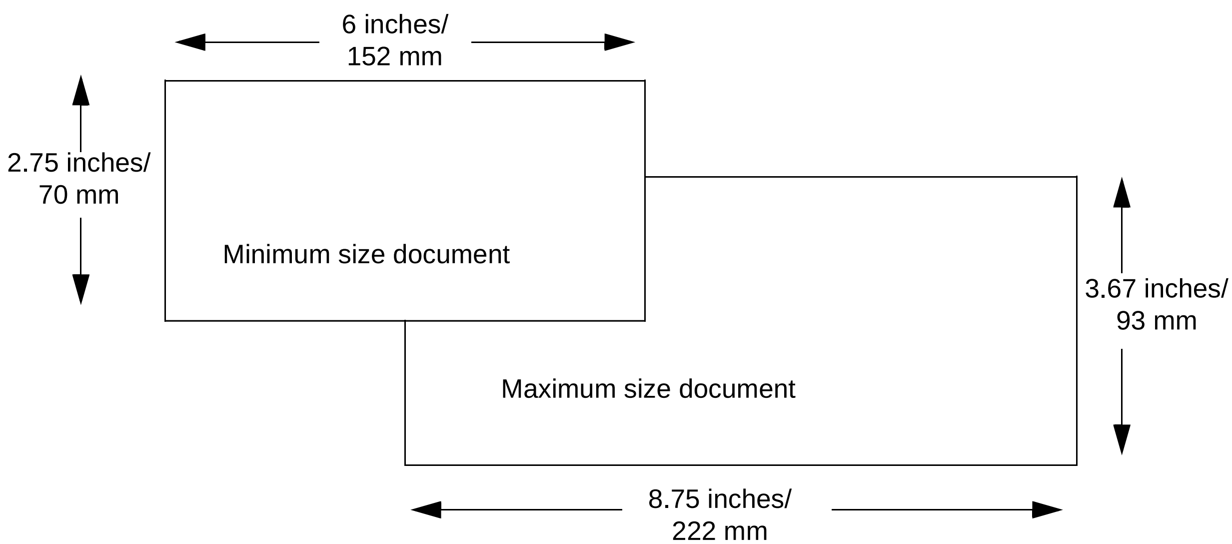


Figure 4-9. Check size limits

Most personal checks in the U. S. use the minimum size requirements. Commercial checks vary in size; however, most are closer to the maximum requirements.

Although the above dimensions are limited to U. S. standards, each national standards organization has established the minimum and maximum size documents that are used in their jurisdictions, shown in the following table. The bank's MICR Document Specifications form usually provides the definitive guide regarding the document sizes.

Table 4-5. **Check dimensions summary chart**

Country	Check dimensions	Notes
Australia	6.25’’ x 2.75’’/162 x 70 mm (min.) 8’’ x 3.66’’/203 mm x 93 mm (max.)	Typically 8’’ x 3 5/8’’
Bermuda	6.125’’ x 2.75’’ 7.4’’ x 3.15’’	10.5’’ x 3.15’’ with stub
Brazil	175 mm x 80 mm	Typically 4 checks per 8.5 x 12’’ sheet if check has stub; otherwise 4 checks per 7.25 x 12’’ sheet
Canada	6’’ x 2.75’’ (min.) 8.5’’ x 3.66’’ (max.)	Typically 6 1/4’’ x 2 3/4’’
France	175 mm x 80 mm	Check booklet: 225 mm x 80 mm, 102 mm x 175 mm, and 225 mm x 102 mm
Hong Kong	7’’ x 3.25’’ 8.5’’ x 3.5’’	
Italy	180 mm x 72 mm (min.) 260 mm x 72 mm (max.)	
Spain	175 mm x 80 mm	175 mm x 100 mm with top stub
UK	6.125’’ x 2.75’’/155 x 102 mm (min.) 8.25’’ x 4’’/209 x 101 mm (max.)	Typically 8’’ x 3’’
USA	6’’ x 2.75’’ (min.) 8.75’’x 3.66’’ (max.)	Typical personal check: 6’’ x 2.75’’ Typical commercial check: 8.5’’ x 3.67’’

Other application considerations

Printing on a Xerox MICR printing system raises some additional application considerations.

Two sided printing

Two sided (duplex) printing may be used in a MICR application, but the forms design and the application structuring require care.

- The reverse side of the clear band must not contain any magnetic printing. The only magnetic printing that is permitted in the clear band on either side of the sheet is the MICR line.
- The MICR line should be printed on the first imaged side of the duplex sheet.
- The endorsement area on the back of the check must be kept free of any printing that would interfere with bank endorsements.

NOTE: This information is applicable only if your system supports duplex printing.

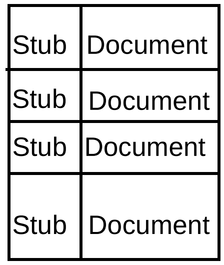
Perforations

If you are using perforated forms, the perforation must not interfere with the clear band area. Therefore, it should not be underneath the MICR line. Refer to “Perforation” in chapter 3, “Paper facts,” for guidelines for using perforations.

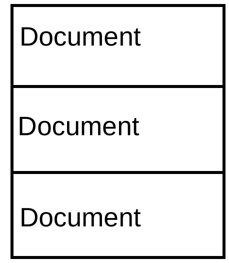
Multiple-up printing

For a check printing operation, several check documents can be printed on each sheet. This is called “multiple-up” or “multi-up” printing, which means that one or more logical pages are printed on one physical page. Perforated paper is often used to separate the documents or they may be separated after printing by gang-cutting or slitting the sheets.

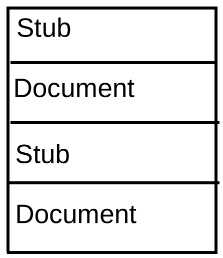
The following figure shows some possible sheet layouts for multiple-up printing.



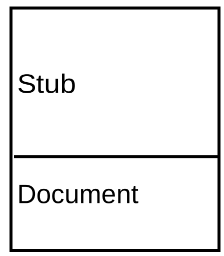
Four-up with check register



Three-up with no stub



Two-up with stub



One-up with stub*

*The maximum check height is 3.67 inches/93 mm, or one-third of an 8.5 by 11 inch/216 x 279 mm sheet.

Figure 4-10. Sheet layouts for 8.5 by 11 inch or A4 paper

A multiple-up format, however, raises the following application considerations.

- Avoid multiple-up applications in which the last sheet is only partially filled.

  Example: In a 3-up check application that will print 100 checks, the last page of the job prints only one check. This would leave the remaining two checks on the form blank. Blank checks on the last sheet are not acceptable.

  Potential solutions include:

  – Ensure there is always enough data to fill the last page, with partial pages being “voided” by the data.

  – Design more than one form when the correct form is being selected for the final page by the software program.

- Problems can occur when the sequence of the printed application does not meet the requirements of the site finishing equipment.

Example: A 3-up application is printed with checks numbered 1 through 6, in that order. After they are cut, three stacks of finished checks are produced: the first with check numbers 1 and 4, another with numbers 2 and 5, and a third with numbers 3 and 6. For this situation, the host application may need to be adjusted to enable the proper sequence to be maintained during finishing.

NOTE: For appropriate page sizes, refer to the printer documentation.

Readability

When designing MICR documents, it is critical to remember that the document acts as a vehicle to transfer money from one party to another. The MICR document must clearly communicate the information required to complete that transfer, without interference from colorful backgrounds or confusing layout. Digital image capture, processing, and storage for the entire check make this requirement more important.

Work is in progress to make the digital image of a check legally binding when captured and processed by banks. This is necessary to permit truncation of the paper documents early in processing and eliminate the cost of transporting the paper to the issuing bank. Checks should be designed to be easily interpreted when digitized into black and white images.

MICR documents are not the only documents in which readability is a concern. Many payment processing systems are designed to use an OCR-printed turnaround document to direct a check based payment. In these cases, readability of the OCR line may be compromised if the document is printed using magnetic ink. The processing system detect checks by the presence of magnetic ink and initiate an E13B font recognition routine. If the turnaround document is magnetic, failure to read would result. Therefore, MICR printers are not recommended when an OCR font is used for data collection.

5. Document processing

The life cycle for a MICR document involves three types of processing equipment:

- Proof machine
- Reader sorter
- Repair station

Proof machine

The proof machine transfers the amount from the Convenience Amount field to the MICR encoded Amount field. It prints the Amount field onto the check using either a thermal transfer or an impact ribbon printer. The proof machine may be manually operated or automated using a scanner and character recognition technology.

Reader sorter

The checks are then sent through a series of reader sorter passes. The reader sorter inputs data from the checks, captures each check image, endorses the checks, and sorts them according to their destination.

The checks are separated into either “transit items” drawn on other banks or On-Us items, drawn on the processing bank. Transit items are segregated into different groups and may receive several reader sorter passes, depending on the destination.

Repair station

If an error occurs in the reader sorter, the document usually goes to a repair station. Here, the MICR line is read both magnetically and optically, with operator intervention in severe cases. A new, corrected MICR line is applied to the check.

The final measure of the quality of the MICR document is how well it passes through the automated payment processing system.

Proofing checks

All checks start automated processing in the Proof of Deposit department. Check processing relies on a series of debits and credits throughout the process to identify errors as close to the source as possible.

The first step is to prove that the deposit is valid. A deposit slip is balanced against the value of the items deposited with it. Errors in MICR amount encoding or deposit ticket completion show up as a failure to balance.

Amount determination errors

To encode the amount, an operator may read the check and manually enter the amount, or an automated scanner may capture and analyze an image of the check to determine the correct MICR Amount field content. Poorly designed checks may interfere with amount determination in the following ways:

- Non-standard amount location
- Amount value written too small or too large
- Interference of check background design elements with amount field identification
- Lightly written check amounts
- Use of colored inks that do not provide sufficient contrast

Whenever the value of the check cannot be quickly and accurately determined, the cost of processing the item increases. The balancing process continues throughout payment processing, but the impact of check design most critical here.

Proofing equipment errors

Another potential problem in proof encoding is compatibility of the laser printed check with the encoding equipment. For many years, all proofing equipment used impact ribbon technology, which proved to be stressful for matrix head reader sorters (see next section).

Non-impact ribbon technology offers higher encoding speed and fewer matrix read processing issues. However, problems occur with transfer of ink to the paper. Paper roughness must be controlled. Also, for MICR laser printers, which apply a release agent or oil to the fuser, the specified fuser agent must be used and the metering system maintained according to Xerox schedules.

Reader sorter function

Reader sorters are machines that read magnetic ink characters that are printed using the E13B or the CMC7 fonts. Reader sorters recognize the magnetic waveform of the character, its magnetic pattern, its visual pattern (using OCR), or a combination of these characteristics. Reader sorters can be programmed to validate and sort by specified MICR line data fields. They may also be capable of endorsing, microfilming, imaging, and providing processing information in hardcopy.

How well the document passes through the reader sorter depends of the following:

- Document characteristics
  - MICR line format and placement
  - Print quality
  - Magnetic signal strength of the image
  - Paper characteristics.
- Reader sorter characteristics
  - Reader sorter type
  - Setup adjustments
  - Quality and quantity of operator maintenance.
  - Operation of the reader sorter
- Damage resulting from prior processing
  - Handling damage
  - Lead edge fluff

Waveform generation

All types of reader sorters react to any magnetic material in the clear band, intentionally placed on a document or not.

Reader sorters read from right to left and the magnetized ink generates a waveform. The following figure illustrates the process.

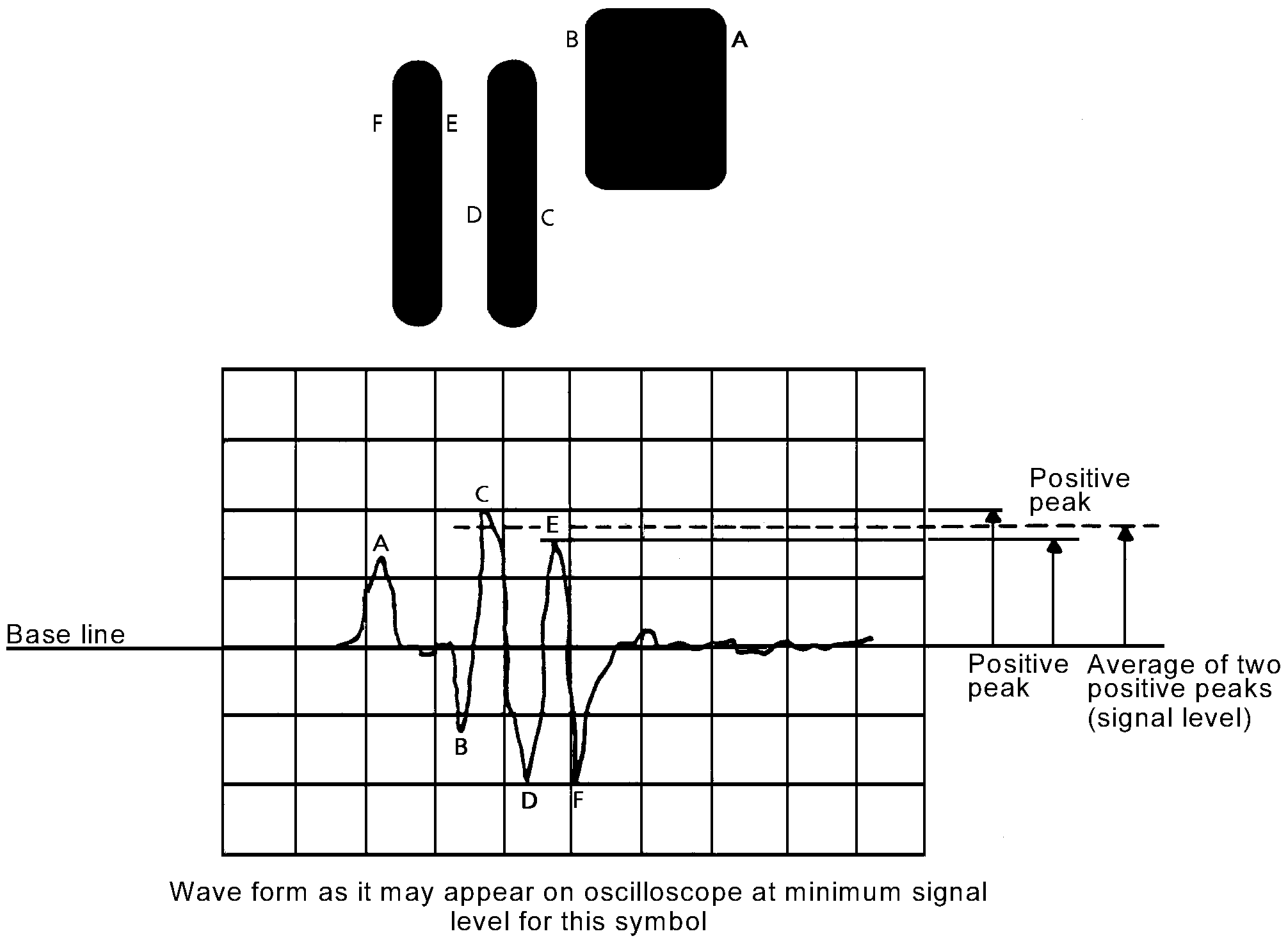


Figure 5-1. On-Us symbol waveform reading

First, the character is magnetized by the reader sorter. Then, as the character passes the read head, edge A generates a change in magnetic flux, producing peak A of the waveform. There is no change in flux as the character between A and B passes the head. As edge B passes the head, a change in flux is sensed producing peak B of the waveform.

This continues through edges C, D, E, and F, producing the entire waveform.

Types of reader sorters

The following recognition technologies have been incorporated into MICR reader sorter devices.

Waveform reader sorters

Waveform reader sorters measure the magnetic signal waveform or pattern of the MICR character as the documents pass the read head. Waveform reader sorters are often referred to as “single slot” or “single gap” readers because the read head contains one magnetically sensitive slot or gap, which covers the height of the entire character string in the clear band. Each MICR character that passes the read slot produces a waveform signal. This signal is compared against the known waveforms of the MICR character set to determine which character was read.

Waveform reader sorters are also called “DC readers,” because they use a constant magnetic field to magnetize the characters.

Waveform reader sorters are generally low to medium speed reading devices. The reject rates for these readers is slightly higher than for matrix readers.

Matrix or AC reader sorters

Matrix readers use a series of small read heads that are stacked in close proximity, each of which reads a small strip of the character string. The segments of the MICR characters register as binary magnetic flux transitions at each read head. These pulses are combined and used to build a two dimensional bitmap for each character. This bitmap is then compared to known bitmap patterns to determine the identity of the character.

To simplify bitmapping, readings from groups of heads are logically combined to produce a single value. This slightly increases sensitivity to spots, but results in lower reject rates for matrix readers.

Matrix readers are also called “AC readers,” because they use an oscillating magnetic field to magnetize the characters. These oscillations cause a series of waveform peaks in a character stroke, which are recorded as a binary 1 in the bitmap image of the character.

Optical reader sorters

Optical readers typically use a light source and some type of photosensitive matrix array to convert an image of the character into a set of electrical signals. Optical readers that can interpret the characters can be used to input data into an automated reading system. They are frequently used in reject repair equipment.

Dual read magnetic reader sorters

Some reader sorters use a dual read approach, in which two read stations magnetize and read the entire clear band area of the document independently.

The simplest dual read reader sorter uses two waveform readers. Like single read waveform reader sorters, each MICR character that passes through the read slot produces a waveform signal at each read station. The waveforms are compared against the known waveforms of the MICR character set, using different algorithms and circuitry in each station, to determine which character was read.

Another type of dual read reader sorter has one single slot waveform read station and one matrix head read station. The single slot reader compares the waveforms against the known MICR character waveforms, and the matrix reader builds a digital bit map for each character and compares that to known character bitmaps.

