Kodak digital science™

Document Scanner 9500 with Image Manager

Document Scanner 9500 without Image Manager

Integrator's Guide

A-61124

1 Introduction

This Integrator's Guide contains information that applies to the following Document Scanners:

- *Kodak Digital Science*™ Document Scanner 9500 with the *Kodak Digital Science* Image Manager
- *Kodak Digital Science*™ Document Scanner 9500 without the *Kodak Digital Science* Image Manager

These scanners are high-performance, high-resolution rotary scanners designed for medium- to high-volume digital capture of business documents. The information captured may include printed characters, handwritten text and graphics from documents of various sizes.

Following are some features of the scanner:

Document size:

Length:	2.5 to 30 in. (64 to 762 mm)
Width:	2.5 to 12 in. (64 to 305 mm)
Thickness:	0.0015 to 0.014 in. (0.0381 to 0.36 mm)

Resolution (dpi): 70 to 200
Transport Speed (ips): 24

Resolution (dpi): 210 to 300
Transport Speed (ips): 16

Page images are transmitted to a host computer (via standard SCSI interface) along with an image header which allows for easy indexing, database storage, and retrieval.

About this guide

This Integrator's Guide provides the information needed to use the *Kodak Digital Science* Document Scanner 9500.

You should be familiar with the operation of the scanner. If you are not, refer the Appendix B, *Reference Materials* for a complete listing of available publications.

In addition to this information, the Integrator's Guide contains the following chapters:

- Chapter 2, *Scanning Concepts*, provides an overview of the scanning process.
- Chapter 3, *Image Headers,* provides an overview of the information generated during the scanning process.
- Chapter 4, *Scanner-host Communications*, describes the communications between the scanner and the host system.
- Chapter 5, *The SCSI Interface*, describes the SCSI bus, SCSI commands, SCSI status and message responses and SCSI conformance.
- Chapter 6, *Scanner-unique Commands,* describes the commands used to control the scanner from the host computer.
- Chapter 7, *The Diagnostic Interface (J45/COIN3),* describes the communications between the scanner and an RS-232 terminal that can be used as an interface to receive diagnostic information.
- Appendix A, *Glossary*, provides a list of commonly used terms and definitions pertaining to the scanning environment.
- Appendix B, *Reference Materials,* provides a list of other available publications from Kodak supporting the Document Scanner 9500.
- Appendix C, *Assigning Image Addresses,* defines the fields required for a valid image address.
- Appendix D, *Image Processing Parameter Defaults*, provides default parameter values and recommended image processing parameters.
- Appendix E, *Image Processing,* provides an overview of the image processing capabilities of the scanner/microimager, which are controlled by the host computer and methods for evaluating digitally scanned images.

2 Scanning Concepts

This chapter provides an overview of the scanning process, a discussion of error conditions, and two methods of fault recovery.

Scanning documents

Follow this sequence to scan documents: set up the scanner, enable scanning, initiate polling, feed documents, and disable scanning.

Setup

To set up the scanner:

1. Determine and select the mode (configuration) to be used for the current application.

   The mode may be selected by the host computer using a scanner-unique command (HA), or by the operator using the scanner control panel.

2. Determine if any changes to the Image Processing parameters need to be made for the current application. Execute the required scanner-unique command(s) to make the desired changes.

   Image Processing parameter changes remain in effect until one of the following conditions occur:

   — The scanner is powered down using the main power switch.

   — A SCSI bus device Reset command is executed.

   — A single parameter change is overridden by another change to the same parameter.

3. Set the Sequential ID Number Seed and/or the Next Image Address using a scanner-unique command (DC and HC, respectively), if desired.

4. Calibrate the scanner. For procedures on how to do this, see the *Kodak Digital Science* Scanner 9500, User's Guide.

5. Prepare documents according to the instructions found in the *Kodak Digital Science* Scanner 9500, User's Guide.

Enable scanning

The host must issue a SCSI Scan command (XX) to enable scanning before documents can be transported through the scanner. If scanning has not been enabled, the feeder and transport system will not turn on.

Initiate polling

Initiate host system polling of the scanner to ensure scanned document images are transferred from the image buffer to the host system. Polling should continue until scanning is disabled.

Feed documents

Feed documents according to the instructions found in the *Kodak Digital Science* Document Scanner 9500, User's Guide.

Disable scanning

Scanning is disabled to allow the host to download configuration/ setup changes between jobs and to handle certain types of errors.

Scanning is disabled when one of the following conditions occur:

- The scanner is first powered on using the main power switch.
- A SCSI bus device Reset command is executed.
- An End-of-Job indicator is sent by the operator from the scanner control panel.
- A scanner-unique End-of-Job command (GX) is issued by the host computer.
- An error occurs requiring fault recovery.
- The scanner portion of the machine has not been calibrated.

NOTE: Once scanning has been disabled, documents cannot be scanned until the host enables scanning by issuing a SCSI Scan command.

Error handling

The scanner recognizes and reports a variety of error conditions. Some errors are reported to either the host (via the SCSI interface) or the scanner control panel, while others are reported to both the host and the scanner control panel.

An error (via the SCSI interface) is defined as either a current error or a deferred error.

A current error results from a problem in processing the current SCSI command. This can include sending an invalid command, trying to read from an empty image buffer, or an end-of-job condition. Since one or more errors may be pending at any time, current errors are reported first.

A deferred error results from an error condition within the scanner, such as a document jam. Deferred errors that may have occurred are reported after current errors.

When an error occurs, the host will receive a SCSI Check Condition Status. This indicates to the host that there may be one current error and potentially one or more deferred errors. The host must follow a Check Condition Status with a SCSI Request Sense command. The Sense data will indicate the type of error that has occurred.

To receive subsequent pending errors, the host must execute a SCSI Test Unit Ready command. If a deferred error is pending, the Test Unit Ready command will terminate with a Check Condition Status. The host follows with a SCSI Request Sense command. The combination of Request Sense followed by Test Unit Ready must be repeated until a "good" status is returned on the Test Unit Ready command. A "good" status indicates no errors (current or deferred) are pending.

IMPORTANT: *If at any point the host receives a Check Condition for a command and fails to issue a subsequent Request Sense command, the scanner will clear all (current and deferred) Sense data.*

Some error conditions disable scanning and cause the document transport to stop. These errors are reported on the scanner control panel. This is done to prevent additional images from entering the image buffer while allowing the host to perform fault recovery activities. To aid in fault recovery, the information bytes of the Request Sense data will contain a Sequential ID Number for the approximate image upon which the error occurred.

NOTE: The scanner cannot determine exactly which images were affected by the error and which images were not.

If an error occurs that disables the scanner, the host can continue to read images from the image buffer without enabling the scanner. However, when the image buffer has been emptied, an error will be generated indicating fault recovery is required. This differentiates between an end-of-job disable and a disable caused by an error. The operator may continue scanning documents after the host enables the scanner.