With the dual read technology, the system compares the results of the first head read with those of the second. If a character can be interpreted by only one of the read stations, the successful reader result is used. If neither read station properly identifies a character, that character is rejected. Conflicting interpretations between the two heads also causes character rejection.

An important aspect of reject rate diagnosis is understanding the recognition mode used by a dual-read reader sorter. Processing performance should be evaluated only in dual-read mode. Use of diagnostic settings to turn off one of the read stations, or to reject on either station independently, inflates the reported reject rate.

Hybrid magnetic and optical reader sorters

Hybrid reader sorters use two read technologies:

- Magnetic waveform recognition
- Optical character recognition

Compared to other types, hybrid reader sorters have very high accuracy rates, because they interpret and compare the results produced by the magnetic waveform recognition and the optical character recognition. If a character cannot be interpreted by MICR waveform analysis, the system takes the results of the optical recognition. In diagnostic situations, understanding the recognition mode is important.

Another form of hybrid equipment, used primarily in lock box and remittance processing, uses optical and magnetic recognition in a fundamentally different way that can cause problems with MICR documents. These reader sorters process an OCR printed turnaround document, followed by a MICR printed check. They identify a check by the presence of magnetic ink, then switch to a MICR font recognition system. If the turnaround document is printed with an OCR font but uses MICR ink, it may be misidentified and rejected, although the OCR font is properly printed.

Processing speeds

Reader sorters are available in a variety of sizes and processing speeds. The smallest can fit on a desk top; the largest may be the size of a mainframe computer. Performance may be categorized as low, medium, or high speed.

The speeds may be defined as follows, based on the speed of handling a 6 inch/152 mm long document:

Low speed: Process 100 to 750 documents per minute. These machines are usually found in small banks or are used for handling small volumes of checks. They use waveform recognition.

NOTE: Proofing devices also process documents at these speeds. Although these devices can operate in reader sorter mode, they may not have automatic document handlers and require manual hand feeding.

Medium speed: Process 1,000 to 1,500 documents per minute. These machines usually use waveform recognition, frequently with dual or hybrid read.

High speed: Process 2,000 or more documents per minute. These machines are typically found in larger banks, clearinghouses, processing centers, etc. They generally use matrix or dual read technology.

Paper handling by reader sorters

Reader sorters are designed to handle batches of check documents of mixed sizes, weights, and conditions (pieces torn away, creased, etc.), at high speed. This may result in reader sorters handling documents somewhat roughly.

Documents may undergo from 10 to 20 separate passes through reader sorters. If the leading edge of a check is damaged slightly in one of these passes, repeated sorting can increase the damage until the document no longer feeds properly. Because of the high cost of handling misfeeds, check processors limit the types of paper that can be used to print MICR documents.

Reader sorters typically use the following mechanisms to handle MICR documents.

Hopper jogger

The hopper jogger is usually least stressful to documents. It vibrates the documents to aid in aligning and separating them.

Separator

A picker belt forces the first document forward, while a restraint system retards the remainder of the documents. The initial shearing force and acceleration applied to the document is generally followed by a deceleration as the document is fed into a multiple-document detection station.

If the forces are too extreme, or the document is too weak, the document could collapse, causing wrinkles. Wrinkles normally appear in the Amount field.

Aligner

Within the aligner, a series of wheels drive the bottom edge of the document toward the back side of the reader sorter so that the MICR line is in a predictable location. The wheels have a series of plastic fingers that make contact with the back side of the document and force it against the aligner drum.

Read/write heads

A wheel with a very short nap bristle brush on its surface presses the document first against the write head, then against the read head. In order to optimize the pressures for handling debossed characters and folded documents, the head may be positioned at a sharp angle. Material can be scraped off the document and spread out by the bristled wheel pressing on the paper.

If the wheel is worn, the spreading or scraping processes could be uneven, resulting in a lump of material being redeposited on a later document.

NOTE: This process is typical only of IBM 3890 matrix reader heads. Other reader sorters may differ in several details.

Item numbering and endorsing stations

After the document is read, belts carry it through item numbering and endorsing stations.

If certain plates or document guides in these stations are misaligned, document abrasion could occur here.

Microfilm or image capture unit

Optionally, the document may enter a microfilm or image scanning unit. In the IBM 3890, the document is held to a plate by a vacuum and driven by a toothed belt that is in the center of the plate. The edges of the plate, the belt-slot, or the teeth may be sharp enough to scrape the document surface.

Sorter pockets

The document finally arrives at a diverter plate, which sends it into the pocket that the reader sorter program selects based on the MICR line data. The pocket has a pair of metal springs that press the document onto the stack that is in the pocket.

If the pocket is empty, the document may impact against the rails at the bottom of the pockets with greater than normal velocity. Short-grain documents are especially vulnerable to leading edge damage from this impact, and layers of paper may separate a small amount on each pass. After multiple passes, this can cause lead edge fluff.

Reject repair

If a MICR document cannot be read or is badly damaged in processing, it goes to a reject repair station. Here, it is read again, using low speed optical and magnetic read stations and operator intervention when these read stations fail to recognize all the characters. A similar process is also used for return processing of rejected items.

After the correct MICR line encoding is determined, a repair strip, encoded with the information that the processing bank requires, is added to the bottom. In effect, a new MICR clear band is added and encoded below the original one.

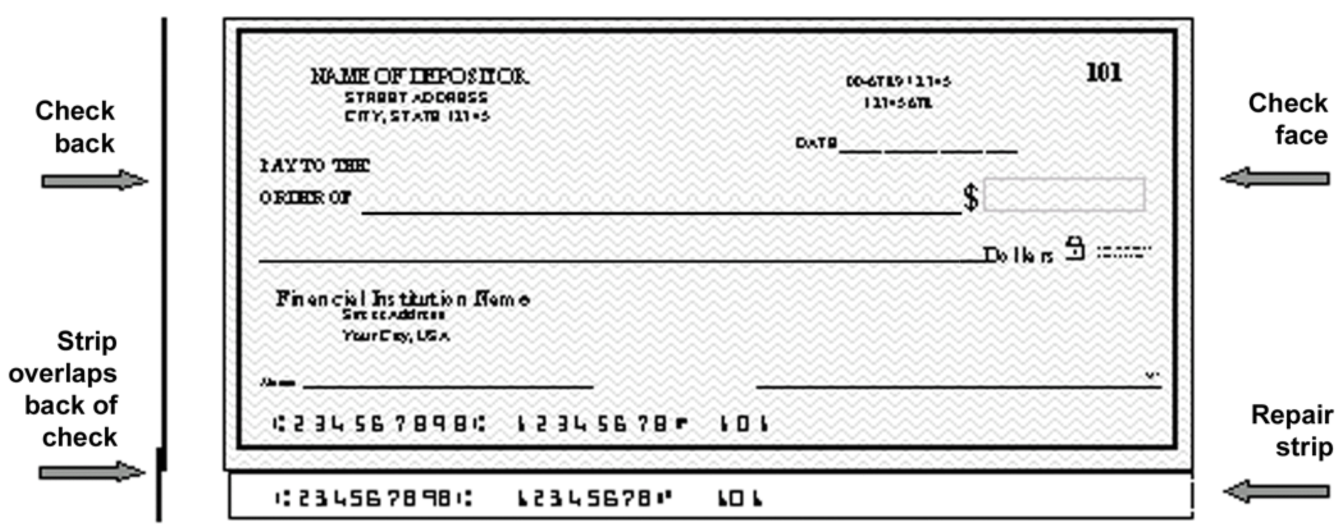


Figure 5-2. Check with reject repair strip

If the document is badly damaged, or if the processing center does not have an automated repair station, a document carrier envelope may be used. This is a check-sized, translucent envelope designed to fully enclose a check while adding a new MICR clear band and encoding area at the bottom.

In most cases, processing banks do not encode the full MICR line on transit items. Instead, they encode only the routing number and amount information that they need in order to pass the document on. This means that when the issuing bank receives the repaired document, it must remove the repair strip and repeat the repair process with all fields encoded.

The reject repair process results in the issuing bank incurring costs for rejects on any bank's equipment, and is a factor in any MICR quality issues that the bank raises due to high reject rates.

6. Quality control

MICR printing requires constant quality control. Special equipment is required to produce quality documents that meet the X9.27, X9.13, X9.7, and ISO 1004 specifications. You should develop a formal quality control program to ensure that all check printing specifications are met.

Key factors for producing good MICR documents include:

- High-grade xerographic print quality
- Good character uniformity when viewed with back lighting
- Few or no defects
- Good fusing
- Good paper quality meeting xerographic and MICR processing needs
- Good forms design
- Consistent printer maintenance

MICR documents should be printed only by operators who have the proper knowledge and experience.

Print quality specifications

Banks use the following print quality specifications for MICR characters:

- Horizontal position
- Vertical position
- Skew
- Character-to-character spacing
- Character size
- Voids or deletions
- Extraneous ink or spots
- Debossment

- Magnetic signal strength

These are the ANSI print specifications for MICR. Other countries that use MICR have similar specifications.

Optical tools used to check MICR

Although MICR documents may appear satisfactory to the unaided eye, the MICR tools are required to determine if a document is within specifications.

MICR Gauge

The MICR Gauge lets you compare the location of Xerox MICR printed information to industry standards. The Gauge is printed on a thin sheet of flexible plastic, which is attached to the bottom of a piece of hard plastic. Slip the document that you are evaluating between the two pieces of plastic.

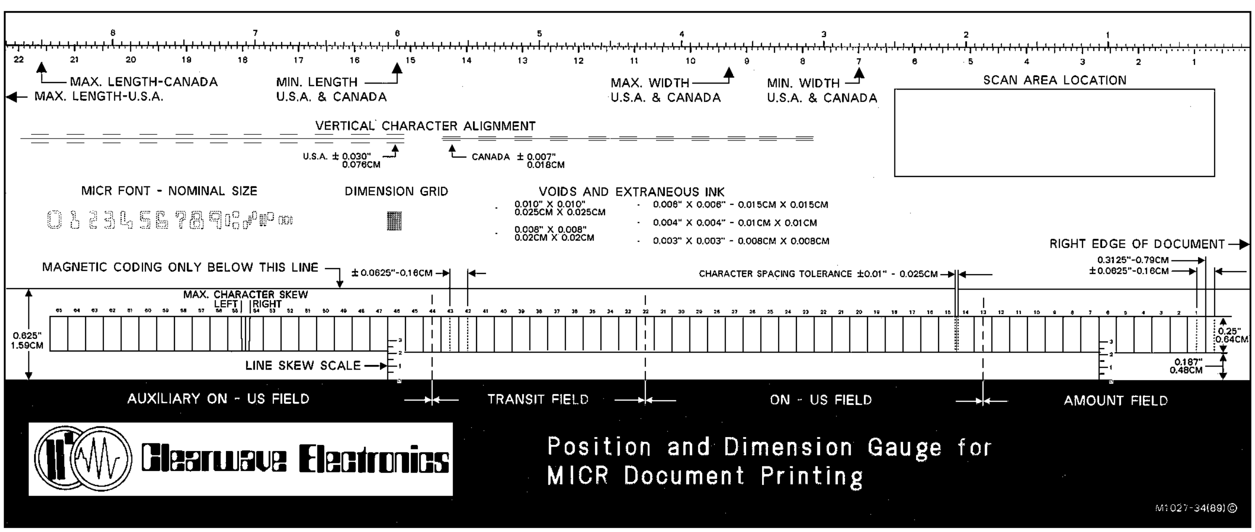


Figure 6-1. Example of a MICR Gauge

Small Optical Comparator

The Small Optical Comparator also compares the MICR printing to industry standards (see the following figure). Its main difference from the MICR Gauge is that the Comparator's nominal 8x to 12x magnification and built-in measuring scales enable you to measure printing characteristics that require greater precision.

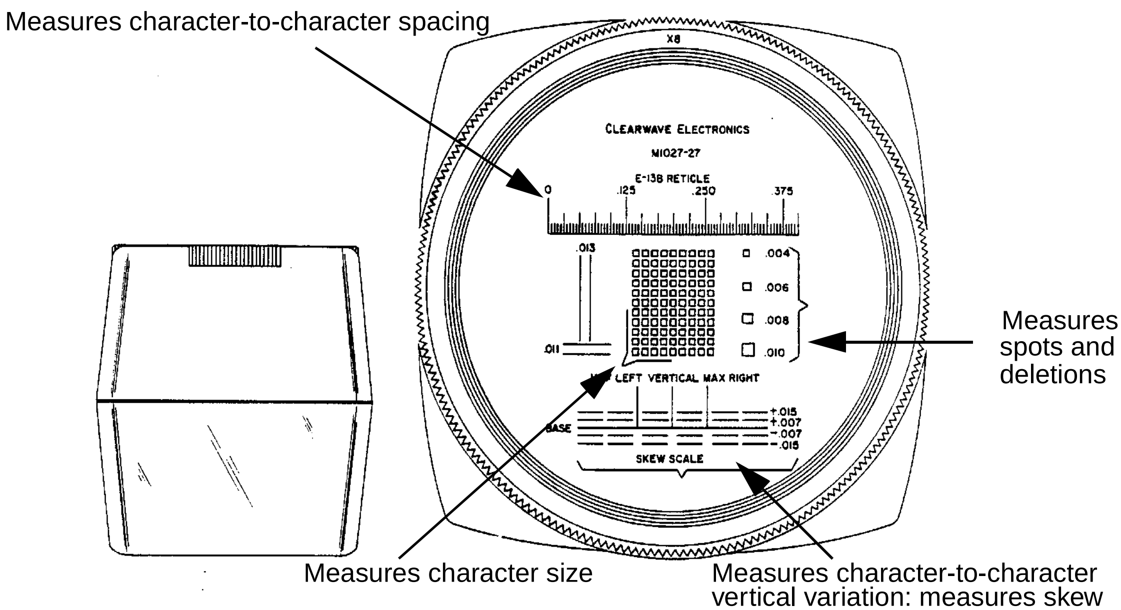


Figure 6-2. Small Optical Comparator

Magnetic testing equipment

Each MICR symbol and character has an ideal waveform and nominal signal strength. Every MICR printing technology modifies the waveform from the ideal in a different way, so that the nominal MICR signal varies somewhat among the characters and symbols. These are characteristics of the printing technology and font design, and cannot be adjusted in Xerox MICR printers. For this reason, the signal strength of the On-Us symbol is used as the Xerox reference for the entire MICR line.

MICR signal strength is the only magnetic specification in ANSI standards. Magnetic testers are needed to identify magnetic versus non-magnetic extraneous ink, and they can be useful in interpreting waveform uniformity issues. All other standards use optical dimensions and require optical or visual inspection.

MICR quality decisions cannot be based solely on magnetic test equipment without regard to ANSI standard conformance requirements. Refer to “Signal strength,” later in this chapter, for information on signal strength test specifications.

NOTE: Due to calibration, design, and manufacturing differences, signal strength readings from MICR testers vary to some degree, even when they are set up correctly and in calibration. These differences are caused partly by the different MICR characteristics of the printing technology that is used and partly by the magnetic read and write head design. If the test equipment is not in correct calibration, there are very large differences.

E13B calibration document

The E13B calibration document is used to determine if the MICR tester is measuring the signal correctly. It provides a printed MICR character (On-Us symbol) calibrated by the manufacturer. The MICR character signal value, read by the master MICR reader, has been written in the space provided (see the following figure). All good calibration documents have the notation “WCC,” reflecting calibration to the most recent ANSI standard. Calibration documents without this notation should not be used until their accuracy can be checked against a known good document.

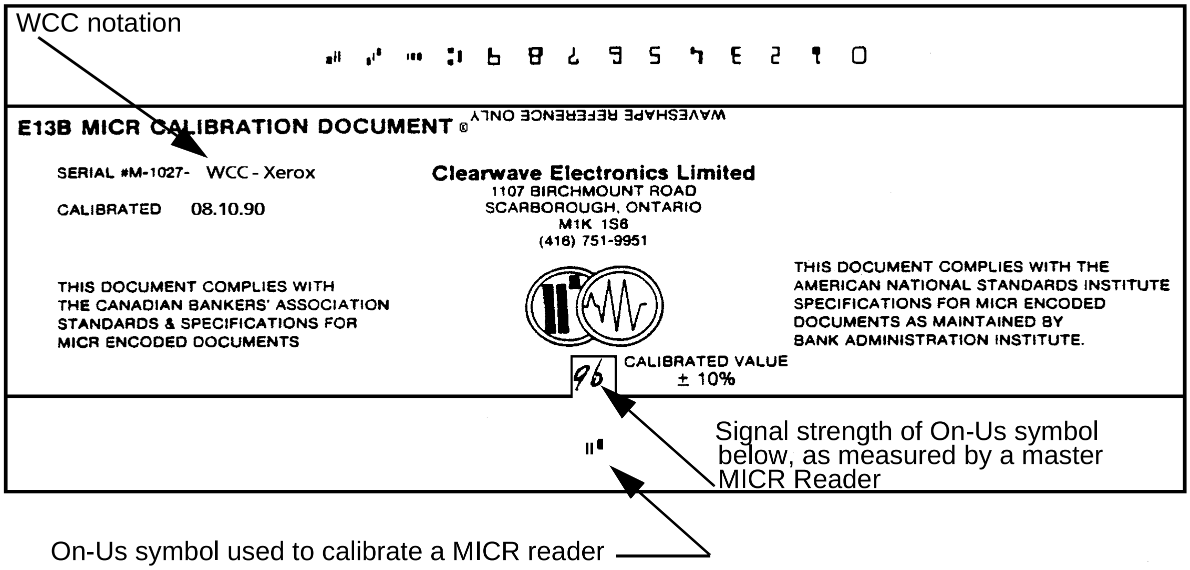


Figure 6-3. Portion of E13B calibration document

The calibration document should be used once during each shift, or just prior to reading the On-Us signal strength from any output document. It may be used for a total of five hours in the MICR reader. When it begins to wear out, the value of the signal strength changes, and the document is no longer useful.