Fault recovery

Fault recovery methods are required when unanticipated circumstances interrupt scanning, such as a document jam. The two methods described below meet the needs of most users. However, other methods may be used.

IMPORTANT: *Before beginning fault recovery, make sure all the images and headers have been transferred from the image buffer to the host system.*

Interactive/online method

Use the Interactive/online method when your primary concern is that the database has no duplicate images.

Follow these steps to use the Interactive/online method:

1. At the host system, search through the most recently scanned files to determine which images have been scanned and transferred.
2. Find the last successfully scanned image. Record the Sequential ID Number and/or the image address assigned to the last successfully scanned image.
3. Sort through the stack of documents being scanned to find the document that produced the last successfully scanned image. You will have to rescan all of the documents that follow the last successfully scanned document.
4. Download the Sequential ID Number and/or the Next Image Address using a scanner-unique command (DC and HC, respectively). The value(s) you download should correspond to the document following the last successfully scanned image.
5. Begin scanning the documents that follow the last successfully scanned document.

Batch/offline method

Use the Batch/offline method when your primary concern is efficient use of time, duplicates in the database do not present a problem, and there is adequate space in the database for the duplicate images (same images with different Sequential ID Numbers and image addresses).

Follow these steps to use the Batch/offline method:

1. Remove the stack of successfully scanned documents from the exit hopper.
2. Take the last three or four documents from the top of the stack and put them into the feed tray or at the top of the next stack of documents.
3. Begin scanning the documents.

3 Image Headers

Image header contents

This chapter provides an overview of the type of information generated during the scanning process, and how to retrieve images and headers.

The scanner collects the following information for each document scanned:

Document number (Sequential ID Number)
The scanner assigns a unique Sequential ID Number to each document. This number may be initialized by the host computer using a scanner-unique command.

Image size
The scanner records the number of bytes required to store the scanned document image.

Document level
The scanner assigns a document level to the scanned document in one of the following ways:

- Press one of the Level Keys (I, II, III) on the control panel.
- Execute function code **F94** (Level 1), **F95** (Level 2), **F96** (Level 3), or **F07** (Level 0).
- Use the Footswitch accessory, if it is installed and enabled.
- Use a patch, if the Patch Reader accessory is installed and enabled.

NOTE: If you do not use one of the methods above to assign a document level, the level will be determined by the mode defaults.

For example, assume the mode defaults assign a Level 2 to a document that follows a Level 3 document; and a Level 1 to a document that follows a Level 2 document. If the last document was assigned a Level 3, then the current document is assigned a Level 2.

Mode
The scanner records the current operating mode that was selected for the application.

Line length
The scanner records the number of pixels-per-line in an image.

Page length
The scanner records the number of lines-per-page in an image.

Image address
The scanner assigns an image address to the scanned document. The image address is based upon the index format defined in the current operating mode and the document level assigned to the document. Refer to Appendix C , *Assigning Image Addresses* for additional information.

Header flags
The scanner records any flags that have been set for special consideration. For example, a document image that may need to go through a quality assurance check can be denoted by setting a flag via the scanner control panel.

There are two types of flags:

- **Latched flags**. A latched flag is enabled and remains set until it is disabled. In this case, the operator can execute function code **F73** and feed a set of documents. A flag is placed in the header of all documents scanned until the operator executes function code **F73** to disable or reset the flag.
- **Momentary flag**. A momentary flag is set only for the next document to be scanned. The operator can execute function code **F74** to momentarily set the flag and feed the document. The flag is automatically reset for the next document.

Compression type
The scanner records the compression type used, which is determined by either the mode definition or by the mode definition override.

Date
The scanner records the date the document is scanned.

Time
The scanner records the time the document is scanned .

Resolution
The scanner records the selected scanned image resolution.

Bit order
The scanner records the selected bit order.

Skew Detection
If the Advanced Document Controller accessory is installed and enabled, the scanner records whether or not a skew error was detected.

Polarity
The scanner records the image polarity.

Bar code header information
If the Bar Code Accessory is installed and enabled and a bar code is detected on the document, the decoded information is included in the image header.

Bar code information can contain a maximum of 106 ASCII characters:

- 80 characters of actual data
- 9 delimiters
- a colon
- 14 bytes of image address information
- a line feed
- a null terminator

Samples:
<Bar Code>:<IA><line feed><null>
<Bar Code 1>;<Bar Code 2>;<Bar Code 3>:<IA><line feed><null>

When using bar code, some situations may require evaluation of Image Header data and, perhaps, manual cleanup of the information contained in the header:

- During normal bar code reading, if a bar code is not decoded properly (i.e., not recognized or only a portion of the code is recognized), the bar code data will not appear in the image header. For example, if there are two bar codes on a document and only the second bar code is read and decoded properly, only the data contained in the second bar code will appear in the image header (making it appear as though only one bar code was placed on the document).
- During partial bar code reading, if a bar code is not decoded (i.e., not recognized or only a portion of the code is recognized), a question mark may appear in the image header. For example, if the start character followed by the minimum number of characters is readable, the image header will contain bar code information (corresponding to what has been successfully read and decoded) followed by a semi-colon (;) and a question mark (?).
- During reading of multiple bar codes, duplicate bar code information may be placed in the header.

Image Deskew Flag
If the image was successfully skew corrected, this flag is set to 1 otherwise this flag is set to 0. This requires the Image Manager.

Skew Angle
The scanner will report the detected skew angle from 0 to 44 degrees independent of whether the image was skew corrected. This requires the Image Manager.

Image header format

The following table gives the position and the format of each piece of data placed in the image header:

Offset	Format	Dynamic Data	Set by Command
7	ASCII-10	Sequential ID Number	DC
27	ASCII-8	Image Size	–
45	ASCII-2	Document Level	–
54	ASCII-2	Mode	HA
71	ASCII-8	Line Length	–
95	ASCII-8	Page Length	–
110	ASCII-9 (Alpha)	Image Address - Fixed Field	–
120	ASCII-10	Image Address - Level 3 Field	–
131	ASCII-10	Image Address - Level 2 Field	–
142	ASCII-10	Image Address - Level 1 Field	–
154	ASCII-2	Momentary Flag	–
156	ASCII-2	Latched Flag	–
165	ASCII-2	Compression Type	FX/Y/Z
175	ASCII-2	Date - Month (1 to 12)	–
177	ASCII-2	Date - Day (1 to 31)	–
179	ASCII-2	Date - Year (00 to 99)	–
189	ASCII-2	Time - Hours (0 to 23)	–
191	ASCII-2	Time - Minutes (0 to 59)	–
193	ASCII-2	Time - Seconds (0 to 59)	–
220	ASCII-3	Resolution	BX/Y/Z
227	ASCII-2	Bit Order	EX
233	ASCII-4	Skew*	–
242	ASCII-2	Polarity	SX/Y/Z
256	ASCII-106	Bar Code Data	–
368	ASCII-2	Image Deskew Flag†	–
375	ASCII-2	Skew Angle†	–

* 0 = No skew warning
1 = Skew warning (if Skew Detection accessory is installed)

† If the Image Manager is installed

NOTES:

- The header created for a rear side image is identical to the header created for a front side image except for the literal value (bytes 0–6); **Front #** is replaced by **Rear #**.
- Each piece of information collected during the scanning process is placed in an image header associated with the scanned document image (two-sided scanning produces two image headers and two images-per-document; one-per-side).
- The image header consists of 512 bytes. The header format is identical for all modes. The format is illustrated on the next page.

Default Image Header Format

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
F	**r**	**o**	**n**	**t**		**#**												**L**	**e**	**n**	**g**	**t**	**h**		**=**				

30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
							L	**e**	**v**	**e**	**l**		**=**					**M**	**o**	**d**	**e**		**=**			**LF**	**L**	**i**	**n**

60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
e		**L**	**e**	**n**	**g**	**t**	**h**		**=**				**=**								**P**	**a**	**g**	**e**		**L**	**e**	**n**	**g**

90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
t	**h**		**=**										**Lf**	**I**	**A**		**=**												**=**

120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149
										=											**=**								

150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
								Lf	**C**	**m**	**p**		**=**					**D**	**a**	**t**	**e**		**=**						

180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209
		T	**i**	**m**	**e**		**-**									**R**	**o**	**l**	**l**		**#**		**=**						

210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
						R	**e**	**s**	**=**					**B**	**O**	**=**				**S**	**K**	**=**						**P**	**0**

240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256		361	362	363
I	**=**			**Lf**	nu	nu	nu	nu	nu	nu	nu	nu	nu	nu	nu	nu	Bar Code Data			nu

364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	...	511
D	**e**	**s**	**=**				**A**	**n**	**g**	**=**				nu	nu	nu	nu	nu

nu = Null (00H)
Lf = Line Feed (0AH)
Blank = Blank (20H)

NOTE: Resolution reported will be actual (rounded to the nearest 10 dpi).

Retrieving images and headers

Headers and images are transferred to the host system via the SCSI Read command. The data can be transferred in one of three forms: header only, image only, or compound image, i.e., header with image. To determine the form, set the transfer type within the SCSI Read command.

The image can be read in one of two ways:

- Read the header, then read the image.
- Read the compound image.

IMPORTANT: *The header should always be read before the image. The header contains information pertinent to the successful transfer of the image, e.g., image size, and should be read prior to reading the image.*

The following table illustrates the results of one Read command followed by another. Assume that Image 1 is followed by Image 2.

Last Transfer	**Requested Transfer**	**Resultant Transfer**
Compound (Header 1 and Image 1)	Compound	Header 2 Image 2
Compound (Header 1 and Image 1)	Header	Header 2
Compound (Header 1 and Image 1)	Image	Image 2*
Header 1	Compound	Header 2** Image 2
Header 1	Header	Header 2**
Header 1	Image	Image 1
Image 1	Compound	Header 2 Image 2
Image 1	Header	Header 2
Image 1	Image	Image 2*

* Note that Header 2 was not transferred. This is not recommended.

** Note that Image 1 was not transferred.

Recommended retrieval methods

The following examples illustrate how to retrieve image headers and images.

To read compound images (image header with image) using packets:

- Perform a SCSI Read asking for 64K bytes of compound data.
- From the header, you find the image is 316,000 bytes long. Assuming the header is 512 bytes long, 65,024 bytes of image were obtained from the first read. That means there are still 250,976 bytes of image to be read.
- Execute three more 64K-byte SCSI Read commands asking for compound data to obtain a total of 261,632 (196,608 + 65,024) bytes of image data.
- Execute a SCSI Read requesting 54,368 bytes of data.

To read the header and then read the image:

- Perform a SCSI Read asking for 512 bytes of header data.
- From the header, you find the image is 316,000 bytes long.
- Execute a SCSI Read asking for 316,000 bytes of image data.

4 Scanner — Host Communications

This chapter provides an overview of the communication link between the scanner and the host system. Communications between the scanner and the host system occur across a SCSI bus. The SCSI interface supports two-way command/data communication between the scanner and the host system. The SCSI-2 command set is supported.

Host to scanner communications

The host transmits machine setup information to the scanner using both the SCSI Define Windows command and the SCSI Send command. The SCSI Define Windows command is used to set up image processing parameters such as resolution, threshold, contrast, etc.

The SCSI Send command transmits scanner-unique commands. These allow settings of both image processing parameters and machine configuration. These commands are embedded within the Send command as data and can be identified by the 2-byte, scanner-unique command field. A series of scanner-unique commands may be sent as one data string within a single Send command.

Scanner to host communications

The scanner transmits digitized images to the host via the SCSI interface using the SCSI Read command.

The scanner is capable of transmitting current image processing setup information using the SCSI Get Windows command. Additionally, the scanner can transmit both image processing and configuration information using the SCSI Read command .

SCSI data rates

The *Digital Science* Document Scanner 9500 has a SCSI controller which is capable of faster SCSI transfer rates. It is capable of operating at a sustained maximum data transfer rate of 7 megabytes-per-second. Actual data transfer rate is a function of the host system configuration.

5 The SCSI Interface

This chapter describes the SCSI interface used with the scanners.

For complete information on the appropriate SCSI specification, refer to SCSI-2 Working Draft ANSI X. 131-198X, Revision 6, 10/29/88.

SCSI overview

The SCSI interface provides a means of communication between a maximum of eight computer and peripheral devices, giving the host computer independence within this system. As a result, tape drives, printers, optical disks, communications devices, etc., can be added to the host computer(s) without requiring modification to the generic system hardware or software. The interface uses "logical" rather than "physical" addressing for all data structures.

SCSI bus

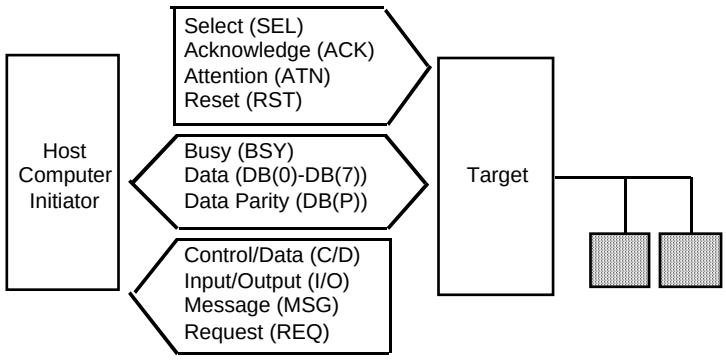
The SCSI bus allows communication between any two SCSI devices at a time. When two SCSI devices communicate on the bus, one acts as an initiator and the other acts as a target. The initiator is usually a host computer that originates operations, and the target is usually a peripheral controller that performs the operation. A SCSI device generally has a fixed role as an initiator or target, but some may assume either role. The scanner acts only as a SCSI target.