Testing sample documents

You should make every effort to detect problems in a MICR job before the documents enter circulation.

- Regularly monitor the printer output.
- Regularly run test documents that simulate production jobs.
- Thoroughly test all new MICR applications to detect design flaws.
- Take production samples while each MICR job is printing.

While a MICR job is running, operator inspection is required to insure the quality of the output. This inspection should include the following:

- At start of job: Horizontal position, vertical position, voids, spots, MICR line appearance, and MICR line content on at least seven sheets

- Periodically (once for each filled output bin): Horizontal position, vertical position, voids, spots, and MICR line appearance

When a clinical test is running—which many banks require before changing check production—the following additional design factors should be checked to provide a representative test:

- The Xerox printing system should be adjusted to manufacturer specifications and operator maintenance tasks performed regularly per the manufacturer's recommendation.
- Only paper stock that meets ANSI and Xerox requirements should be used.
- A large group of documents should be generated, several thousand at a time.
- Test documents must be fresh and undamaged.
- The test application should mimic the live data, but its appearance should not resemble a negotiable document. The form should represent the correct document size, MICR line, and a unique serial number for each document for identification purposes.
- The test application should be validated for skew, vertical alignment, and character size. (Any change in job resources may alter MICR quality parameters that do not normally vary.)

Specifications for testing

The following specifications apply only to MICR characters that are printed within the clear band. Printing outside the clear band area should follow standard xerographic specifications.

Note that most MICR line positional errors (horizontal, vertical, skew, and character) are due to poor document design rather than problems with the MICR printing system technology.

Horizontal position

To check horizontal positioning, place the check at the bottom of the MICR Gauge with the right edge of the check lined up with the right edge of the gauge. Place the right edge of the first transit symbol on the left between the dotted lines in boxes 42 and 43 of the gauge (see the following figure).

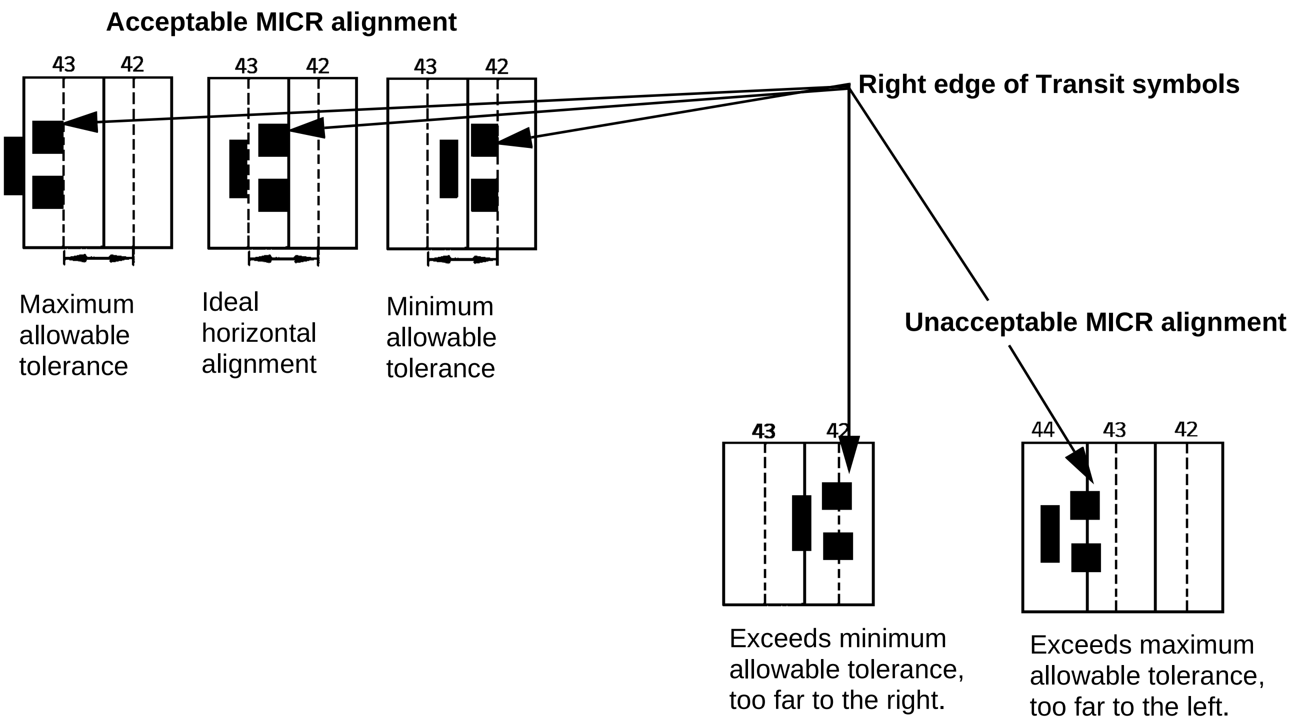


Figure 6-4. Horizontal position check using MICR Gauge

- If the right edge of the transit symbol is not between the dotted lines in boxes 42 and 43, the entire MICR line is out of horizontal adjustment (too far to the left or right).
- If the MICR line is out of horizontal adjustment, but the rest of the form is in the correct position, there is an error in the software program.
- If all printing on the entire document is out of horizontal adjustment, there is probably a registration problem.

Several documents should be checked before action is taken. Compare actual documents with prints of the diagnostic MICR line test pattern to help isolate printer and application software problems.

Vertical position

Check for the following types of vertical variation:

- Vertical variation from character to character
- Proper vertical placement of the entire MICR line on the document, or line vertical variation

The bottom edges of adjacent characters within each field should not vary vertically by more than 0.030 inch/0.75 mm (ANSI), 0.015 inch/0.381 mm (ISO), and 0.007 inch/0.18 mm (CPA). Vertical variation occurs most often in the Amount field, which indicates an impact printer problem.

Use the MICR Gauge to measure character-to-character vertical position (see the following figure). Vertical variation from one character to the next is seldom produced by a Xerox MICR printing system unless the document has design problems.

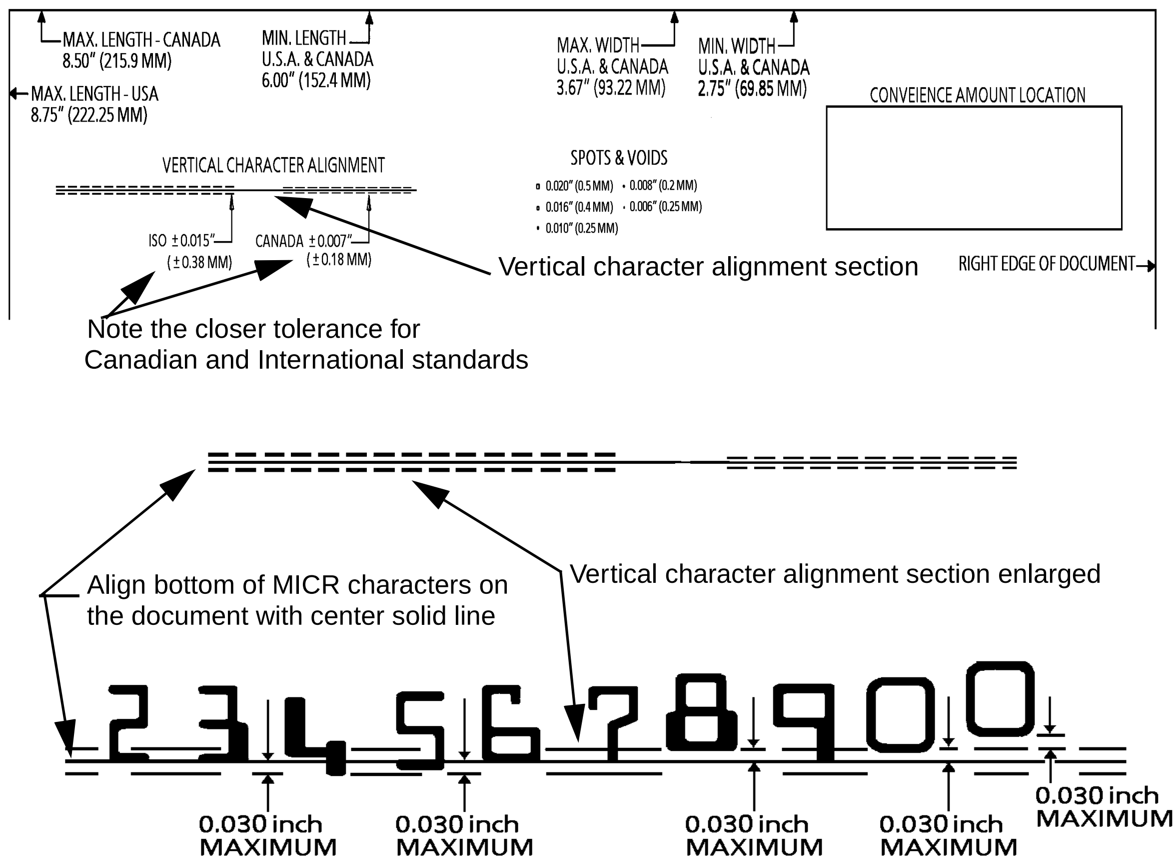
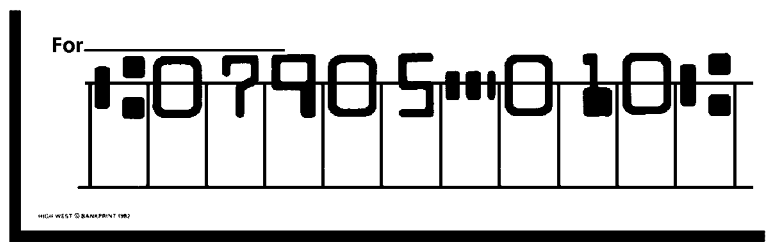
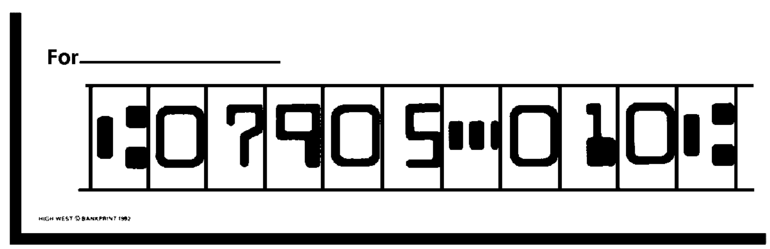


Figure 6-5. Vertical variation check using the MICR gauge

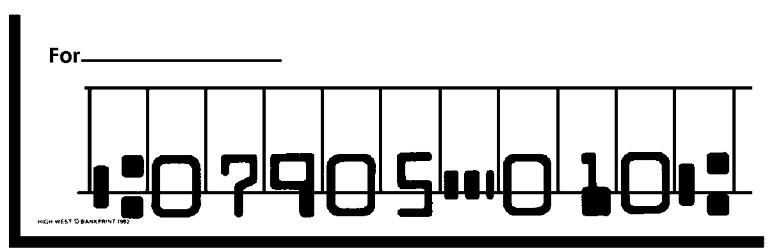
The vertical position for the entire line is evaluated with the MICR Gauge. To check the vertical position, line up the right edge of the check with the right edge of the gauge, and place the bottom edge of the check as far down as possible between the flexible and the hard plastic on the gauge. Notice if the characters are between the top and bottom lines of the character boxes. If the characters appear too high or too low (see the following figure), a software or a registration problem is indicated.



Entire MICR line too high



Entire MICR line properly centered vertically



Entire MICR line too low

Figure 6-6. MICR line vertical position

Skew

Skew is the rotational deviation of a character from the vertical with reference to the bottom edge of the document. The maximum skew or tilt of any character or line cannot be more than 1.5 degrees either way, using the bottom edge of the document as the horizontal reference.

Character skew does not occur with Xerox printing systems. However, line skew may occur if the paper skews when passing through the printer or is poorly cut along the critical edge (see the following figure).

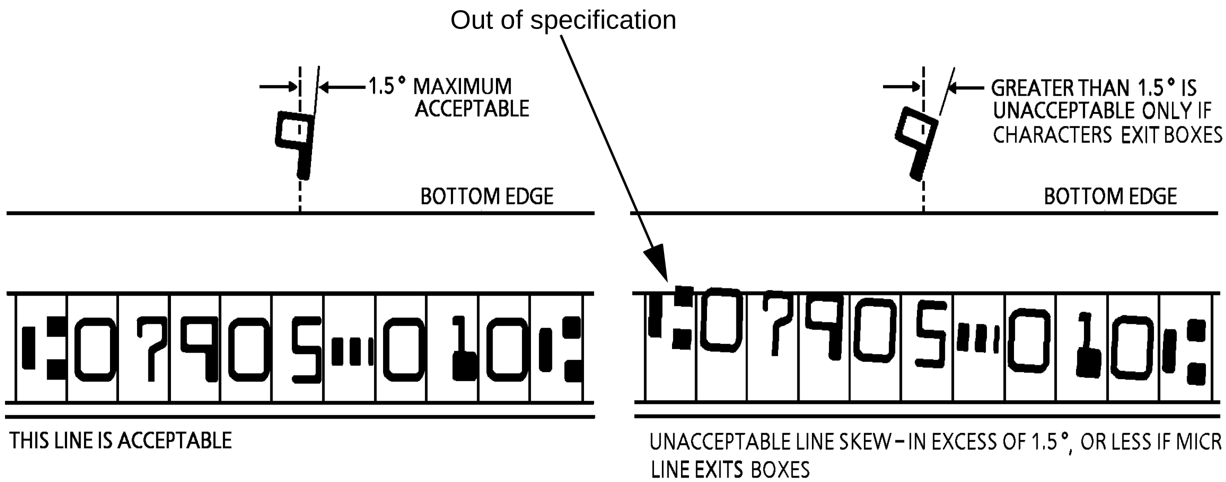


Figure 6-7. Acceptable versus unacceptable line skew (figures are exaggerated)

To check for line skew, follow these steps:

1. Place the document in the MICR Gauge. Place the document so that the tops of all the MICR line characters touch the line forming the top of the MICR line boxes, (shown in the following figure).

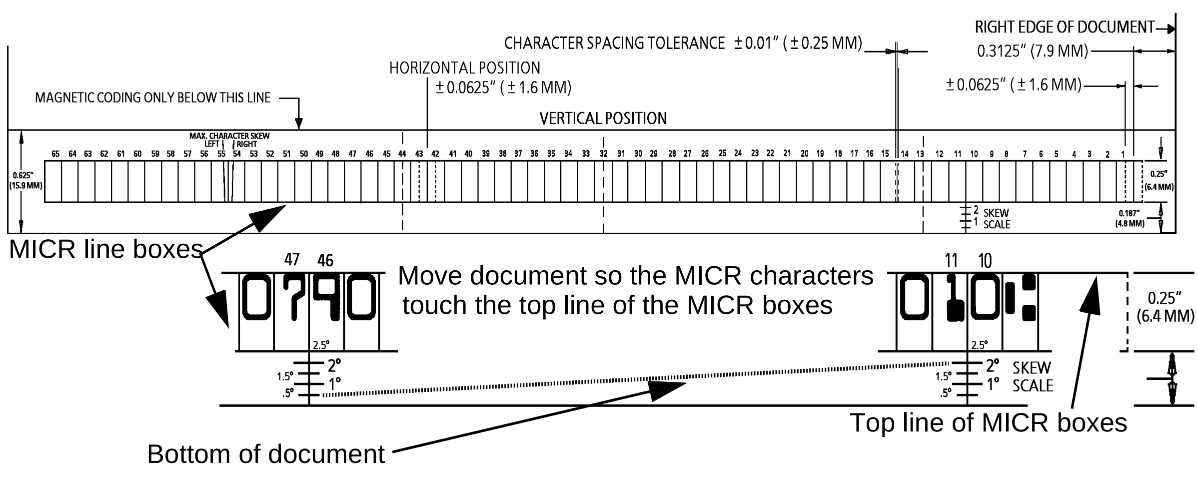


Figure 6-8. Line skew on the MICR Gauge

2. Hold the document firmly so that it does not slip. The bottom of the document should now bisect the vertical skew scales below boxes 10 and 46. The scales are graduated in 0.5 degree divisions from 0 (not marked) to 2.5 degrees (also not marked).
3. Write down, to the nearest degree, where the document bisects the skew scales.
4. Subtract the smaller degree number from the larger. The remainder is the degree of line skew.

Line skew in excess of 1.5 degrees may cause characters to be out of the MICR vertical registration specification.

Character-to-character spacing

Character-to-character spacing is the distance from the right edge of one MICR character to the right edge of the next. This distance is 0.125 inch/3.175 mm with a tolerance of ±0.010 inch/0.25 mm. Each character box on the bottom of the gauge is 0.125 inch/3.175 mm wide, as shown in the following figure.

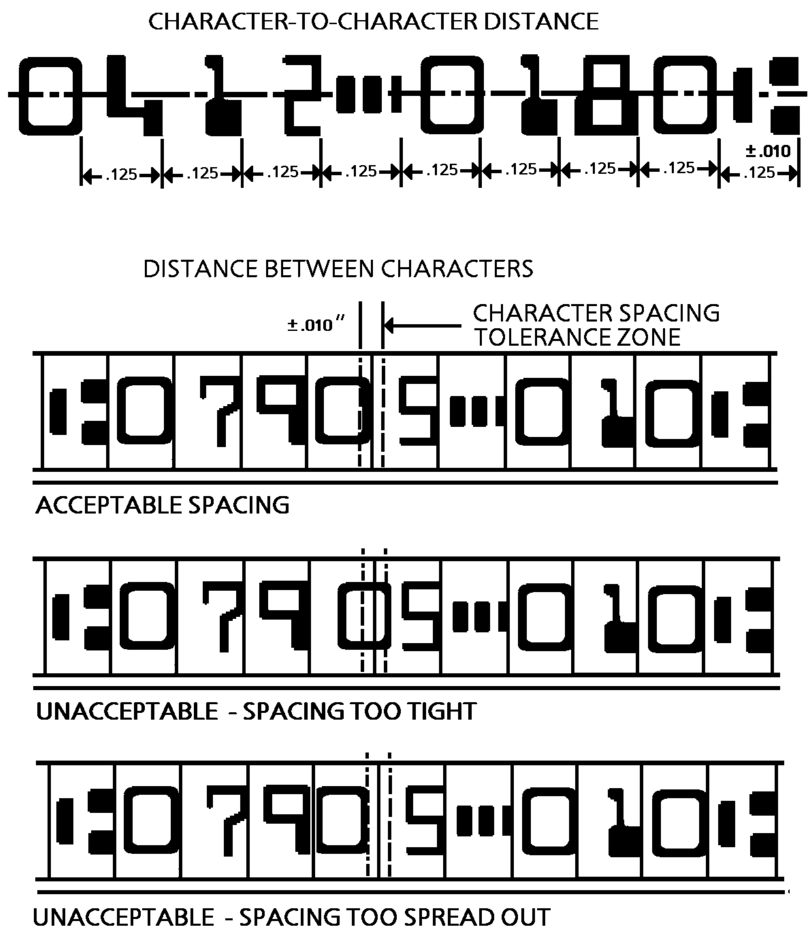


Figure 6-9. Character spacing

If it is possible to move the check so that all characters are within a character box, place the right edges of as many characters as possible at the right edges of their character boxes.

Look at the entire line and notice any characters whose right edges are not touching the right edges of their boxes. These characters are more or less than 0.125 inch/3.175 mm from their next closest character.

To find out how much more or less the spacing is for a character, follow these steps:

1. Bring the suspected character into the character box containing the spacing tolerance zone, as shown in the previous figure.
2. Line up the right edge of an adjacent character with the right edge of an adjacent box.

3. Look at the suspect character to see if its right edge falls between the two dotted lines defining the spacing tolerance zone.

If the right edge of the character falls outside the dotted lines, it is outside the ±0.010 inch/0.25 mm leeway and is out of specification. It is also too close to, or too far away from, the character on its right. Additional tolerances are required between the fields in the MICR line to account for multiple printing steps.

If a spacing problem occurs, verify that the job was written correctly and that the correct MICR font was used. Small spacing variations that accumulate over many characters affect MICR readability as long as the MICR line field boundaries are not violated. They are frequently the result of failure to properly specify character spacing or improper use of the spacing algorithm.

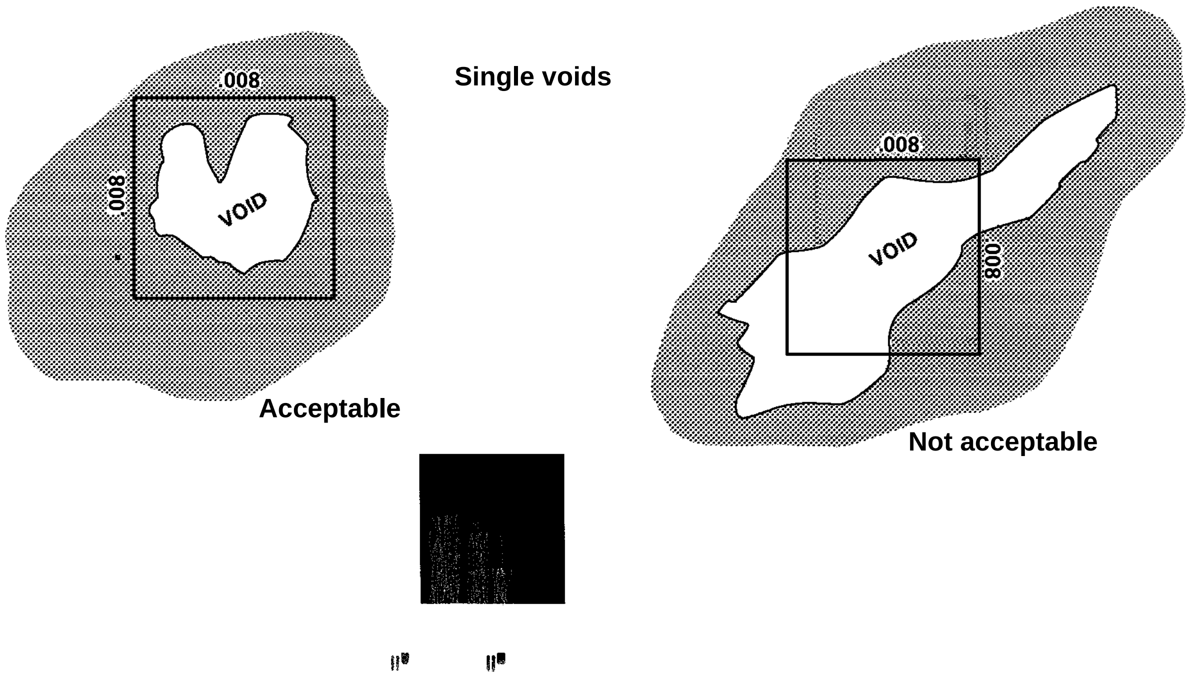
Voids

The absence of ink is called a “void” or “deletion.” Voids can be generated by excessive paper dust, a hardware problem, or excessive paper moisture. This problem occurs more often with cold fusion xerography and ionography technologies than with hot fusion based xerography (like Xerox MICR systems).

Voids must be contained within a 0.008 inch/0.2 mm square. An exception is made for internal voids that extend over two or more zones of characters, a zone consisting of 0.013 by 0.013 inch/ 0.33 by 0.33 mm square. For such a situation, a void must fit within a 0.010 by 0.010 inch/0.254 by 0.254 mm square. The squares on the MICR Gauge can be used to test this.

Single voids that are long, narrow, and predominately horizontal or vertical are called “needle” type voids. They are allowed in any length, anywhere in the character, provided they do not exceed 0.002 inch/0.05 mm in width.

The combined areas of all voids in any vertical column or horizontal row (nominally 0.013 inch/0.33 mm wide) must not exceed 20 per cent.



Trail edge deletion (Note: This depends on the check printing orientation.)

Figure 6-10. Examples of voids

Extraneous ink spots

Extraneous ink spots are unwanted bits of ink that result from unavoidable splatter and smear of the magnetic printing inks. These spots, which may be invisible to the unaided eye, can affect the wave patterns of MICR characters, depending upon their size, quantity, and position.

According to ANSI standards, any number of spots may be present within the clear band, if they are contained in a 0.003 by 0.003 inch/0.08 by 0.08 mm square. Random spots that are contained within a 0.004 by 0.004 inch/0.10 by 0.10 mm square are also permissible, but they are limited to one spot per character space and no more than five in any one field.

There is one exception to this rule. On the back side of the page, any number of spots can be present within the clear band area, if they do not exceed a 0.006 by 0.006 inch/0.15 by 0.15 mm square.

Xerographic ink spots can be larger than the ANSI specifications because of the low ferromagnetic component of the dry ink. Also, the xerographic soft spotting effect minimizes the signal pattern defect.

The following table shows the Xerox MICR printing system xerographic specification for extraneous ink or spots in the clear band.

Any number of black spots	0.25 mm and smaller / 0.01 inch
Total 16 black spots per page	0.25 mm – 0.40 mm* / 0.01 inch – 0.016 inch
One black spot per page	0.40 mm – 0.50 mm / 0.016 inch – 0.02 inch
No black spots	0.50 mm or larger / <0.02 inch
*No more than one spot per 6 by 3 mm / 0.25 by 0.125 inch area is allowed if the spot is greater than 0.01 inch/0.25 mm in size.	

Examples of extraneous ink or spots are illustrated in the following figure.

Figure 6-11. Examples of extraneous ink spots

Signal strength

Signal strength or level is the relative ability of magnetic ink characters to generate a signal in an electromagnetic sensing device. The signal strength is a percent of a nominal value for each character. The ANSI specification is 50% to 200% of the nominal specified peaks signal for each character.

NOTE: Under normal conditions, the signal strength of a Xerox MICR printing system does not require measurement unless some degradation of MICR quality is observed during inspection. Information on MICR signal level measurement is provided here for those customers who have access to magnetic signal strength test equipment.

As a document passes over the read head of the reader sorter, the magnetized particles in the MICR ink cause a flux change within the windings of the read head, changing the output voltage. This voltage passes through an amplifier and is translated into readable signals that can be recognized and input to a computer. Each MICR character has a nominal signal strength and wave shape. If the level is either too high or too low, the reader sorter is not able to properly identify the characters.

The following table identifies the signal level tolerances for all of the MICR characters. These standards are required by ANSI standards; tolerances for other standards might vary.

Table 6-1. **Signal level tolerances**

Character	Peak number	Minimum (50%)	Nominal (100%)	Maximum (200%)
0	1	78	130	260
1	2	51	85	170
2	1	63	105	210
3	1	51	85	170
4	3	63	105	210
5	1	63	105	210
6	5	63	105	210
7	1	45	75	150
8	4	63	105	210
9	1	99	165	330
dash	3 and 5	40	67	134
transit	3	63	105	210
amount	1 and 5	42	70	140
On-Us	3 and 5	60	100	200

Example: A dash symbol has a nominal signal level of 67. If a signal level reading of 65 is taken of this symbol, the result would be 97% ((65 ± 67) x 100 = 97%), which is an acceptable specification range.

Distortions of the waveforms can be caused by a MICR character that is noticeably skewed, by extraneous ink spots, or by a void that exceeds specifications.

The following figure shows a graphic display of the magnetic footprint for each MICR character. The number above a waveform peak is the nominal signal strength value. The waveforms shown here are for ideal characters.

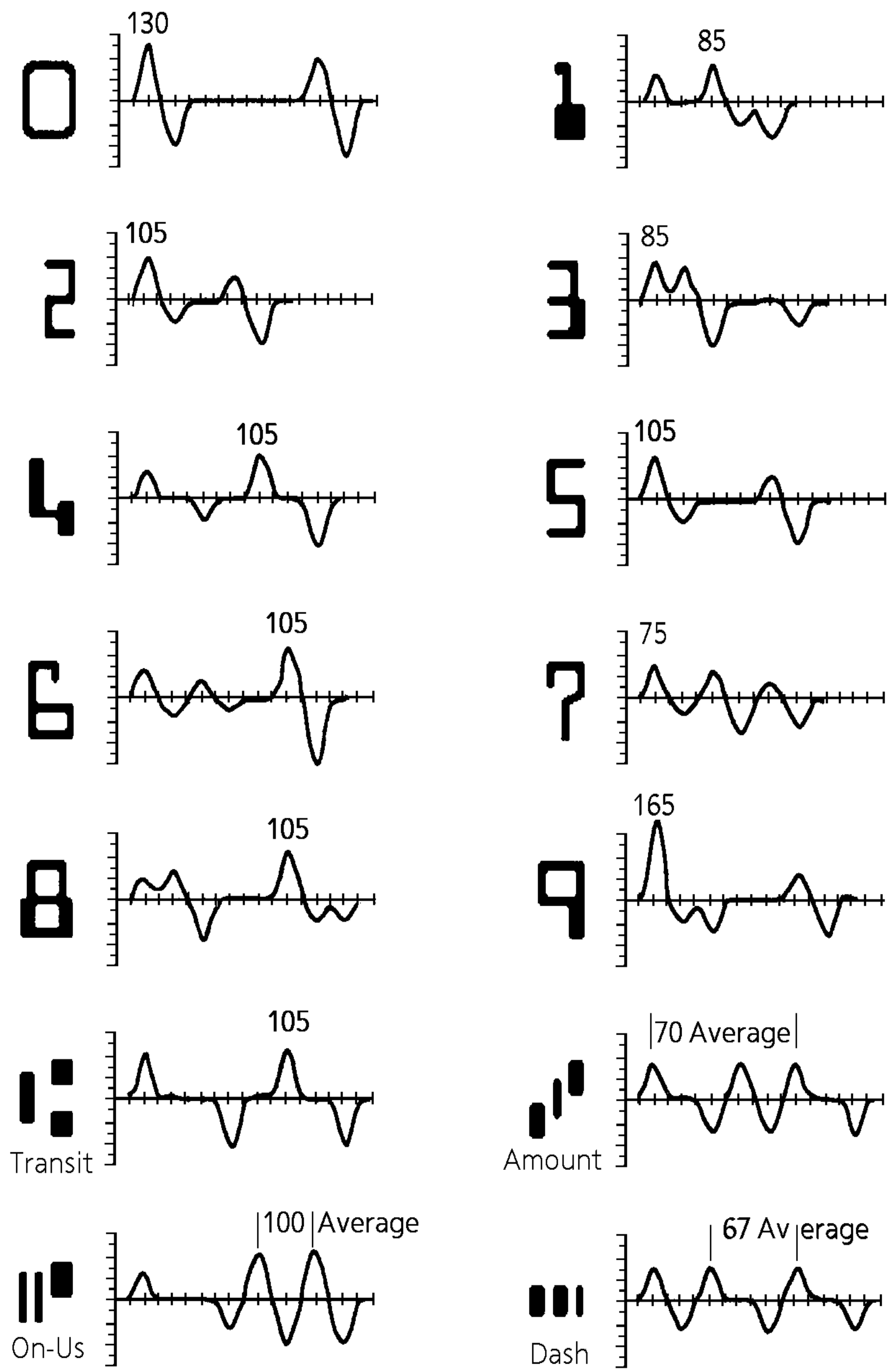


Figure 6-12. E13B characters and waveforms

Debossment and embossment

Debossment is the depression of the paper surface caused by printing pressure. It is commonly associated with letterpress and impact printing technologies, and is not produced by xerographic printing. However, when the bank adds the amount to the Amount field, unacceptable debossment could result at that point.

The maximum depression allowed is 0.010 inch/0.03 mm. The amount of debossment is determined by measuring the distance between the lowest point of each encoded character and the maximum reading obtained from the surrounding paper within that character space on the same horizontal plane.

Embossment refers to an image extending above the surface of the paper. This can occur in xerographic printing as well as in letterpress and impact printing.

The maximum allowable embossment is 0.0006 inches/0.02 mm. The amount of embossment is determined by measuring the distance between the highest point of each encoded character and the minimum reading obtained from the surrounding paper within that character space on the same horizontal plane.

Summary of ANSI standards

Parameter	Specifications	Testing tool
Format	• Right edge of first or right symbol must be 0.0625 inch/15.87 mm ±0.0625 inch/7.937 mm from the edge of the paper. • All E13B characters must be within 0.25 inch/6.35 mm horizontal printing band. • 0.625 inch/15.87 mm clear band must be free of magnetic ink other than E13B font.	MICR Gauge
Character spacing	• Distance between right average edge of adjacent characters must be 0.125 inch/3.175 mm ±.010 inch/0.254 mm. • In other, or adjoining fields, minimum space between right average edge of adjacent characters must be no less than 0.115 inch/2.92 mm.	MICR Gauge and Comparator
Vertical alignment	Bottom edge of adjacent characters must not vary vertically more than 0.030 inch/0.381 mm.	MICR Gauge
Character or line skew	Must be no more than ±1.5 degrees with respect to the bottom reference edge.	MIRC Gauge and Comparator
Character dimension	• Average edge tolerance must be ±0.005 inch/0.0381 mm from nominal dimension. • Minimum width of horizontal bars must be no less than 0.011 inch/0.330 mm.	Comparator
Character edge irregularities	• Irregularities about the average edge may extend ±0.0035 inch/0.089 mm from nominal edge dimension. • Sum of edge present in 0.0015 to 0.0035 inch/0.038 to 0.089 mm zone shall not exceed 25% of total edge.	Comparator
Voids	• Voids are acceptable if contained in 0.008 by 0.008 inch/0.2 by 0.2 mm square. • Voids are acceptable in double zones if contained in 0.010 by 0.010 inch/0.254 by 0.254 mm square. • Total area of all voids must be less than 20% of the area of the line. • Voids 0.002 inch/0.051 mm by any length, vertical and horizontal, are acceptable.	Comparator
Extraneous ink (Front)	Spots contained in 0.003 by 0.003 inch/0.08 by 0.08 mm area are acceptable in any amount.	Signal level tester
	Spots contained in 0.004 by 0.004 inch/0.10 by 0.10 mm area are limited to one character space totaling no more than five per field.	Comparator
Extraneous ink (Back)	Spots contained in 0.006 by 0.006 inch/0.15 by 0.15 mm square, or equivalent area, are acceptable.	Signal level tester and Comparator
Debossment/ embossment	• Measure is limited to 0.001 inch/0.03 mm depth measured from face of document. • Measure is limited to 0.0006 inch height, measured from the face of the document.	Microscope with an oblique light or electronic probe with a tip of 0.004 inch/0.10 mm radius
Signal strength	Relative signal strength of any character may vary -50% to +200% of nominal signal level.	Signal level tester

Additional performance considerations

The following printing problems also can prevent the reader sorters from identifying a MICR character.

Dry ink slivers

Dry ink slivers are caused by a sharp point or edge gouging the characters. This gouging could occur at a number of different places within a reader sorter.

Damaged or ragged characters

Damaged or ragged characters may prevent the reader sorter from identifying a MICR character. If the damage is random and infrequent, it may be due to a paper grain defect. Consistently ragged characters may be caused by a failed dry ink cartridge, or the need for machine service.

Character damage may also occur if the paper is sharply creased or folded before printing or during reader sorter processing.