Access to the SCSI bus is handled through bus arbitration. The SCSI device with the highest priority (as determined by its SCSI ID bit) is given control of the bus. The SCSI device with an ID of 7 is the highest priority device. The initiator then selects a target and the target controls all further communications. Data transfers on the bus are asynchronous and follow a Request/Acknowledge handshake protocol. One 8-bit byte of information is transferred to the initiator with each handshake.

NOTE: The amount of time required to execute the SCSI commands is affected by the number of peripheral devices on the bus, as well as the priorities assigned to each peripheral device. Therefore, the amount of time required to execute the SCSI commands will vary based upon the system configuration. It is recommended that a dedicated host adapter be used with the scanner.

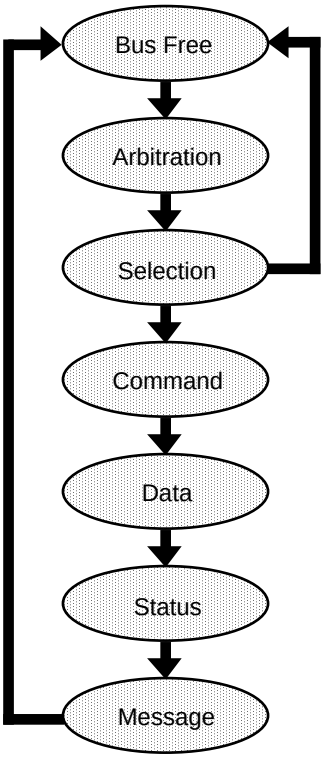
SCSI interface signal lines

The SCSI interface uses 18 signal lines:



Issuing SCSI commands

There are seven steps or phases for issuing commands to the scanner or controller:



Bus Free phase — the SCSI bus is not being used by an initiator (host computer) or the target (scanner). No signals on the bus are asserted.

Arbitration phase — an essential phase in a multi-host environment with multiple initiators. In this phase, multiple initiators compete for control of the bus. Only one initiator can have control of the bus at a time. The initiator asserts the BSY signal, simultaneously this initiator outputs its own SCSI ID bit to the SCSI bus. The initiator with the highest SCSI ID will win the arbitration and assert the SEL (select) signal. If the initiator does not win the arbitration, it will revert to the Bus Free phase.

Selection phase — software connections are established between an initiator and a target device. The initiator selects the target device by asserting the ID bit of the selected device and its own ID bit. The initiator then de-asserts the BSY signal, selecting the target device.

Command phase — the initiator issues a command to the target device. Commands are transmitted in a fixed format of 6, 8, or 10 consecutive bytes. Each command is distinguished by a unique op code.

Data phase — data will be exchanged between the initiator and the target device after the specific commands are executed.

There are two types of data phases:

- Data-In, where the data is transmitted from the target device to the initiator, or
- Data-Out, where the data is transmitted from the initiator to the target device.

Status phase — a status code is returned from the target to the initiator indicating the status in which the command terminated. Occasionally, the system enters the Status phase from the Command phase. Refer to the section entitled, “SCSI status responses” later in this chapter.

Message phase — messages will be exchanged between the initiator and the target device. A message is transmitted from the target device to the initiator, indicating the completion of a command. Refer to the section entitled, “SCSI message responses” later in this chapter.

SCSI status responses

In the SCSI communication mode, a function is considered incomplete until a valid status response is received from the other end of the SCSI link. There are three valid SCSI status responses:

Status Response	Code	Meaning
Good Status	00H	The frame was successfully received and individual fields within the frame contained legal characters.
Check Condition Status	02H	A special condition occurred. A SCSI Request Sense command is required to obtain information about the cause of the condition. Some host adapters automatically perform a Request Sense command.
Busy Status	08H	Target is unable to accept commands at the present time. Host should try again. The host should wait a minimum of 100 milliseconds before trying again.

NOTE: "H" in the list above indicates hexadecimal notation.

SCSI message responses

Message	Code	Direction	Function/Action	SCSI Spec Ref
Command Complete	00H	scanner->host	Scanner indicating the I/O process is completed and a valid status has been sent.	Section 5.6.5
Initiator-Detected Error	05H	host->scanner	Scanner continues current I/O process.	Section 5.6.11
Abort	06H	host->scanner	Scanner terminates current I/O process.	Section 5.6.1
Message Reject	07H	host->scanner	Scanner continues current I/O process.	Section 5.6.15
Message Reject	07H	scanner->host	Scanner rejected current I/O process.	Section 5.6.15
No Operation	08H	host->scanner	Scanner continues current I/O process.	Section 5.6.17
Message Parity Error	09H	host->scanner	Scanner continues current I/O process.	Section 5.6.14
Bus Device Reset	0CH	host->scanner	Scanner terminates current I/O process and performs a hard reset.	Section 5.6.3
Identify	80H	host->scanner	Scanner retains Logical Unit Number sent and moves to the Command phase.	Section 5.6.8
Extended Message	01H	host->scanner	Scanner transfers remaining message bytes and sends a Message Reject. Synchronous Data Transfers are not supported.	Section 5.5

NOTE: "H" in the list above indicates hexadecimal notation.

SCSI conformance

The scanner conforms to the SCSI specifications as follows:

- Single-ended, 8-bit bus, Cable A, shielded connector (Alternative 2). Cable B is not supported.
- Single-initiator (one host) is supported. Disconnect and Reselect are not supported.
- Asynchronous maximum transfer rate of 1.2 M Bytes per second.
- Linked commands and command queuing are not supported.
- Programmable target ID dip switch is factory set to 1.
- RST signal reset is only monitored. See the hard reset alternative in SCSI Specifications (Section 5.2.2.1).
- The scanner supports Unit Attention condition following power-up, SCSI bus device reset command or hard reset. Refer to Section 6.13 of SCSI Specifications.
- The scanner operates as a target.
- The internal SCSI cable consumes 5 feet (1.5 meters) of the maximum cable length allowed (19.7 feet/6 meters).
- The scanner provides termination power.

SCSI commands

This section lists the SCSI commands that the scanner supports. Information for each command includes:

- Command format operation codes (op codes).
- Section numbers to reference in the SCSI-2 Specifications.
- Command block descriptor.
- Command specifics (parameters).

SCSI command summary

Command	Page Number	Command Op Code
Define Window Parameters	5-8	24H
Get Window	5-12	25H
Inquiry	5-17	12H
Read	5-19	28H
Release Unit	5-20	17H
Request Sense	5-21	03H
Reserve Unit	5-24	16H
Scan	5-24	1BH
Send	5-25	2AH
Test Unit Ready	5-27	00H

Define Window Parameters command

Command op code: 24H
SCSI Specification: Section 14.2.1

Command block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (24H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB) Transfer Length							
7								
8								(LSB)
9	Vendor Unique		Reserved				Flag	Link

NOTE: For single-sided documents, a single Define Window Parameters command should be sent. For two-sided documents, two Define Window Parameters commands should be sent; one containing information for the front and one containing information for the rear.

Define Window Parameters header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB) Window Descriptor Length							
7								(LSB)

Define Window Parameters header data

Descriptor	Data	Definition
Window Descriptor Length	= 46	Length of a single window descriptor.

Define Window descriptor bytes

Bit Byte	7	6	5	4	3	2	1	0
0	Window Identifier							
1	Reserved							
2	(MSB)	X Resolution						
3								(LSB)
4	(MSB)	Y Resolution						
5								(LSB)
6	(MSB)							
7		Upper Left X						
8								
9								(LSB)
10	(MSB)							
11		Upper Left Y						
12								
13								(LSB)
14	(MSB)							
15		Width						
16								
17								(LSB)
18	(MSB)							
19		Length						
20								
21								(LSB)
22	Brightness							
23	Threshold							
24	Contrast							
25	Image Composition							
26	Bits Per Pixel							
27	(MSB)	Halftone Pattern						
28								(LSB)
29	RIF	Reserved				Padding Type		
30	(MSB)	Bit Ordering						
31								(LSB)
32	Compression Type							
33	Compression Argument							
34... 39	Reserved							
40	Image Enhancement Filter							
41	Noise Filter							
42	Reserved						Allow 0	No Scan
43	Reserved							
44	Reserved						Border reduction	Deskew
45	Reserved							

Define Window Parameters data

Descriptor	Data	Definition
Window Identifier	= SFFFFF00	S=Side (0-Front, 1-Rear) FFFFF=Mode (0-18)
Auto	= 0	Auto windows not supported
X Resolution	= 0 = 70 to 300	If zero, will default to 200 dpi Document Scanner 9500
Y Resolution	=	Defaults to X resolution
Upper Left X †	= 0 to 14400*	0 to 12 inches (0 to 304.8 mm)
Upper Left Y †	= 0 to 24000*	0 to 20 inches (0 to 508 mm)
Width †	= 0,96 to 14400*	0 or 0.08 to 12 inches (2 to 304.8 mm)
Length †	= 0,96 to 36000*	0 or 0.08 to 30 inches (2 to 762 mm)
Brightness	= 0	Automatic brightness not supported
Threshold	= 0, 1 to 255	When zero and "Allow Zero for Threshold & Contrast" is zero, return to default value
Contrast	= 0, 1 to 255	Percentage of adaptive threshold. When zero, and "Allow Zero for Threshold & Contrast" is zero, return to default value
Image Composition	= 00H, 01H	00H = Bi-level (default) 01H = Dithered (see halftone pattern)
Bits per Pixel	= 1	Only one bit available (8 bits internal)
Halftone Pattern	= 0 to 7**	**ATP On:** 0 = 2-level screen (no screen) **ATP Off:** 1 = 16-level screen 2 = 32-level screen 3 = 64-level screen 4 = 3-level screen 5= 4-level Bayer dither 6= 16-level Bayer dither 7= 64-level Bayer dither
RIF	= 0, 1	0 = zero white, one black 1 = zero black, one white (default)
Padding Type	= 00H	Pad with 0s cannot be disabled

* Measurement unit for scan region parameters is 1/1200 inch (0.0212 mm).

** Image Composition	Halftone Pattern	Result
00	any	Halftone Pattern -> 0
00	0	No dithering (ATP or fixed threshold)
01	any	Dither using specified halftone pattern
01	0	Image Composition -> 0

† If the *Digital Science* Image Manager is installed and enabled and all four parameters are 0, auto-cropping is selected. If the *Digital Science* Image Manager is not installed and enabled, 0000 should not be used.

Descriptor	Data	Definition
Bit Ordering	= 0000H 0001H	Always scans left to right, top to bottom Data packing within a byte (bit ordering) is selectable: 0000H=msb/right;lsb/left 0001H=msb/left;lsb/right (default)
Compression Type	= 00H, 01H, 02H, 03H	00H = no compression 01H = TSS Group III, 1-dimensional 02H = TSS Group III, 2-dimensional 03H = TSS Group IV
Compression Argument	= 000 - 255	K-parameter value for TSS Group III, 2-Dimensional
Image Enhancement Filter	= 0, 2, 3 = 1	0, 2, 3 = no filter (all pass) 1 = halftone removal
Noise Filter	= 0, 1, 2	0 = no filter 1 = remove lone pixels 2 = majority rule
Allow Zero for Threshold & Contrast	= 0 = 1	When zero is entered for threshold or contrast, use default. When zero is entered for threshold or contrast, use zero.
No Scan	= 0 = 1	No scan off (scanning enabled) No scan on (scanning disabled)
Border Reduction	= 0 = 1	Border Reduction Disabled Border Reduction Enabled
Deskew	= 0 = 1	Skew Correction Disabled Skew Correction Enabled

Get Window command

Command op code: 25H
SCSI Specification: Section 14.2.2

Command block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (25H)							
1	Logical Unit Number			Reserved				Single
2	Reserved							
3	Reserved							
4	Reserved							
5	Window Identifier							
6	(MSB)							
7	Transfer Length							
8								(LSB)
9	Vendor Unique			Reserved			Flag	Link

Get Window data

Descriptor	Data	Definition
Single	= 0	Window descriptors are returned for the current mode with any temporary overrides and all 18 saved modes. For a duplex machine, 38 windows are sent. For a simplex machine, 19 windows are sent.
	= 1	A single window descriptor will be returned as specified by the window identifier.
Window Identifier	= SFFFF00	S=Side (0-Front, 1-Rear) FFFFF=Mode (0-18)

Get Window Parameters header

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)			Window Data Length				
1								(LSB)
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	(MSB)			Window Descriptor Length				
7								(LSB)

Get Window Parameters header data

Descriptor	Data	Definition
Window Data Length	= 54 882 1756	The value is equal to the data header, not including the window data length (8 bytes) plus the number of windows multiplied by the window descriptor length single window = 46 bytes all windows/simplex = 874 bytes all windows/duplex = 1748 bytes
Window Descriptor Length	= 46	Length of a single window descriptor

Get Window descriptor bytes

Bit/Byte	7	6	5	4	3	2	1	0
0	Window Identifier							
1	Reserved							
2	(MSB)			X Resolution				
3								(LSB)
4	(MSB)			Y Resolution				
5								(LSB)
6	(MSB)							
7				Upper Left X				
8								
9								(LSB)
10	(MSB)							
11				Upper Left Y				
12								
13								(LSB)
14	(MSB)							
15				Width				
16								
17								(LSB)
18	(MSB)							
19				Length				
20								
21								(LSB)
22	Brightness							
23	Threshold							
24	Contrast							
25	Image Composition							
26	Bits Per Pixel							
27	(MSB)			Halftone Pattern				
28								(LSB)
29	RIF	Reserved				Padding Type		
30	(MSB)			Bit Ordering				
31								(LSB)
32	Compression Type							
33	Compression Argument							
34..39	Reserved							
40	Image Enhancement Filter							
41	Noise Filter							
42	No Scan						Allow 0	No Scan
43	Reserved							
44	Reserved						Border reduction	Deskew
45	Reserved							