Crayoning

Crayoning results when material collects on a write or read head and is redeposited on a following document. Frequent occurrence may indicate a defective reader sorter pressure brush. Other possible causes include out-of-adjustment print density, fusing, or a poor choice of paper.

Operational maintenance

The performance of any mechanical device, whether a high-speed reader sorter or a Xerox printing system, depends on how well it is set up and maintained. Refer to the reference manual for your product to find out how to avoid possible problems.

Quality measurements: magnetic versus optical

If a MICR quality issue arises, it should be visible on the printed document. Even signal strength problems can be seen if prints are compared. Low signal characters are thin and poorly formed; high signal characters are fat and usually surrounded by xerographic background.

Occasionally, problems are reported by test equipment, but no problem is visible. This is usually due to improper use of intelligent magnetic test equipment, which evaluates optical specifications using magnetic waveforms. Equipment vendors are aware of the limitations of their products, and therefore recommend visual inspection of suspected characters. Some users, however, misinterpret these findings as specifications failures. It is important to understand the differences between optical and magnetic measurements and why all ANSI standards for MICR character dimensions can be evaluated optically only.

Magnetic testing equipment usage

MICR signal strength is measured magnetically, along with uniformity and spots, and is specified numerically as 50 to 200 per cent of nominal. Waveform uniformity is not specified numerically, but as an indicator for visual inspection. Spots are categorized as magnetic or non-magnetic, because different size allowances apply.

No other specifications are measured magnetically. Any MICR failures other than signal strength must be confirmed optically. The following parameters are commonly flagged, but are not specified magnetically:

- Character dimensions (±0.003 inch/0.076 mm tolerance)
  - MICR font dimensions are defined from an “average edge” in the straight portion of a stroke. Waveform-based measurements include the corners, which make magnetic dimensions narrower than average edge separations. Mathematical waveform models of perfect characters show that this can be as large as 0.0013 inch/0.033 mm, which is nearly half the tolerance.
  - Magnetic edge gradients vary with printing technology. When combined with different MICR tester designs, this variation was shown in a 1993 study to be nearly as large as the dimensions of the character strokes.

- Waveforms measure only vertical stroke locations, while optical standards apply also to horizontal strokes. Some recognition technologies do not use waveforms, relying on locations of both horizontal and vertical strokes in a two-dimensional matrix.
- MICR test equipment precision is limited by digitizer resolution. The minimum encoding interval limits the precision of a single measurement. In Xerox's RDM MICR Qualifier GTs, this interval is 0.00104 inch/0.026 mm—one-third of the tolerance.
- Digital MICR font designs are optimized for recognition performance in the full range of equipment used in check processing. As a result, some characters—typically the 4 and the 6—are frequently flagged for character width. Fonts could be changed to eliminate these flags, but bank rejection rates would be higher if the font were optimized to meet magnetic dimensional limits imposed by MICR tester manufacturers.

NOTE: Excessive or persistent dimensional flags may indicate a real problem, which must be verified by optical inspection.

• Character-to-character spacing (±0.010 inch/0.254 mm tolerance)

- Character spacing controlled by the font varies cyclically by a small amount: ±0.00167 inch/0.042 mm (1/600) every other character at 300 DPI.
- In LCDS data streams, a spacing algorithm is required to prevent accumulation of errors.
- Any variation beyond this, or any adjacent characters shifting in the same direction, indicate a problem.

The best way to check for character spacing issues is to inspect the entire MICR line in the Position and Dimension Gauge, to see if characters remain a consistent distance from their cell boundaries. If one character is aligned to its cell boundary, all characters should be very close to theirs. Any cumulative change in character spacing that reaches the ±0.010 inch/0.124 mm tolerance level should be investigated as a potential application or machine problem, even though it is not an ANSI specification failure.

Using the MICR Position and Dimension Gauge to check registration is a basic task that the operator performs at the printer whenever checks are being printed.

- Character placement (0.125 inch/3.175 mm interval)
  - MICR line registration is controlled by the right edge of a single Transit character that is nominally 5.625 inches/ 142.89 mm from the reference edge.
  - Transport speed calibration accuracy, speed variations, and document slippage over this distance contribute to errors in MICR tester measurements of horizontal MICR line placement.
  - MICR testers can not measure vertical MICR line placement.

  NOTE: These errors and limitations never occur with a MICR Position and Dimension Gauge.

Optical testing equipment usage

The majority of automated optical MICR test equipment is aimed at document design, for which stringent limitations on density and contrast require sophisticated analysis. With different analysis software, this optical test equipment can be used to evaluate E13B font characters optically. However, there are some issues to consider before accepting it as a replacement for a MICR reticle on an eye loupe.

- The optical test equipment does registration, character spacing, and character alignment well, because these tolerances—0.0625 inch/1.588 mm, 0.010 inch/0.254 mm, and 0.020 inch/0.508 mm respectively—are within the resolution limits of all scanners. However, MICR dimensional tolerances are ±0.0015, so the measuring device would require twice this resolution to sense the tolerance. This requires a 0.0008 inch/0.02 mm spot size and a 1200 dpi sampling rate. It may be argued that the tolerance is 0.003 inch/0.076 mm—the sampling rate of a 300 dpi scanner; but that is a cumulative tolerance for the two sides of a stroke. A 300 dpi scanner can evaluate only 0.0066 inch/0.168 mm tolerances well.
- All dimensions are referenced to the “average edge,” defined as the line that bisects any edge noise so that half the black area is on each side. The eye does this well, but automated scanners do not have the processing advantages of an eye. They need to resolve the edge noise due to the Yule-Neilsen effect, which causes an unresolved object to appear darker than the amount of ink coverage would predict.

- When the results are displayed, the use of a template with highlighted “bad areas” does not indicate if there is a specification failure due to edge void and edge irregularity allowances. The dimensions of the template may be limited by screen resolution. An accurate report tells you which parameter is suspect and how likely it is to be out of spec. The operator must then make the final judgment.

Recommendation

Automated test equipment is a valuable tool for highlighting areas that require close inspection. This inspection must be performed by a trained inspector who understands the limitations of both MICR specifications and test equipment. A judgment call is required to identify real problems from automated flags, call for a second sample to verify the consistent nature of the problem, or simply recognize a printing technology characteristic that warrants little further attention.

A trained inspector using a MICR gauge and Small Optical Comparator can make all MICR quality judgments when MICR signal strength is not available.

7. Problem solving

MICR problem investigations take different forms, depending on the nature of the problem, the availability of actual problem documents, and the willingness of the parties involved. Timely problem identification and resolution is especially important for products covered by the MICR Quality Guarantee.

When problem solving is required

New accounts

If the customer is opening a new account or validating a new check issuance system, banks frequently request sample checks for quality inspection and to verify MICR performance in a test environment, before negotiable checks are circulated. Reject rate investigations are less complicated at this stage because the rejected documents are not negotiable and the parties are already involved in document testing. When rejected characters can be identified and studied, the reason for their rejection is frequently obvious.

Existing applications

When an existing check application has an elevated reject rate, the analysis is more difficult for the following reasons:

- Issued checks are negotiable and contain real customer data; banks and customers may be unwilling to part with them.
- Banks typically track rejection rates by account, resulting in a one to two month lag between printing and reports of problems.
- Banks that receive checks with correction strips are reporting rejections from another bank, earlier in the check processing system. Therefore, rejected characters cannot be identified.

- The customer may issue checks from a single account that uses multiple printers. These printers may not all be Xerox printers and they may be located in different cities.
- The account holder may possess a blank check book order for years before using all the checks.

Possible misinterpretations

In some cases, no reject rate problem exists, but the bank or customer feels that there is a MICR quality problem. If a problem exists, it can be identified using the diagnostic procedures described in the product service documentation and the quality tools discussed earlier in this guide. However, the customer may have misinterpreted a quality control evaluation or used aggressive requirements beyond ANSI standards.

Problem solving process

MICR problems are usually identified through one of the following:

- Problem notification from the bank or other financial institution
- Returned documents with correction strips
- Errors discovered by internal quality control, within the internal operation

For internal errors, operators should follow the visual inspection procedures described in the “Quality control” chapter.

For problems that result in returned documents or calls from financial institutions, a detailed and structured analysis should be performed. This analysis involves:

- Gathering information from the bank
- Collecting the rejected documents
- Verifying authenticity of rejected documents
- Correlating rejected characters to factors that may have caused the rejection
- Verifying effectiveness of corrective measures

A structured approach is required to discern which of the many sources is actually responsible for a high reject rate. The following flow chart illustrates the steps.

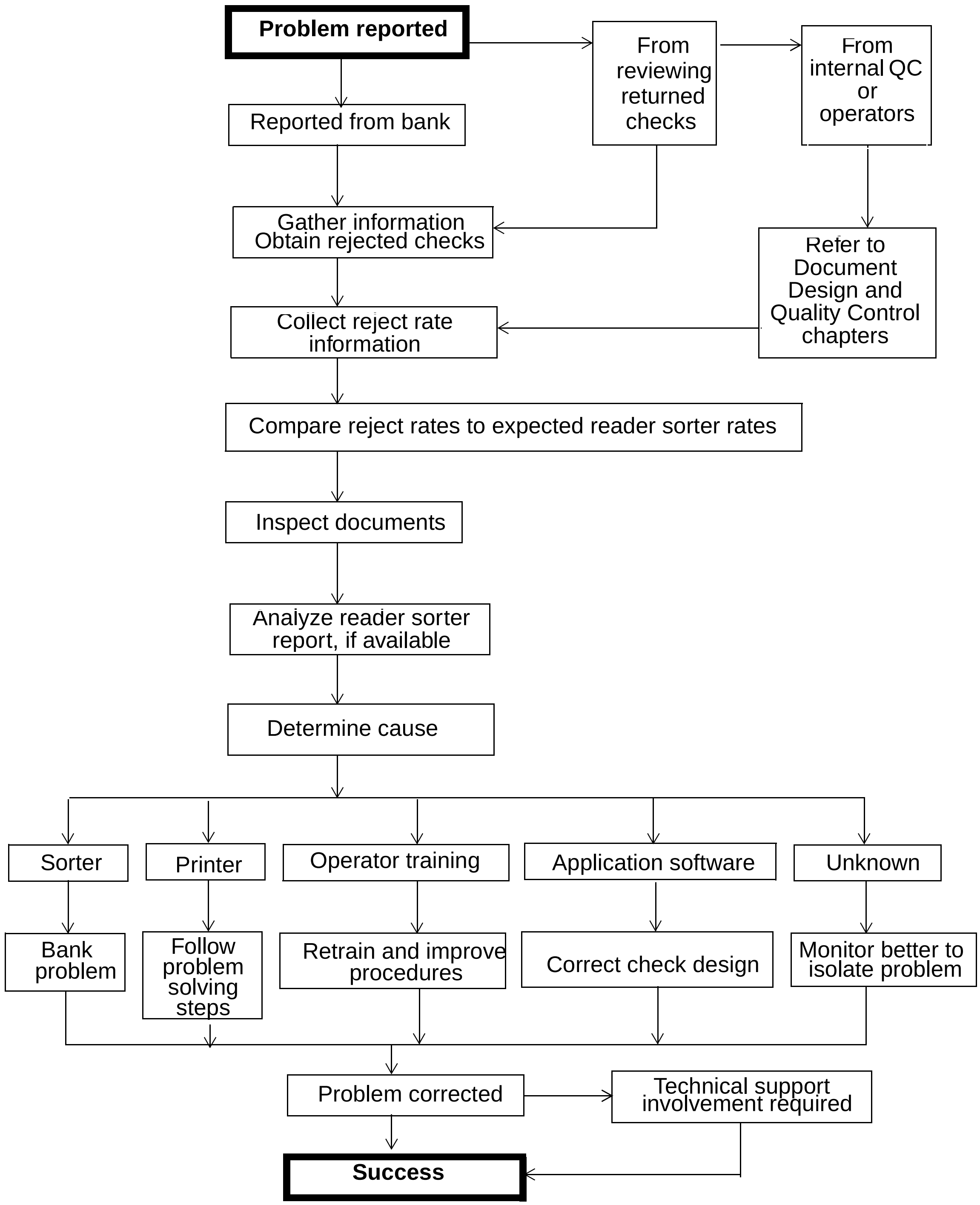


Figure 7-1. Problem solving flowchart

Determining the problem source

You must identify the source of the problem before you can implement corrective actions. For document quality problems, you can best identify the cause by examining the rejected document and determining the most likely reason for rejection. However, rejected documents may not be available, or they may not show any printer or application-related issues.

Reader sorter

If the problem resides with one of the processing banks, verification requires the cooperation of the bank. Testing the document in another reader sorter, preferably of the same make and model, shows if a particular piece of equipment is at fault. For amount encoding errors, different encoder ribbon batches and part numbers can help to isolate the problem. You should also investigate the effect of base paper stock and the preprinting of forms.

Printer

If the printer is the cause of the rejection, you can verify this by examining the rejected documents or MICR quality control samples. Use the service documentation as your diagnostic tool to conduct a thorough quality inspection using the methods and tools described earlier. If a problem has been traced to the printer, but no corrective measures can be identified, escalate the problem to the next level.

Operator training

The operator often has the first opportunity to detect poor MICR quality. Operators should be familiar with all aspects of printer operation, paper loading, application features, job requirements, and MICR quality control procedures. The operator should identify and rectify problems such as image registration, gross defects, and poor print quality before running a MICR job. If a problem cannot be corrected, place a service call rather than issuing MICR documents that are of questionable quality.

Application software

Any application change should be reason for a thorough inspection. Although new applications must be thoroughly tested before MICR documents are issued, subtle application changes can have an impact on MICR document performance. Some problems, such as a new authorized signature that extends into the MICR clear band, are easy to detect. Others, such as a MICR font change, may require sophisticated tools to identify. If the change coincides with a reject rate problem, you should revert to the prior version for testing.

Unknown cause

When the cause of a rejection rate problem cannot be determined, or the initial corrective actions prove ineffective, a dual approach is indicated. Additional attention to printing and processing details may uncover the cause. In addition, institute an active reader sorter testing program to replicate the problem under controlled conditions. You should also closely examine the four areas of investigation discussed earlier in this chapter.

Reader sorter testing

Reader sorter qualification testing must occur under a controlled set of circumstances for accurate results. The results from a single reader sorter test can vary significantly, depending on:

- Printing conditions
- Reader sorter model
- Adjustment of the reader sorter
- Statistical design of the test

A valid qualification test should meet these conditions:

- The reader sorter is adjusted to manufacturer specifications and is cleaned regularly by the operator according to the manufacturer's recommendation.
- Process a large group of documents, several thousand at a time.
- Acquire reject performance data for the particular reader sorter that is used for the test.
- Fan documents before placing them in the reader sorter for each pass.

- Process documents through the reader sorters a minimum of 20 passes.
- Use more than one reader sorter of the same model, if available.
- Retain a control batch of the test deck from processing in case there is a need for later runs.
- Remove jammed and rejected documents from further processing.

Interpreting test results

Reader sorters typically provide the following information:

- Reader sorter ID
- Date of print run
- Total volume read
- Number or percentage of rejects
- Complete item listing of characters read
- Reject summary with ID codes

The reader sorter reject rate is the critical indicator of quality for the batch of documents that are printing. In order to know whether test results are good or bad:

- Know the average performance. Keep adequate records for individual machines performance, including maintenance records and run information.
- Interpret the reject rate properly. Documents are rejected not only for visual or magnetic defects, but also for other considerations that are not related to document quality (such as jams or misfeeds).
- Make sure that the rejects are correctly analyzed. Rejects that are not caused by print quality must be removed prior to any calculations.
- Consider the operating characteristics of the reader sorter. More rejects occur under the following conditions:
  - Using single slot readers
  - Near the beginning of a run
  - On short runs
  - On uncirculated documents

Questions to consider

When analyzing the results from a batch of documents that were tested in a reader sorter, you must ensure that the returned documents correspond to the reported rejects. You should ask the following questions:

- What is the reject rate?

  This varies depending on the reader sorter that was used. It is based on documents and defined for each pass through the reader sorter. It is not based on field or character rejects.

- How was the rate calculated?

  Improperly oriented items such as blank sheets, pages inserted upside down or backwards, paper handling rejects, and Amount field rejects should not be used in the calculation.

- Are jams counted as rejects?

  Many systems log several items as rejects each time a jam occurs. This is often misunderstood by those who use the reader sorters. Identify and remove jams from the calculation.

- Are multifeeds counted as rejects?

  Documents may stick together, causing multifeeds. This is common with paper that was cut by a guillotine cutter, or with perforated paper that is torn in groups. Multifeeds often produce sequential clusters of failures, which are usually read when the set is resubmitted. You must determine if any rejects are due to multifeeds and remove them from the calculation.

- Are numerical calculations correct?

  Make sure that the conversion to a percentage was made correctly. Improper truncation and slipped decimal points are common errors.

- Were rejects resubmitted?

  In general, rejects should not be resubmitted as part of the basic run. Reentering rejects distorts the actual reject rate. It may be useful to show that most rejects are read successfully on the next pass.

- Was the batch large enough?

A statistically significant test to detect a 0.5 per cent rejection rate can be achieved with 2,000 to 3,000 documents. (The test case should not be less than 200 documents.) If the test set is too small, it may be biased by the fact that reader sorter performance is poorer when the machine is starting up than when it has been operating steadily for some time.

- Are there characters that appear more often as the reason for rejection?

  Although a reject rate based on character failure is not generally significant, a specific character may be causing the problem. Check to see if a certain character is driving the reject rate, and if failure occurs when the character is in a particular position in the document.

- Are the rejects clustered by field?

  If multiple rejects occur in a particular field, a mechanical problem may exist in the printer or the reader sorter.

- Is there a pattern to where the rejects occur?

  Rejects can appear in the document consecutively, in groups, or randomly. Look for a pattern; for example, the same character, the same field, or appearance after every certain number of sheets.