Get Window Parameters data

Descriptor	Data	Definition
Window Identifier	= SFFFFF00	S=Side (0-Front, 1-Rear) FFFFF=Mode (0-18)
Auto	= 0	Auto windows not supported
X Resolution	= 70 to 300	Document Scanner 9500
Y Resolution	=	
Upper Left X †	= 0 to 14400*	0 to 12 inches (0 to 304.8 mm)
Upper Left Y †	= 0 to 24000*	0 to 20 inches (0 to 508 mm)
Width †	= 0,96 to 14400*	0, 0.08 to 12 inches (2 to 304.8 mm)
Length †	= 0,96 to 36000*	0, 0.08 to 30 inches (2 to 762 mm)
Brightness	= 0	Automatic brightness not supported
Threshold	= 0 to 255	
Contrast	= 0 to 255	
Image Composition	= 00H, 01H	00H = Bi-level (default) 01H = Dithered (see halftone pattern)
Bits per Pixel	= 1	Only one bit available (8 bits internal)
Halftone Pattern	= 0 to 7**	**ATP On:** 0 = 2-level screen (no screen) **ATP Off:** 1 = 16-level screen 2 = 32-level screen 3 = 64-level screen 4 = 3-level screen 5 = 4-level Bayer Dither 6 = 16-level Bayer Dither 7 = 64-level Bayer Dither
RIF	= 0, 1	0 = zero white, one black 1 = zero black, one white (default)
Padding Type	= 00H	Pad with 0s cannot be disabled
Bit Ordering	= 0000H 0001H	Always scans left to right, top to bottom Data packing within a byte (bit ordering) is selectable: 0000H=msb/right;lsb/left 0001H=msb/left;lsb/right (default)
Compression Type	= 00H, 01H, 02H, 03H	00H = no compression 01H = TSS Group III, 1-Dimensional 02H = TSS Group III, 2-Dimensional 03H = TSS Group IV
Compression Argument	= 000 - 255	K-parameter value for TSS Group III, 2-Dimensional
Image Enhancement Filter	= 0, 2, 3 = 1	0, 2, 3 = no filter (all pass) 1 = halftone removal

* Measurement unit for scan region parameters is 1/1200 inch (0.0212 mm).

** Halftone Pattern is automatically set to 0 if Image Composition is 0.

† If all four parameters are zero, auto-cropping is selected.

Descriptor	Data	Definition
Noise Filter	= 0, 1, 2	0 = no filter 1 = remove lone pixels 2 = majority rule
No Scan	= 0 = 1	No scan off (scanning enabled) No scan on (scanning disabled)
Border Reduction ‡	= 0 = 1	Border Reduction disabled Border Reduction enabled
Skew Correction	= 0 = 1	Skew Correction enabled Skew Correction disabled

‡ Status indicated is the requested state. If auto-cropping is enabled, Border Reduction is ignored. See the Y/X/Y/Z Command description.

Inquiry command

Command op code: 12H
SCSI Specification: Section 7.2.5

Command block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (12H)							
1	Logical Unit Number			Reserved				EVPD
2	Page Code							
3	Reserved							
4	Allocation Length							
5	Vendor Unique		Reserved				Flag	Link

EVPD = 0 Not supported
Page Code = 0 Not supported
Allocation Length = 0 - 56 If greater than 56 is specified, only 56 bytes will be returned

Inquiry descriptor bytes

Bit Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Peripheral Device Type				
1	RMB	Device-Type Qualifier						
2	ISO Version		ECMA Version			ANSI-Approved Version		
3	AENC	Reserved			Response Data Format			
4	Additional Length							
5	Reserved							
6	Reserved							
7	RelAdr	WBus32	WBus16	Sync	Linked	Reserved	Cmd Queue	Soft Reset
8...	(MSB)	Vendor Identification						
...15								(LSB)
16...	(MSB)	Product Identification						
31								(LSB)
32...	(MSB)	Product Revision Level						
...35								(LSB)
36	Reserved (Front Side Accessories - 1)							
37	Reserved (Front Side Accessories - 2)					Image Manager Front	400 dpi Front	ATP-Front
38	Reserved (Rear Side Accessories - 1)							
39	Reserved (Rear Side Accessories - 2)					Image Manager Rear	400 dpi Rear	ATP-Rear
40...	Reserved (Vendor Specific)							
...55								

Inquiry data

Descriptor	Data	Definition
Peripheral Qualifier	000b	
Peripheral Device	06H	Scanner device
Remove Medium	0b	Not removable
Device-Type Modifier	01H 02H	Simplex (front only) Duplex (front and rear)
ISO Version	0	No compliance claims
ECMA Version	0	No compliance claims
ANSI Version	2H	ANSI X3.131
Asynchronous Event Notification Capability	0	Set by initiators only
Response Data Format	2H	ANSI X3.131
Additional Length	33H	Additional bytes of inquiry data
Relative Addressing	0	Not supported
WBus32	0	32-bit wide transfers not supported
WBus16	0	16-bit wide transfers not supported
Sync	0	Synchronous transfers not supported
Linked	0	Linked commands not supported
CmdQue	0	Command queuing not supported
SftRes	0	RESET condition causes hard reset
Vendor Identification	KODAK␢␢␢	Kodak
Product Identification	DS␢Scanner␢9500␀	Document Scanner 9500
Product Revision	Current Version	Current version
Adaptive Threshold Processor Front	0 1	Front ATP not available Front ATP available
Adaptive Threshold Processor Rear	0 1	Rear ATP not available Rear ATP available
400 dpi Front	0 1	400 dpi not available Front 400 dpi available
400 dpi Rear	0 1	400 dpi not available Rear 400 dpi available
Image Manager Functions — Front*	0 1	Front Image Manager Functions not available Front Image Manager Functions available
Image Manager Functions — Rear*	0 1	Rear Image Manager Functions not available Rear Image Manager Functions available

␢ = blank
␀ = null
* Image Manager functions will **both** either be available or not available with duplex.