- How do the rejects compare with accepted documents?

  Check to see if the rejects have been improperly cut, or if any other difference is obvious.

- Are all documents accounted for?

  At the end of a run, the number of accepts plus the number of rejects should equal the total number of documents submitted.

- What is the sorter type and location?

  If there are problems, it may be useful to know what type of sorter was used. If possible, obtain the following information for reference and machine identification purposes: sorter type, model number, user ID, and serial number.

- Is there a hardcopy report from the reader sorter?

  In many cases, a hardcopy report is not available from the reader sorter. Obtaining a printout from a test run is possible, but many runs present little data other than the problem documents. A report listing all items, or an exception report listing only the rejects, are critical tools in determining the reason for the reject problem.

- Are the reader sorter performance expectations realistic?

  Xerox MICR documents meet ANSI specifications for reader sorter performance. However, actual reject rates vary greatly, depending on paper types, the reader sorters used, printer maintenance, and reader sorter hardware conditions.

- What is the reject rate significance?

  The expected reject rate for reader sorters is between 0.5 and 3 per cent. You should investigate for causes if this rate suddenly increases.

Expected reject rates

There is no ANSI reject rate specification. However, the expectation for high-speed reader sorters is a reject rate below 0.5 per cent for unprocessed documents in good condition.

Xerox MICR documents are expected to be rejected less than 0.5 per cent on the first pass in high speed reader sorter tests. (This standard varies according to the country.) However, since financial documents are processed by reader sorters that are not directly under your (or Xerox's) control, output quality may vary. Reject rates vary with:

- Printing conditions
- Reader sorter model
- Adjustment or maintenance of the reader sorter
- Check batch size

Reducing reject rates

To keep the reject rate as low as possible, do the following:

- Adjust the Xerox MICR printer to specification.
- Use the current release of the E13B or CMC7 MICR font.

- Load Xerox 4024 Dual Purpose, 24-pound paper (or a high quality equivalent).
- Verify that the bank regularly adjusts and cleans the reader sorter to the specifications set by the manufacturer.
- Make sure that the reject rate is based on a statistically valid number of documents and reader sorters. The 0.5 per cent is the average of a large number of documents. A reject rate for a small batch (for example, 500) may vary greatly. Use the following guidelines:
  - Use a batch of 3000 to 10,000 documents.
  - Sort continuously, not in bunches.
  - Use several sorters of the same model, not a single unit.

    NOTE: The 0.5 percent expectation applies to the first pass through a typical high speed reader sorter working with fresh and unsorted documents.

- Use normal document sizes.
- Ensure that the paper grain of the finished documents is compatible with the reader sorter mechanical requirements (normally long grain).
- Avoid jams by making sure that the reader sorter is in good working order and operates in optimal environmental conditions.

The following table identifies typical problems that are associated with different reject rates. Note that the source of the problem can include the reader sorter itself.

Table 7-1. **Problems indicated by different reject rates**

If the reject rate is:	**Look for:**
Marginally high (1.0 to 3.0 per cent)	• Type of sorter and normal sorter variation • Sorter testing methods (for example, long or short runs) • Miscalculation of reject rate • Printout not properly interpreted • Printer quality control procedures not followed (for example, paper and dry ink cartridge loading, maintenance, etc.) • Out of specification for spots • Image quality out of specification • Paper stock impacts • Amount field encoding by bank • Low signal strength • Low density characters • Document handling problems (for example, uncirculated documents can cause misfeeds). Fresh, smooth, perfectly stacked documents such as newly produced and cut test documents are much more difficult to separate than slightly rumpled, jumbled, or used documents.
High (3.0 to 9.0) per cent	• Intrusion into clear band (front or back) • Sorter document handling problems • Sorter read and write problems • Document cutting problems • Forms creation problems • Extreme vertical misregistration of MICR line
Catastrophic (10.0 to 100 per cent)	• Wrong font • Spacing algorithm improperly used • Sorter software incompatibility: – Wrong header cards – No amount field – Incorrect MICR line codes • Gross finishing errors • Sorter malfunctions

Inspecting documents

Always check for obvious problems first.

- Make sure that you are looking at the right documents.
- Check for the following:
  – Correct font
  – MICR clear band intrusion
  – Correct vertical or horizontal position of font
  – Correct format (for example, was the Amount field printed twice—by you and the bank?)
  – Document damage (folds, tears, edge damage)
  – Smears on the MICR line, or crayoning

Correct font placement or format

Always use a MICR font. Ask yourself the following questions:

- Was a non-qualified font purchased and installed from a source other than Xerox?
- Is the font in the correct position?
- How was the positioning determined?
- Has the positioning been modified by a font editor?
- Was the information about the MICR line content and structure obtained directly from the bank, or was an old document used as a model? Either the hardcopy directions may be wrong, or the old model document may be obsolete.

MICR character defects

Check the MICR characters for the following:

- Voids
- Spots
- Density loss
- Trail edge deletion
- Dry ink depletion
- Wear

Document damage

Even subtle damage can ruin a document. Characters may be cut by sharp edges within the reader sorter. If there are wrinkles in the document, the reader sorter may be causing its own errors. Leading edge damage in the reader sorter is a common problem with short-grain documents.

Check to find out if the paper stock was damaged in some way before it went through the laser printer. Damage can include spots, weak areas in the paper, and creases. If possible, obtain quantity samples of the stock to assess its quality before a print run.

Excessive ink smears

Abrasion should be negligible in a well adjusted reader sorter. However, at speeds of up to 400 inches per second, treatment may be rough enough to abrade paper. If there are many smears, investigate the following causes:

- Stock incompatibility
- Paper surface too rough or too smooth
- Paper moisture content too high
- Poor dry ink adhesion to the paper

Since the reader sorter operation is usually not under the supervision or control of the check issuing agency, ask the proper agency to investigate the document-to-head pressure (either the read or the write head) in the reader sorter.

Paper size and characteristics

Make sure that the paper requirements for both the printer and the reader sorter are met.

MICR line format

Check for the following in the MICR line:

- Is there anything unusual about the content or intended position of the MICR line?
- Are the MICR line content and position correct?
- Are there any dependencies between the MICR line and the reader sorter control documents?

Job history or results

Ask the following questions:

- Is this the first time that this job has been run?
- What happened on the other occasions?
- Is the current result an exception?

Compare the documents with previous samples

Keep a record of base information and samples of previously printed jobs to help isolate and resolve recurring problems. Keep in mind that reader sorter operation is usually not under the supervision or control of the check issuing agency.

- Does the bank printing appear in the same location on the checks? Note the placement of the “endorsement” printing from the bank.
- Were the checks sorted upside down or backwards?
- Was the machine serviced immediately after this check run? An accurate dated record of base information may indicate this.

Analyzing reader sorter printout

Obtain a copy of the reader sorter reject report from your bank, if it is available. Also, ask the bank to provide definitions of all status and error codes that are used in the reject report. When analyzing the report, ask the following questions:

- Does the printout correspond with the job in question?

  There could be a mismatch between the report and the documents.
- What is the reject rate?

  Find out how the reject rate was calculated, by asking these questions:
  - Were paper handling rejects and Amount field rejects subtracted from the total?
  - Were blank sheets and documents that were inserted upside down or backwards removed from the total? (These items may not produce recognizable characters.)

- Where in the document do the rejects occur?

  Determine if they appear consecutively, in groups, or randomly:

  – Is there a pattern to these rejects? For example, are they the same character, the same field, or do they regularly appear after a certain number of sheets?

  – Does this pattern suggest that the dry ink cartridge may be defective by repeating the cycle?

- Is there an obvious pattern to rejects related to character or position?

  Inspect to see if a certain character seems to be causing the problem. Does a character fail often if it is in a particular position in the document?

- How are blank, backwards, or upside down documents indicated?

  Find out if there is a special code for these items, or if they are treated as other types of rejects. Are they completely missing from the report, or do they appear garbled?

- Are all the documents accounted for?

  At the end of a print run, the number of accepts plus the number of rejects should equal the total number of documents that were submitted. If they do not, ask the following questions:

  – Did some of the documents disappear or jam?

  – Did the system add something?

  – Did the operator reenter additional documents?

Test patterns: alternative to reader sorter testing

Reader sorter testing requires the cooperation of the issuing bank, and it addresses only problems with the bank's processing equipment. If appropriate reader sorters are not available, you must rely on analysis of print samples to identify potential quality issues and determine corrective actions for problem machines.

All Xerox MICR printers incorporate MICR diagnostic test patterns. These forms combine the needs of service diagnosis and call closeout with MICR problem analysis and escalation. You may want to use separate test pattern files to verify individual PostScript, PCL, and LCDS fonts. The MICR line on these forms is in the correct format for reader sorter testing. On the test pattern that is accessed through diagnostics, additional image elements are incorporated to provide insight into potential MICR problems. All of the MICR quality control and diagnostic procedures described in this guide can be performed on these documents.

The use of these test patterns with advanced MICR test equipment permits very sophisticated analyses, validating all magnetic waveform characteristics against established expectations. Problem escalation should always include these print samples, to facilitate quick identification of problems.

Verifying problem resolution

Unlike print quality or paper handling problems, MICR quality problems require some vigilance, even after the source has been identified and the problem resolved to the satisfaction of the customers and their bank. Bank reconciliation processes and check cashing policies may require a month or more for the full benefit of corrective actions to be seen. In the case of blank check books, the old stock may take years to deplete. Depending on the severity of the problem, you may need to take a proactive approach to ensure that MICR performance issues have been resolved.

8. Security

The success and security of MICR printing depends on the implementation of security procedures, document security features, and commitment by the customer.

Xerox printing systems security

Security in the laser printing environment refers to features that prevent unauthorized access to privileged data or forms that are not intended for general use.

To determine the degree of security that you need, you must evaluate the present risk and the value of what will be protected. Although any printing system may handle sensitive material, a MICR printing system is of special sensitivity, because outputs often include negotiable documents.

The key to security of a Xerox MICR printing system is to control access to critical and sensitive files, and to keep track of the legitimate use of these files through audit procedures. The critical files vary depending on check printing application implementation. The most common are the MICR fonts, logos, check forms, and the check print file.

NOTE: The available security and audit features may vary depending on the printer and controller configuration. You must consider your equipment capabilities when assessing your security needs. Periodic review is highly recommended, especially if equipment capabilities are upgraded or major system elements change.

Many techniques are available to protect checks and other valuable documents after printing. No security method provides absolute protection, but any feature that makes a check harder to alter or reproduce is desirable if it does not impair the production and automated processing of the document.

Important characteristics of a good security system are:

- Restricted access to printing capabilities
- Protection of the system software and key files
- Establishment of a complete and unalterable audit trail.
- Use of document security features that protect against both alteration and duplication

Physical security

The primary aspects of physical security for the Xerox MICR printing systems include the following.

Restricting physical access

Access to printing system

The most important security feature is control of access to check printing facilities and to the MICR printing system. If access is sufficiently limited, you may not need to consider further security procedures. However, as usage increases, the number of people who need access to the printer also increases.

Therefore, the first step in implementing any sort of security process must include a means of controlling the group of people who have access to the printing system, as well as limiting what they can bring to, or remove from, the printer environment.

For a higher level of security, the following is recommended:

- Install alarms on all doors to at least indicate if they are opened.
- Do not admit visitors unless they are properly screened by authorized managers.
- Provide proper escorts and do not allow free access to any visitor.

Access to media

A Xerox MICR application consists of a combination of fonts, logos, signatures, and forms. One way to secure these files is to place them on media that can be physically secured. When these application resource files are located on the host computer, host access control is needed.

Securing paper stocks

The ability of the Xerox MICR printing system to print a form, signature, logo, and MICR line on a check at the same time as the variable data eliminates the security problems resulting from keeping a supply of preprinted checks in storage.

However, because security paper is one of several resources used to print the checks, securing the paper stock is a wise extra precaution. Paper should be kept in locked storage, in sealed boxes, with each ream separately wrapped and sealed. Employees should not be permitted to take security paper from the building unless they are cleared by a security officer.

The amount of paper brought out of storage for printing can be used as an audit cross check against the number of sheets that are printed. After the checks are printed, the stacked documents should be carefully secured, because loose sheets are susceptible to pilfering. Numbered stock helps control check stock, but it increases job complexity.

Storage and disposal

Equipment

It is important that you regularly inventory and monitor the equipment used to manufacture and process checks. If you are selling equipment, you should sell or place it with reputable firms (for banking purposes). If you are discarding equipment, first make sure that the castings are broken up and that it cannot be used. Always keep the serial numbers and disposal records for at least ten years.

Checks and materials

Follow these guidelines for storing and disposing of checks and printing materials:

- Keep printing supplies, such as paper and ink, in secure storage areas.
- Inventory unprinted reams and rolls of paper and preprinted standard stock check bodies on a regular basis.
- Shred or incinerate all spoiled documents.
- Shred all unprinted security paper waste before recycling.
- Store the plates used to print documents in secure areas, and make them useless before scrapping them.
- Do not permit employees to take anything in or out of secured areas without authorization.

Responsible presence

The key to security in any document generation process is an individual or group that is responsible for safeguarding the printing process. For critical applications, the auditing operation has this responsibility. In small organizations, the printer operator may be responsible for security.

You can create a higher security level by combining physical security with a responsible individual or group when the system and supplies are not secured. Thus, two persons can have responsibility for the printing facility, by either dual key access to the media or knowing a password to access the data files and run the print job.

Software security

Software security focuses on restricting access to key files to authorized individuals.

Many software features provide different levels of protection, from class level logon control to automatic deletion of files at completion of a print job.

NOTE: Internal audit features vary depending on the printer and controller configuration. You must consider your equipment capabilities when assessing your auditing needs. Refer to your printer customer documentation for information on the security and auditing features that are available to you, and the processes for enabling them.

Logon levels

Several Xerox MICR printers provide some level of logon or password security as standard or an option. Many systems have a logon level at which the user files can be restricted from all of the other levels so they cannot be edited, deleted, or used by other jobs.

Memory

Fonts, logos, graphics, and other resource files may need to be restricted from other users. Even if these resources are adequately protected, unauthorized access could be obtained through the residual contents of font memory or disk storage.

If your system does not clear the contents of font memory, you can clear it by the following methods:

- Downloading a set of data that uses all available memory
- Powering the printers on and off
- Using special font utilities

The print file should also be cleared.

System commands

Some Xerox MICR printers provide a series of system commands that control access and presence of files.

Audit control processes

The primary audit function for Xerox MICR printers is to identify the processes or procedures that could compromise control of valued items. The auditor then finds ways to stop that loss of control.

You can maintain an audit record by doing the following:

- Create an audit control worksheet to account for each page.
- Keep a record of information that is compiled by the operator and other responsible personnel.
- Maintain a job log, including completed and failed jobs, paper jams, and system restarts.

Accounting information

When print jobs are processed by the printing system, the system software accumulates and saves usage data.

This information may be printed on the printer or transcribed for analysis by the host computer.

Paper jams

Reduction of jams depends on proper machine adjustment, paper quality, and storage and loading of supplies. The important item to consider is the clearing of jams.

The operator captures and accounts for all jam scrap and makes sure that no missing or duplicate checks result from the jam. The audit process works only if all of the sheets in the jam are discretely identified. These sheets should be considered part of the output for the job until the auditor is satisfied that the job has successfully completed.

Note that some pages may not have been properly fused in the printer. Careless handling of jam scrap could contaminate good output.

Samples

You may need to sample pages during a MICR print run. Some form of sample output is needed to verify the continued quality of the MICR characters.

You can obtain samples during printing by the following methods.

Sample button

Using the Sample button or key involves a significant security risk. If the MICR documents are not negotiable or if the print facility is highly secure, it may be an acceptable method. Any extra copies must be voided. You might prefer to have the Sample button disabled.

On most printers, pressing the Sample button generates an extra print of the current page. If your system does not produce this extra print, you must ensure that each item is returned to its appropriate location in a serialized print stream.

Sampling whenever output is removed from the printer provides an easy method of evaluating output quality without disturbing the job order.

NOTE: Inline sample prints may not available, depending on the printer and controller configuration.

Printing a test pattern

A test pattern should be printed at designated intervals, especially at the beginning of a job. You can direct the printed test pattern to a different tray or use colored paper to distinguish it from the rest of the output. The application program should be designed so that an electronic form with the word “VOID” is merged with these pages.

Tampering methods

There are several methods by which data on a check may be altered. The security papers on which negotiable documents are printed are designed to thwart these forms of tampering.

Chemical tampering

Many inks can be affected by particular chemicals, making chemical alteration of checks possible. These chemicals could be some combination of solvent and bleach. Certain inks can be bleached without materially affecting the paper stock. Other inks can be selectively removed without affecting the rest of the image.

Select check stocks that contain materials that make altering the printed transaction information difficult. For example, if ballpoint pens will be used to complete the check, the paper should contain indicators for ballpoint ink solvents. If organic dye based inks, which are susceptible to bleaching, will be used, select papers containing a bleach indicator. (Because dry ink images are encapsulated in a plastic resin, they are almost impossible to bleach.)

Check stock must also remain compatible with the MICR printing system on which it is used. Some chemical security features can damage printer subsystems. A marginally effective security feature could actually degrade overall document security.

Mechanical tampering

Mechanical alterations include erasing, picking ink out of a document, and scraping to remove sections of the original document. The part of the image that is removed is replaced with a section that looks similar. Mechanical alterations are often attempted on xerographic images.

Ways to discourage this kind of alteration include:

- Repeating critical information at several locations on the document. This turns a simple change of vital information into an extensive modification of large areas of the document.

- Selecting checks with a structured background pattern. This type of background accentuates the pattern change that results from tampering. Random check backgrounds may camouflage damage due to alteration.
- Using “fugitive” inks, which run when a solvent is applied. A water soluble ink shows any attempt to loosen and remove paper fibers attached to a dry ink image.

Modifying printed checks

The ease with which a tamperer can modify an image, either chemically or mechanically, depends on how intertwined the printing inks are with the fiber of the paper with which the inks have been in contact.

The following printing technologies react in different ways to the different tampering methods.

Lithographic printing

Lithography is difficult to modify. The inks are liquid when applied and soak into the fibers of the paper. The flow of the ink through the paper fibers makes the edges of the characters indistinct.

If a nonabsorbent paper is used, or a paper with an ink hold-out layer, the image may sit on the top layer of the paper, making it easy to erase. The deeper the ink soaks into the paper, the more paper fibers must be disturbed to remove the ink, and the more noticeable the alterations are.

Impact printing

The two types of impact printing are letterpress and ribbon ink transfer.

- **Letterpress:** This method is not recommended for printing variable data required for check applications.
- **Ribbon transfer:** This process involves either fabric or mylar ribbons.
  - The fabric ribbon ink is semi-liquid. An example is a fabric typewriter ribbon or printer ribbon that leaves ink on your hands when you touch it.

Fabric ribbon inks also soak into and around paper fibers. How much the inks soak in depends on how new the ribbon is. As the ribbon is reused, ink levels are depleted and the image does not bond as much to the paper. At this point, the image is easier to remove. Some images printed with fabric ribbon are impossible to remove, while others can be removed with a damp finger.

– A mylar ribbon is used only once. It carries a waxy or jelled layer of ink that is designed to transfer completely to the paper when struck with enough force. The result is a transferred image that bonds well to the paper.

  Mylar ribbon ink is not as liquid as the ink on a fabric ribbon. Some of the ink from the impact printed image penetrates into the paper, but the ink sits higher on the page fiber than it does with a lithographic image. Generally, the waxy nature of the mylar ribbon inks resists bleaches.

Altering an impact printed image has different results, depending on the nature of the inks and the pressures that are used. In some cases, mylar ribbon images bond so poorly to the paper that they can be removed with sticky tape. With enough pressure and the proper inks, the image can bond well, but it is still vulnerable to picking tools.

Cold pressure fix

Cold pressure fix is used by some non-impact printers. Dry ink is fused to the paper by pressure alone. The image bonds poorly to the paper, but it is relatively well compacted and bonded to itself. The dry ink rests on the surface of the paper and is highly bonded only to the top layer of paper fibers. The image may be picked away without leaving much residue.

Xerography

Xerography is a printing process that uses heat and pressure to melt and fuse thermoplastic dry ink to the paper. The pressure applied during fusing forces the dry ink into the paper.

This process makes the ink very difficult to remove without detection. A xerographic dry ink image is also difficult to alter chemically, because the colorant material is well protected by its plastic binder.

Even in a well-designed printing system, some factors affecting the dry ink to paper bond remain under user control.

- Excessive paper moisture causes poor heat transfer due to the energy dissipated driving off the water.
- Preprinted backgrounds with high ink coverage prevent contact of dry ink to paper, which is a prerequisite of a bond between them.

Either problem can make a dry ink image easier to remove.

Preventing tampering

Document tampering can not be eliminated completely; however, you can strongly discourage it by making it more difficult.

The quickest and most cost-effective methods of preventing check falsification include the following:

- Use a printing process that provides firm bonding between ink and paper. Avoid factors that interfere with the bonding process.
- Use a secure check stock that works with the printing process, compensating for its vulnerabilities without interfering with its capabilities.
- Use redundant data for critical fields—a statement of the check amount, for example, provided in both numeric and text versions.

A traditional check protection method uses multiple fields to indicate the payable amount. This amount can be written as a numeric field and a text string. The text amount field provides good protection, but it requires advance planning for forms design and for host application programs.

The small, compressed fonts of the Xerox MICR laser printer allow multiple lines and can fill the requirement for the multiple language statement. For example, Canada requires English and French.

If you use a multiple approach, remember that the text string is considered the legal amount field. The numeric field takes second place in legal precedence.

The ability of the Xerox MICR laser printer to use special fonts, or fonts on a special background field, makes check modification very difficult. However, these fonts and background also make check processing more difficult. For this reason, industry standards now require light backgrounds and clearly readable numbers for automated processing. Use of a legal amount provides protection against amount alteration.

Safety papers

Safety papers have a background that makes alteration easily visible. Scenic backgrounds or a repetitive pattern, such as a logo, are some examples. Safety papers that consist only of a patterned background are not foolproof.

Many financial documents are produced on a base paper, on which a safety pattern is printed using stable inks. These inks do not have the same sensitivity to chemical or mechanical erasure as true safety inks. They are used because they look better and are easier to print with. However, documents printed on these papers are much easier to alter than those printed on true safety paper.

Overprints

Overprints consist of a pattern or a scene that is printed over all or parts of a printed document. Overprinting may be combined with a texturing process. The varied colors and the texture make it very difficult to modify the characters under the overprint without affecting the overprint itself. However, overprinting adds a step, which can make the check production process much slower.

Textures

Textures can be printed on a form before the data is printed, or applied with an overprint afterwards.

One type of preprinted texture is called “intaglio.” An intaglio surface is created using a “male and female” die set. The engraving is usually fine and the production cost of the final documents can be high. Intaglio is a popular method used for travelers' checks.

A problem with intaglio is that the surface is abrasive and can cause problems for the reader sorter manufacturers. In addition, attempts to place a dry ink image on a textured surface can result in image deletions and distortions.

Amount limit statements

An example of an amount limit statement is “NOT VALID FOR MORE THAN $xxx DOLLARS.” The “$xxx” may be stated alphabetically or numerically. Both ways offer protection because two areas of the document must be altered.

Some countries may require that the statement be printed in more than one language. The Xerox printing system allows selection of small or compressed fonts to create space for the statements on the document.

Amount in Words fields

One of the safest protection methods is the use of multiple fields that indicate the payable amount. For example, the payable amount can be printed once as a numeric field and once as a text string. Most handwritten checks use this protection technique.

Machine-produced checks often do not use multiple amount fields. One reason is the difficulty in deciding on an appropriate text string for larger amount values.

The text Amount field requires advance planning for forms design and for the application program. Using small, compressed fonts allows for multiple lines and statements.

NOTE: The text string is considered the legal amount field, and takes legal precedence over the numeric amount field, which is the convenience amount.

Preventing check duplication

Like check tampering, document duplication can not be eliminated completely. In fact, there are legitimate reasons for check duplication, including image capture by banks for automated processing or audit purposes and copies of personal checks for third party reimbursement. However, checks are not duplicated for the purpose of transferring funds.

Several features can be built into a check to make the task of check duplication more difficult, without hindering legitimate duplications.

Microprint

Microprint is extremely small text that, unmagnified, looks like part of the check design. When magnified, it is a readable text message. Microprints are very effective in preventing check duplication because of their small image size.

Like safety patterns, microprints are usually applied using conventional wet ink technologies before the stock is used in the MICR printing system.

Microprints are typically used as check borders, signature or memo lines, or as part of the endorsement control areas on the back of the check.

Watermarks

Watermarks are images that appear to be part of the paper and which are visible only under special viewing conditions. True watermarks are paper structure deformations that are built into the paper stock during the manufacturing process. They are most easily seen when the paper is held up to the light. Artificial watermarks are light colored inks that look like part of the paper unless viewed at an angle. True watermarks are expensive and frequently make MICR encoding difficult. Artificial watermarks are commonly used on the back side of the check, in the endorsement area.

Drop-out print

Drop-out print is an imagewise pattern printed with light gray ink and a very light halftone screen. The image is visible under close inspection, and it can not be copied.

Drop-out print is frequently applied to the back of the check with the words “genuine document” spelled out in reversal script. When held at arms length, the words appear as light areas on a slightly dark background. Drop-out print can also be used on the face of the check as part of a check border or in place of a VOID pantograph (refer to “VOID pantograph,” later in this chapter).

Dataglyph™

Dataglyph is a new technology that permits duplicate encoding of all variable data in a covert but machine readable form. Dataglyphs appear to be shaded areas. Under close examination, patterns of left and right tilted diagonal lines can be seen. When they are scanned and properly interpreted, these diagonal lines form a code that conveys a message.

VOID pantograph

VOID pantograph is a background printing technique that uses a variation in halftone screen frequencies or ink colors to spell out the word “void” on the face of the check. The word is invisible on the original document, but when the document is duplicated, “void” appears in several places across the face of the duplicate.

In recent years, this device has become less popular due to its negative impact on those who have legitimate reasons for duplicating checks. Its effectiveness has also degraded due to improvement in color duplicating systems that permit the pantograph to be duplicated intact.

Avoiding counterfeit and stolen checks

The other side of the transaction process is represented by the checks a business issues to pay its obligations and employees. Failure to recognize and adequately address the risk inherent in the activity can result in larger losses than would be suffered by occasionally accepting a bad check from a customer. The principal threats include alterations, embezzlement, stolen checks, and counterfeits.

Alteration

Alterations may occur when a criminal steals a check and changes the amount, the payee information, or both, and then cashes or deposits the check. To guard against this, follow these guidelines:

- **Use a check that is protected.** Many checks are printed on paper that has a chemical coating or has chemicals in its internal composition that react visually when solvents are applied or erasure is attempted.
- **Avoid using correctable typewriter ribbons.** The same feature that let you easily remove typing mistakes enables a criminal to change the information on a check.
- **Enroll in a positive pay program.** Many banks offer this type of program to commercial accounts. The account holder must give the bank a list of all checks issued each day by serial number and amount. The bank enters this information in a database, and the amount and serial number are compared to the list each time a check clears. If the information does not match, the bank notifies the account holder and refuses payment until authorization is received.

  Positive pay does not prevent payment of a correct amount to a different payee, or honoring of a duplicate check that arrives before the legitimate one.

Embezzlement

Embezzlement involves an employee writing checks for fictitious invoices, overpays invoices and then intercepts refunds, issues payroll checks to nonexistent employees, overpays employee accomplices, or underpays bills and pockets the difference. To protect against embezzlement, use the following guidelines.

- **Separate duties.** Assign responsibility for issuing checks and depositing receipts to different employees.
- **Tighten procedures.** Establish systems to positively associate payments with invoices. Using checks with duplicate copies can be helpful.
- **Reconcile statements promptly.** Balance the accounts as soon as you receive the bank statement and canceled checks. Compare all issued checks to the current invoice file, and all deposits to the current receivables file. Ideally, this should be done by a third party that does not issue checks or deposit receipts.
- **Perform audits.** Inspect the status of all accounts at frequent but irregular intervals.

Stolen checks

Blank checks may be removed from the premises by employees, delivery personnel, service technicians, customers, emergency personnel, or burglars. Missing checks may not be noticed immediately. In some cases, checks are intentionally thrown away without secure disposition. Stolen checks that are successfully passed are the responsibility of the account holder, and the losses are usually not recovered. Guard against stolen checks by doing the following:

- **Secure the check supply.** Make sure that all blank checks are stored in a secure place. Limit access to checks to a small number of authorized employees.
- **Secure the environment.** Limit check writing to an area that unauthorized individuals cannot access, or schedule check writing when no one else is in the area.
- **Examine checks thoroughly.** If an unauthorized entry occurs, such as during a burglary, fire, or medical emergency, make sure that no unissued checks are missing.
- **Enroll in a positive pay program.** This program is effective against stolen checks because unlisted serial numbers are caught by the bank and are not paid.
- **Dispose of outdated check stock in a secure manner**, preferably by burning or shredding.

Counterfeits

With high quality duplicating and printing equipment readily available, individuals with no training or experience can create presentations and reports that have a very professional appearance. Office copiers, color copiers, and computer-controlled laser printers are used in check counterfeiting. Like stolen checks, counterfeits that pass through the payment system are often the responsibility of the account holder, and not the bank. This is especially true when the check can be easily reproduced, or account reconciliation procedures do not ensure prompt discovery of the counterfeit.

Consider the following when planning for a counterfeit protection program:

- **Select a good check design.** Review the design features that are effective against counterfeiting. Consult with the security officer at your bank and with your check supplier when considering specific protections.
- **Install reconciliation procedures.** Make sure that accounts are posted promptly, and that bank statements are balanced immediately upon receipt. Inspect all checks in the statement to ensure that counterfeits are included.

Cost considerations

Some methods of preventing alteration and duplication are costly. Intaglio surfaces are probably the most effective and the most expensive. Overprinting is somewhat less expensive, but there are hidden costs in terms of speed of operation, damaged documents, and operational problems.

The most popular protection method is safety paper. If the applications design permits its use, a safety paper is one reasonable way to protect a document against modification.

The most inexpensive and effective method for protecting documents is by printing controlled information in a way that makes it difficult to alter. If information can be printed more than once, a tamperer would have difficulty making the changes look the same.

An effective combination of methods uses the following:

- A printing process that provides a good bonding between the ink and the paper
- A font that is difficult to alter for the areas of the document that need protection but are not intended for machine readability
- A redundant statement of the check amount
- Use of at least two security features on the check, one to address alteration and another to address duplication

A. References

Standards documentation

The following references are for both domestic and international check standards.

Table A-1. **Domestic check standards**

Domestic standard	Number	Publication date
Bank Check Background and Numerical Convenience Amount Field	ANS X9.7	1988; Revised 1999
Specifications for Placement and Location of MICR Printing	ANS X9.13	1990; Revised 1999
Paper Specifications for Checks	ANS X9.18	1993; Revised 1998
Print and Test Specifications for Magnetic Ink Printing (MICR)	ANS X9.27	1988; Revised 2000
Check Carrier Envelope Specifications	ANS X9.29	1992; Revised 1998
Specification for Bank Deposit Tickets	ANS X9.33	1999
Specification for Electronic Check Exchange	ANS X9.37	1994; Revised 2001
Check Correction Strip Specification	ANS X9.40	1994; Revised 1998
Financial Image Interchange Architecture Overview and System Design Specification	ANS X9.46	1997
Creating MICR Document Specification Forms	ANS X9.47	2001
Fraud Deterrent Icon Standard	ANS X9.51	1999
Specifications for Check Endorsements	ANS X9.53	1996
Specification for Universal Interbank Batch/Bundle	ANS X9.64	2001

Table A-2. **U. S. MICR Industry Guidelines**

Domestic standard	Number	Publication date
Understanding and Designing Checks	ASC X9/TG-2	1990; Reaffirmed 1995
Quality Control of MICR Documents	ASC X9/TG-6	1995; Revised 2000
Check Security Guideline	ASC X9/TG-8	1995
To Aid in the Understanding and Implementation of Financial Image Interchange	ASC TG-15	1998

Table A-3. **Significant international check standards**

International standard	Number
International Standards Organization MICR Printing Specifications	ISO 1004 - 1995
Australian Banks Payment Association	ABPS # 3 R2 ABPS # 11 R3
Association for Payment Clearing Services (UK)	APACS Standard 3
Canadian Payments Association MICR Printing Standards and Specifications	CPA 006

Instructions for ordering U. S. standards

The ANSI standards are available electronically and in hardcopy. You may order them from the following sources:

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You can obtain ANSI standards documentation and information from the following web sites:

ANSI standards catalog:

http://x9.org/catalog.html

ANSI standards documents:

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You can order the standards by phone, fax, or mail as follows:

American National Standards Institute (ANSI)
11 West 42nd Street, 13th Floor
New York, NY 10036
Attn: Customer Service
Phone: (212) 642-4900
Fax: (212) 302-1286

Standards development process information (U. S. only)

For information on joining the U.S. standards development process, contact:

Associate Director, ASC X9 Secretariat
c/o American Bankers Association
1120 Connecticut Avenue N.W.
Washington, D.C. 20036
Phone: 1-202-663-5284
Fax: 1-202-663-7554

Glossary

ABA American Bankers Association or Australian Bankers Association

AFNOR L'Association Francoise de Normalisation (AFNOR). Paris-based organization like the APACS. Standards authority for CMC-7 (NFZ 63-001).

aligning edge The lower edge of the check when its face is viewed.

alignment The relationship between the bottom edge of a character and the bottom edge of its adjacent right character. Also known as vertical alignment.

amount field The character positions within the MICR line of a check which contains the amount of the check.

amount symbol Special MICR character to separate the amount field from the next adjacent field.

ANSI American National Standards Institute. Supervises the accreditation of US standard development committees.

APACS Association for Payment Clearing Services. An organization similar to ABA, but with standards setting authority for banking systems in the U.K. (Used to be known as CLCB.)

auxiliary domestic field Area to the left of the MICR encoded BSB field. Also called the “auxiliary serial field.”

auxiliary On-Us field An optional data field within the MICR line of a check which contains information determined by the individual bank.

auxiliary serial field See auxiliary domestic field. (Australia)

average edge An imaginary line (vertical or horizontal) through the ragged edge of a magnetic ink character. The measurements relating to spacing, dimension, and alignment are made from one specified average to another.

background The basic color (pattern) of a document, as distinct from the lines and information printed on it. (See fugitive background.)

bank check A draft drawn by a bank on itself, or by one bank against funds deposited to its account in another bank, and payable immediately on demand.

basis weight The industry term for expressing the weight per unit of paper. Generally defined as the weight of a given size sheet in pounds per ream (usually 500 sheets) or grams per square meter (g/m2). For banking papers, this is normally the weight in pounds of 500, 17 by 22 inch/432 by 559 mm sheets.

batch header The process control documents (usually serially numbered) that precede a batch of items to be entered for processing.

BFD Bank of First Deposit

black band document Typically a batch separator document or other control document. (See batch header.)

bond paper A grade of printing paper where strength, durability, and permanence are essential requirements. Bond papers are either rag or sulfite bonds. Used for letterheads, business forms, checks, etc.

brightness The whiteness of a paper

bristol paper A stiff, heavyweight paper with a softer surface than index and very receptive to ink. Ideal for high-speed folding, embossing, or stamping.