Read command

Command op code: 28H
SCSI Specification: Section 14.2.5

Command block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (28H)							
1	Logical Unit Number			Reserved				RelAdr
2	Transfer Data Type							
3	Reserved							
4	(MSB)	Transfer Identification						
5								(LSB)
6	(MSB)	Transfer Length						
7								
8								(LSB)
9	Vendor Unique		Reserved				Flag	Link

Read data

Descriptor	Data	Definition
Logical Unit Number	= 0	Only one logical unit
RelAdr	= 0	Not supported
Transfer Type	= 00 = 80 = 81 = 82	Image Data (raster data) Scanner-unique command Header Compound Image (header, raster)
Transfer ID	= 0 = Scanner Unique	Not used when Transfer Type is 00, 81, or 82 When Transfer Type is 80, this field is used for a scanner-unique command.
Command Transfer Length	= length	Maximum number of blocks (block size = 1 byte) to transfer. NOTE: If Transfer Type = 80, use 128*

If the quantity of data is less than the transfer length blocks, Check Condition Status is returned. Incorrect Length Indicator (ILI) will be returned to the Request Sense that follows.

When performing continuous read commands, if a Check Condition returns an indication the buffer is empty (sense key = B, sense code = 80, and sense qualifier = 02), delay subsequent read commands by at least 100 milliseconds.

* For scanner-unique commands, a transfer length of 128 is recommended. The command string is filled with nulls to a length of 128, ensuring the host receives the data without generating a Check Condition for incorrect length.

Release Unit command

Command op code: 17H
SCSI Specification: Section 14.2.6

Command block descriptor

This command is not fully implemented. A Good Status will be returned if it is executed.

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (17H)							
1	Logical Unit Number			3rdPty	Third Party Device			Reserved
2	Reserved							
3	Reserved							
4	Reserved							
5	Vendor Unique		Reserved				Flag	Link

Request Sense command

Command op code: 03H
SCSI Specification: Section 7.2.15

Command block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (03H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Vendor Unique		Reserved				Flag	Link

Request Sense descriptor bytes

Bit Byte	7	6	5	4	3	2	1	0
0	Valid	Error Code						
1	Segment Number							
2	Filemark	EOM	ILI	Reserved	Sense Key			
3	Information Bytes							
4								
5								
6								(LSB)
7	Additional Sense Length							
8	(MSB) Command-Specific Information							
9								
10								
11								(LSB)
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	FRU #							
15	SKSV	Sense Key Specific						
16								
17								

Request Sense data

Descriptor	Data	Definition
Valid	= 1	Data is always valid
Error Code	= 70H = 71H	Current Error Deferred Error
Segment Number	= 0	Not used
Filemark	= 0	Not valid
EOM	= 0	Not valid
ILI	= 0 = 1	No Incorrect Length Incorrect Length Indicator is on
Sense Key	= 00H = 01H = 02H = 04H = 05H = 06H = 0BH = 0DH	No Sense or Incorrect Length Recovered error Not ready Hardware error Illegal request Unit Attention Aborted Command Volume overflow (buffer overflow)
Information Bytes	= residue = image #	Difference between the requested bytes and the actual bytes of data received (when ILI is on) Sequential Image ID Number of approximate image where Check Condition occurred
Additional Length	= 10	Additional bytes of sense data (17–7)
Cmd Spec Info	= 0	Not used
Additional Sense Code, Qualifier	=	See “Request Sense data” section
FRU#	=	Field Replaceable Unit
SKSV	=	Not used
Sense Key Specific	=	Not used

Sense Key	Additional		Description	Info	Scanner Disabled			Stop Trans	Error
	Sense Code	Sense Qualifier		Bytes Seq. Id#	Recovery Required	Fatal Error	Calibration Required		Control Panel
0	00	00	No additional information						
5	20	00	Invalid command operation code						
5	20	80	Invalid scanner-unique command						
5	20	82	Invalid scanner-unique command — unknown error						
5	20	83	Invalid scanner-unique command — unknown command						
5	20	84	Scanner-unique command executed at wrong time						
5	20	85	Invalid scanner-unique command — bad data						
5	20	86	Invalid scanner-unique command — wrong model						
5	20	87	Invalid scanner-unique command — accessory not available						
5	20	88	Internal communications failure during scanner-unique command processing						
5	20	89	Internal processor failure during scanner-unique command processing						
5	24	00	Invalid parameter in Command Data Block (CDB)						
5	25	00	Unsupported Logical Unit						
6	29	00	Power-on Reset						
4	47	00	Parity Error on SCSI						
4	4C	00	Logical Unit Failed Self-configuration — front	*		*			E721
4	4C	00	Logical Unit Failed Self-configuration — rear	*		*			E722
2	80	00	No data — End-of-Job condition		Scanner disabled due to end key				
2	80	01	No data — Fault recovery condition		Scanner disabled due to previous error				
B	80	02	No data - Buffer empty						
D	81	00	Buffer Fault — Full	*	*			*	E701
D	81	00	Buffer Fault — Front Compression Error	*	*			*	E715
D	81	00	Buffer Fault — Rear Compression Error	*	*			*	E716
D	81	01	Buffer Fault —- Document Queue Full	*	*			*	E297
4	81	02	Front Image Lost (document record without page detect)	*	*			*	E702
4	81	12	Rear Image Lost (document record without page detect)	*	*			*	E703
4	81	03	Front Queue Error (document count out of sync)	*				*	E705
4	81	13	Rear Queue Error (document count out of sync)	*				*	E706
4	82	00	Machine Error —- Fault recovery required	*	*			*	many
4	83	00	Low Contrast Failure — black, front	*	*			*	E292
4	83	10	Low Contrast Failure — black, rear	*	*			*	E292
4	84	01	Calibration Failure — ARC, front				*		E713
1	84	02	Calibration Failure — dead pixels, front						E294
1	84	03	Calibration Failure —- hot pixels, front						E294
1	84	04	Calibration Failure — low lamps, front (scan camera)						E110
1	84	04	Calibration Failure — low lamps, front (DSA)						E208
4	84	05	Calibration Failure — target not seen, front				*		E296
4	84	11	Calibration Failure — ARC, rear				*		E714
1	84	12	Calibration Failure — dead pixels, rear						E295
1	84	13	Calibration Failure — hot pixels, rear						E295
1	84	14	Calibration Failure —- low lamps, rear (scan camera)						E111
1	84	14	Calibration Failure — low lamps, rear (DSA)						E209
4	84	15	Calibration failure — target not seen, rear				*		E296
4	85	00	Board failure (AIP, PC, IM Checksum or IM Runtime)	*		*			E710
4	85	00	Board failure (Front Buffer Parity Error)						E718
4	85	00	Board failure (Rear Buffer Parity Error)						E719
4	85	00	Board failure (SCSI Init Error)	*		*			E709

Reserve Unit command

Command op code: 16H
SCSI Specification: Section 14.2.6

Command block descriptor

This command is not fully implemented. A Good Status will be returned if it is executed.

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (16H)							
1	Logical Unit Number			3rdPty	Third Party Device			Reserved
2	Reserved							
3	Reserved							
4	Reserved							
5	Vendor Unique		Reserved				Flag	Link

Scan command

Command op code: 1BH
SCSI Specification: Section 14.2.7

Command block descriptor

Transfer length must be set to zero.