BSB field The Australian Bank/State/Branch field is an area in the MICR line which provides the routing information for the document.

BSB symbol The Australian special MICR character to separate the BSB field from the next adjacent field.

calibration document A document with a known magnetic strength character used to calibrate magnetic readout equipment.

character space/ position The position or space where a magnetic ink character (digit or symbol) appears in the MICR line. Only one character is permitted in a character space; each space or position in the MICR line is numbered.

Character-to-character spacing Distance between adjacent characters, measured from the right edge of one character to the right edge of the adjacent character.

check Any negotiable payment document written against an account maintained by a financial institution for the transfer of a dollar amount from one party to another.

check digit A digit, usually the first digit read in the transit field, that can be computed from the other digits in a field. The check digit is used as a validity check of the total field.

check routing The denominator of a fraction (located in the top right corner of a check), which appears on checks drawn on all Federal Reserve member banks. The numerator of the fraction is the ABA transit number.

check truncation The conversion of the information on a check into some form of electronic recording after it enters into the processing system. The process is called truncation because the physical processing of the check is cut short.

chipping The removal of Xerox MICR LPS toner in reader/sorters, which is due to wear and tear stresses placed on the image by these processing devices.

CLCB Committee of London Clearing Banks. Formally an organization similar to ABA, but with standards setting authority for banking systems in the U.K. (Replaced by APACS.)

MICR clear band A horizontal band on a document that extends upwards 5/8-inch (0.625-inch/15.87-mm) from the bottom edge of the document containing the MICR line. Sometimes referred to as the MICR band, although the definitions are different (see MICR band).

clearinghouse A voluntary association or corporation that acts as a medium through which banks in some areas exchange items drawn on each other and make settlements.

CMC7 A font used in magnetic ink printing

code line, MICR The .25-inch (6.35-mm) high region centered in the clear band that contains the MICR characters. Also known as the MICR “band”.

convenience amount The value of the check expressed in numbers.

convenience amount An area above and below the convenience amount

clear area Scan band held clear of printing that would interfere with the convenience amount.

comparator An special optical tool to measure MICR character dimension and positional attributes.

correspondent bank A bank that maintains an account relationship or exchanges services with another bank.

cover stock A heavyweight paper available in white or colors, designed for use as covers on booklets, etc.

CPA Canadian Payments Association. An organization, headquartered in Ottawa, having standards setting authority for banking systems in Canada equivalent to APACS in the U.K.

crayoning A smudging of the MICR line on documents, commonly associated with the IBM 3890 reader/sorter.

curl The distortion of paper built in when paper is manufactured and placed on large rollers before being cut into sheets. Effect is intensified when paper is exposed to heat, pressure, moisture, and drying. A major cause of paper handling problems in printers.

cut sheet paper Paper that has been cut into sheets 11- by 17-inches (279- by 432-mm) or smaller.

DACS Document Audit and Control System

DDA Direct deposit account

debossment The sunken impression of a printed character on a paper document. Debossment is caused on the face of a document by impact processes that may use an excessive amount of pressure to imprint the character on the document. Debossment that is in excess of .001-inch in depth may cause a significant decrease in the measured magnetic signal level of the affected MICR characters. (See embossment.)

dimension The shape of a character measured within the space that it occupies.

document One or more recorded or printed pages forming a logical whole.

dot A unit of measurement representing the smallest unit of image placement (also referred to as “spots”).

domestic field An area on the check where information relevant to that bank only (e.g., bank account number) is encoded. Sometimes referred to as the On-Us field or serial field. (Australia)

domestic symbol Special MICR character to separate the domestic field from the next adjacent field. Sometimes referred to as the On-Us field or serial symbol. (Australia)

dry ink A fine black powdered substance used by printers to form images on the printed pages. Also called “toner” or “dry imager.”

duplex Printing that occurs on both sides of the paper.

duplicator paper An extremely smooth paper, highly resistant to liquids, for use in spirit (alcohol) duplicating machines.

E13B The type of font used in magnetic ink printing. Use of the term E13B generally implies both the character shape as well as the magnetic aspects of the printing. It consists of ten numeric characters and four symbols.

embossment The raised impression of a printed character on a paper document. Embossment is caused on the back side of a document by impact processes that may use an excessive amount of pressure to imprint the character on the document. (See debossment.) Also termed with the type of non-impact printing.

encoding **1.** Imprinting MICR characters on checks, deposits, or other bank documents. **2.** The magnetized recording of data on the magnetic strip on a bank card.

extra auxiliary domestic field Area on the check where information is relevant to the bank only. Commonly used for a serial number in deposit transactions. Also called “extra auxiliary serial field.” (Australia)

extra auxiliary serial field See extra auxiliary domestic field. (Australia)

extraneous ink Magnetic ink or other ink not intentionally printed which is located within the clear band.

felt side During manufacturing of paper, the pulp mixture is poured onto a screen so that the liquid drains out, leaving only the pulp, which dries to form the paper. The side of the paper that is exposed (away from the screen) is called the felt side. This side has a felt-like texture with more short fibers and sizing that the opposite (wire) side.

ferromagnetic Having characteristics of substances with magnetic properties resembling those of iron. MICR systems use a ferromagnetic dry ink.

field A specified portion of the MICR line that is limited to a set of one or more characters that may be treated as a unit of information.

fillers Compositions used to fill in the pores in paper to improve smoothness, opacity, and affinity for ink. Clay is often used as a filler.

fine-sort The sorting of a group of documents into a particular sequence for the next processing step. The fields that are sorted are usually some portion or all of the On-Us, transit, or auxiliary On-Us fields.

finish The final coating or surface of a paper. May be rough or smooth, glossy or dull, etc.

font A collection of characters with a consistent size. Refers to the printer's internal fonts, or fonts stored in optional font cartridges and soft font diskettes.

fugitive background A special print pattern, usually incorporating numerous repetitions of the bank's corporate logo, found on check documents. The pattern reacts chemically or physically if the document is tampered with, thus providing some measure of security over whatever information is overprinted onto the pattern.

fuser The area of the laser printer where the image is permanently fixed to the paper by heat or by heat and pressure.

fuser oil High-purity refined silicone oil used as an external release agent in fusers to keep paper from sticking to the fuser roll.

grade Degree of brightness of paper. The higher the brightness, the lower the grade number.

grain On a sheet of paper, the direction in which most fibers run. Long grain papers have most of their fibers run parallel to the long side; while in short grain papers the fibers run parallel to the short side.

grammage Term for expressing paper basis weights in Australia and Europe, which is the weight in grams of a square meter of paper. Also called grams per square meter (g/m2 or gsm).

hole plugs The circular pieces of paper residue produced from punching holes (for binding purposes) in paper.

home bank The bank from which a check (or other MICR document) has been drawn upon.

housekeeping The regular operator cleaning and maintenance procedures for mechanical devices (such as the LPS printer module and reader/sorters) which manufacturers deem necessary for optimum machine performance.

host The source of data, or the input device, for the printer. Could be a personal computer or a mainframe.

image A process of digitization of all or a portion of the document. The digitized image might be used to enhance the microfilming process, or it might be used for storage, transmission, or electronic printing of the document (e.g., as part of the account owner's statement).

intaglio printing The printing process commonly used for travelers checks and other security documents. This process produces a noticeably raised surface of ink, and in doing so places quite severe stresses on the paper. Getting MICR encoding to properly fix onto intaglio printed documents, by any technology, is quite difficult.

ionographic printer A printer that forms images by directing an array of negative ions onto a drum. After dry ink is attracted to the charged areas of the drum, the image is fused to the paper by cold pressure.

ISO International Organization for Standardization

item numbering A number that is applied as a part of the sorting process. The number is usually linked to the microfilm sequence and is used to located the appropriate microfilm image during document research.

label stock Adhesive-backed sheets of paper that may be applied to a variety of surfaces and may be used for mailing addresses, identification or price tags, etc. Sheets may be backed with pressure-sensitive adhesive or dry gum. Label sheets may be uncut or divided into any number of individual labels.

landscape Landscape orientation refers to printing across the length of the page, as opposed to portrait orientation which prints across the width of the page. The term “landscape” is derived from pictures of landscapes, which are usually horizontal in format.

legal amount The value of the check expressed in text. If this value differs from the convenience amount, the legal amount prevails.

laser printer A non-impact xerographic printer that uses a laser beam to form images on a photoreceptor. The images are then fused to paper by heat and pressure. Xerox calls their laser printers Electronic or Laser Printing Systems (EPS or LPS).

leading edge The right edge of a check, which is the first edge of the document to feed into a reader/sorter and is most susceptible to damage.

logo The name of a company or product in a special design; used as a trademark in advertising.

magnetic ink Usually printer ink to which iron oxide particles have been added. On Xerox MICR printing systems, it is the dry ink with magnetic characteristics.

mailer Specialized product incorporating glued margins, cross gluing, and carbonizing or carbonless coating so that both the outside address and insert can be printed simultaneously.

Matrix reader/ sorter Reader/sorters that use a number of read heads, which in turn replicates the character read in terms of a matrix. An example of this type of device is the IBM 3890.

MICR Acronym for Magnetic Ink Character Recognition. It consists of magnetic ink printed characters that can be recognized by high-speed magnetic and/or optical recognition equipment.

MICR band — **1.** The .25-inch (6.35-mm) high region centered in the clear band that contains the MICR characters. **2.** The MICR characters printed in the MICR band.

mimeo paper — An extremely rough, porous paper. Its high absorbency makes it ideal for the mimeograph printing process, which uses a stencil through which ink is pressed.

moisture content — A physical property of paper. High moisture content causes curl, jams, and poor fusing; low moisture content causes static problems, leading to increased jams and misfeeds.

multi-up printing — The printing of more than one document per physical sheet of paper. For example, the printing of three checks per page (e.g., 3-up in portrait).

mylar — A polyester film used to reinforce the edges of Xerox 3-hole drilled, reinforced-edge paper. The bording material for impact ribbon inks.

OCR — Optical Character Recognition. A technique for reading a font optically. The font can be an OCR font, the E-13B, or others depending on the capabilities of the hardware. OCR may refer to the technique, the machine, or any aspect related to the technique or machine.

offset printing — A printing process where an image formed on a metal plate or other type of master, is transferred (offset) to a rubber blanket, then transferred again to paper.

offsetting — The process of ink from one printed sheet rubbing off or marking the next sheet as it is leaving the printer. Also refers to a printer or copier delivering printed sheets to an output station and stacking a specified number of sheets slightly to the left or right of the previous set.

On-Us field — A U.S. data field in the MICR line of a check reserved for bank use. It usually contains information such as the customer account number or other bank specified information. Also referred to as the “domestic field” and “serial field.”

opacity — Degree of show-through of print on a sheet from the back side to the front, or from one sheet to another. High opacity paper is difficult to see through.

orientation — Choice of printing portrait (vertically) or landscape (horizontally).

pantograph — A printed pattern of a logo or art creating a decorative background containing hidden images when duplicated. Usually intended as an anti-alteration feature of the document.

paper dust As saw dust is to wood, paper dust is to paper. It is made up of loose paper fibers and other residues which naturally accrue to paper. Controlling paper dust is a serious issue for the Xerox MICR printing system in terms of extraneous ink spots.

peaks & valleys, waveform Represent the “highs” and “lows,” or in the magnetic waveform signal patterns of the MICR characters.

perforated paper Paper pierced with one or more rows of small holes to permit easy tearing off or separating into sections.

permanence Also called “archival property.” A measure of how long a sheet will last without becoming excessively brittle and yellow. The permanence of a sheet is directly related to its acidity. Also refers to the degree of adhesion of an image to the paper and the ability of a MICR image to retain its human and machine readability over the normal life cycle of a check.

personalization The relatively recent concept in MICR printing for including non-MICR variable data on the documents (e.g., council rate notices with MICR encoded deposit slip attachments. (UK))

phantom Any light image placed on a document, usually for decorative purposes. The subject is intended to be printed or written over and is generally lightened by means of screening.

pigments Substances used to produce color or different degrees of whiteness in paper. Sometimes pigments are coated on papers, which can cause contamination problems in printers.

photoreceptor In laser printers, a drum or belt device with a light-sensitive coating, which converts an optical image into a latent electrostatic image on its surface.

pH Chemical measurement of level of acidity or alkalinity in paper or other substances.

porosity Measurement of the ability of air to pass through a sheet of paper.

portrait Refers to the printing across the width of a page (letter style). This is the opposite of landscape orientation, which is printing across the length of the page. The term portrait is derived from portraits of people, which are usually vertical in format.

post-encoding Amount field encoding of deposited items prior to the receipt by a bank.

predrilled paper Paper having two or more holes drilled along one edge, for use in ring binders or notebooks.

pre-encoding Amount field encoding of deposited items prior to the receipt by a bank.

preprinted forms Forms that have been previously printed which can be run through a printer in order to add variable data to them.

print density Print density refers to the relative darkness of print on the page. Very dense print appears totally black. Less dense print looks lighter, and solid filled areas may not be totally black.

proof department The bank department that sorts, distributes and checks (or proves) all transactions arising from the bank operations.

proof machine Equipment that simultaneously sorts items, records the dollar amount for each sorted group and balances the total to the original input amount.

psi Pounds per square inch. Unit used to measure amount of pressure.

rag bond A type of paper containing a large percentage of cotton fiber. Such papers are extremely strong and durable, with an attractive, rich-looking appearance.

reader/sorter An automated MICR document processing machine that performs a number of functions, including:

Magnetizes the MICR characters and senses the electrical signals generated by the subsequent passage of the characters under a read head.

Decodes the signals, identifies the characters and validates the field structures.

Separates valid documents from invalid or unreadable documents and further separates the acceptable documents into groups.

May optionally endorse and microfilm each document.

read head The sensing device in reader/sorters that picks up the magnetic signals of E-13B characters. These are converted into electrical pulses and subsequently interpreted by the reader/sorter's processor.

reflectance The relative brightness of an illuminated paper surface. The term may have several interpretations, depending if it is a function reference to human perception, microfilm, or other image sensing equipment.

registration The printing of variable data so that it fits correctly into areas provided for it on preprinted forms.

reject repair system High-speed equipment that can simultaneously read, repair, and reenter previously rejected checks back into the check processing system.

ribbon encoding The use of conventional computer impact printing technology for MICR encoding, using a print chain with the E13B characters on it and a special ribbon impregnated with magnetic material.

routing number A numbering system that identifies the issuing bank.

safety paper Bond paper having a surface design and/or hidden warning indicator to identify any attempt at fraudulent alteration.

serial field See domestic field. (Australia)

serial number Often used to refer to the sequential check or document number found in the auxiliary domestic and extra auxiliary domestic fields. (Australia)

serial symbol See domestic symbol.

Sheffield Smoothness A device for measuring the roughness or smoothness of a paper. Higher numbers indicate rougher papers.

signal level/ strength The current (or equivalent voltage) produced by a magnetic ink character in a reader/sorter or signal reader. Each character has a nominal peak signal level (designated in the ANSI specification), as well as an acceptable signal level range. This is also called “signal strength.”

single-slot reader sorters See waveform reader sorters.

sizing Resin that is added to papers during manufacturing to increase the paper's resistance to liquid penetration. Also helps prevent feathering or fraying.

skew Allowable tilt or angle of a character, to the left or right, measured with respect to the bottom edge of the document.

smoothness The degree of continuous, even finish on paper.

stiffness The degree to which paper resists bending.

substance The weight in pounds of a ream of paper cut to 17 by 22 inch/432 by 559 mm standard size for business papers. Similar to basis weight of other types of paper.

surface strength Term indicating how well fibers and chemicals are bonded to the surface of a paper. Papers with low surface strength may release fibers and particles in the printer, causing machine contamination.

symbol An E13B character separating the fields or separating digits within a field. U.S. symbols are amount, On-Us (domestic), transit, and dash.

tensile strength A measure of paper's resistance to tearing.

texture The composition and feel of the surface of a paper, such as rough or smooth.

TAPPI The abbreviation for the U.S. Technical Association of the Pulp and Paper Industry which develops standardized test procedures for various properties of paper.

trailing edge The left edge of a check when its face is viewed.

transit number The U.S. Federal Reserve System and drawee bank identification information

transit routing symbol A U.S. Federal Reserve district number that controls the routing of a check through the banking system.

turnaround documents Any type of transaction requiring the recapture of data.

void The absence of ink within the specified outline of the printed MICR character.

void pantograph A pantograph that produces the word “void” or other warning on a copy of the original.

warrant A form of draft, which in itself is not negotiable, that can be converted into a negotiable instrument. Warrants are considered “cash items” by banks.

waveform reader sorter A device which interprets MICR characters by measuring their magnetic waveforms. These were the first type of MICR reading devices used. An example model of this device is the NCR 6780. These devices are also known as “single slot reader sorters.”

wire side During manufacturing of paper, the pulp mixture is poured onto a screen so that the liquid drains out, leaving only the pulp, which dries to form the paper. The side of the paper that is against the screen is called the wire side. This side has a more pronounced grain, fewer short fibers and less sizing than its opposite (felt) side. Xerography prefers printing on this side of the paper.

wrap pattern A MICR test printing pattern used for ribbon encoding to check for possible wear and tear in the print chain.

write head The device in reader/sorters that magnetizes the ink printed in the clear band area of a MICR document.

Xerographic bond paper Paper specifically designed to work in xerographic copiers, and laser and ionographic printers. They are generally smoother than other types of bonds.

Xerography An imaging process used in copying and printing, where a photoreceptor (usually a drum or a belt) is electrically charged. Mirrors or a laser beam then remove the charge from selected sections of the photoreceptor that are not to be imaged. Afterwards, dry ink is attracted to the charged areas, forming the image to be printed.

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