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1BH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Transfer Length							
5	Vendor Unique		Reserved				Flag	Link

Send command

Send is required when executing scanner-unique commands.

Command op code: 2AH
SCSI Specification: Section 14.2.8

Command block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2AH)							
1	Logical Unit Number			Reserved				RelAdr
2	Transfer Data Type							
3	Reserved							
4	Transfer Identification							
5								(LSB)
6	(MSB) Transfer Length							
7								
8								(LSB)
9	Vendor Unique		Reserved				Flag	Link

Send data

Descriptor	Data	Definition
Logical Unit Number	= 0	Only one logical unit
RelAdr	= 0	Not supported
Transfer Type*	= 80	Scanner-unique command
Transfer ID	= 0	Not used
Transfer Length*	= length	Maximum number of bytes to transfer

*The maximum number of bytes which can be transferred is 256.

Using the Send command for scanner-unique commands

Scanner-unique commands may be sent to the scanner during the Data Transfer phase of a SCSI Send command.

IMPORTANT: *The Transfer Type field must be set to 80H.*

The following tables illustrate how a scanner-unique DA command with a data field of 345.6 would be sent:

Command block

Byte Number	Description	Hexadecimal Value
0	Operation Code = Send	2AH
1	Logical Unit Number = 1 and Reserved = 0	20H
2	Transfer Type = Scanner-Unique Command	80H
3	Reserved = 0	00H
4	Transfer Identification (MSB) = not used	00H
5	Transfer Identification (LSB) = not used	00H
6	Transfer Length (MSB) = 0	00H
7	Transfer Length = 0	00H
8	Transfer Length (LSB) = 7	07H
9	Vendor Unique, Reserved, Flag, Link = 0	00H

Information sent during Data Transfer phase:

Byte Number	Description	Hexadecimal Value
0	Scanner-unique Data Field = 3	33H
1	Scanner-unique Data Field = 4	34H
2	Scanner-unique Data Field = 5	35H
3	Scanner-unique Data Field = .	2EH
4	Scanner-unique Data Field = 6	36H
5	Scanner-unique Command Field = D	44H
6	Scanner-unique Command Field = A	41H
7	Transfer Length (MSB) = 0	00H

Test Unit Ready command

Command op code: 00H
SCSI Specification: Section 7.2.17

Command block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (00H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Vendor Unique		Reserved				Flag	Link

6 Scanner-unique Commands

This chapter provides information about the scanner-unique commands used for communication and data exchange between the scanner and host system.

Scanner-unique commands, which are used to establish or change the scanner configuration can be executed by sending a SCSI Send command (with the Transfer Type set to 80H) from the host system.

The host may query the scanner to determine the current scanner configuration by executing a SCSI Read command with the Transfer ID set to the 2-byte scanner-unique command. The scanner will return the data field value and the scanner-unique command as data for the Read command.

Scanner-unique command format

The scanner-unique command format is used to exchange commands and data between the scanner and host. The scanner-unique command format is described below.

Data Field	Command Field

Data Field — contains numerical data (in ASCII format) and ASCII character strings. It is variable in length.

Command Field — contains two bytes of upper-case alphabetic ASCII characters that represent a unique scanner command. The second command character received in a command sequence indicates an End-of-Frame condition has been reached.

The following example shows how to create a scanner-unique command:

This command transmits the numerical value 345.6 with scanner-unique command DA.

HEX	33	34	35	2E	36	44	41
CHAR	3	4	5	.	6	D	A

NOTES:

- One or more of the scanner-unique commands may be sent using the SCSI Send command.
- A command requiring a data field is not accepted by the scanner without the data field.
- Do not add leading zeros to parameters unless instructed to do so for a particular command.
- Limited auditing of the data fields is performed. Invalid data in a data field may cause unexpected results.

Command summary

The following table provides a summary of all available scanner-unique commands. Detailed descriptions of each command appear on the pages indicated.

Machine Level Commands	Description	Command	May be used with:		Page
			SCSI Send	SCSI Read	
Setup	Bit Order	EX	Yes	Yes	6–6
	Count Only Mode	MC	Yes	No	6–11
	Sequential ID Initiator	DC	Yes	No	6–5
	Define Mode	JA	Yes	No	6–9
	Set Mode	HA	Yes	No	6–8
	Last Image Address	GC	No	Yes	6–7
	Level of Next Document	NF	Yes	No	6–12
Control	Clear Buffers	CX	Yes	No	6–5
	End of Job	GX	Yes	No	6–8
	Next Image Address	HC	Yes	No	6–8
Mode Level Commands	**Description**	**Command**	**May be used with:**		**Page**
			SCSI Send	**SCSI Read**	
Scanner Configuration	No Scan	DX	Yes	Yes	6–6
	Simplex/Duplex Status	TX	Yes	Yes	6–13
Image Processing Commands	Border Reduction	YX/Y/Z	Yes	Yes	6–14
	Compression	FX/Y/Z	Yes	Yes	6–7
	Cropping/Auto-Cropping	AX/Y/Z	Yes	Yes	6–4
	Dither Pattern (Screen)	LX/Y/Z	Yes	Yes	6–11
	Image Enhancement Filter	MX/Y/Z	Yes	Yes	6–12
	Noise Filter	NX/Y/Z	Yes	Yes	6–12
	Reverse Image	SX/Y/Z	Yes	Yes	6–13
	Scan Contrast	KX/Y/Z	Yes	Yes	6–11
	Scan Resolution	BX/Y/Z	Yes	Yes	6–5
	Scan Threshold	JX/Y/Z	Yes	Yes	6–10
	Skew Correction	WX/Y/Z	Yes	Yes	6–14

NOTE: Image processing parameter defaults vary from mode to mode. Refer to *Appendix D, Image Processing Parameter Defauults* to determine the default(s).

There are three types of image processing commands:

- X commands affect both front and rear scanning.
- Y commands affect only front scanning.
- Z commands affect only rear scanning.

When using SCSI Send:
For duplex scanners, all three types of commands may be used.
For simplex scanners, only the Y command type may be used.

When using SCSI Read:
Use only the Y and Z command types.

Commands

Each scanner-unique command is described in this section. The command descriptions appear in alphabetical order.

AX/Y/Z Cropping/ Auto Cropping

The AX/Y/Z command defines the scan window (cropping parameters) to be used for the current mode.

Data Field				Command Field	
xs3...xs0	xl3...x10	ys3...ys0	yl3...yl0	A	X/Y/Z

Data Field	Description	Value(s)
xs3...xs0	Start location for left side of scanning window — ASCII 4 bytes	0000–1200**
xl3...xl0	Width of the scanning window — ASCII 4 bytes	0000–1200**
ys3...ys0	Top of the scanning window — ASCII 4 bytes	0000–2000**
yl3...yl0	Length of the scanning window — ASCII 4 bytes	0000–3000*,**

* This command accepts 3000 (30 inches). The maximum document length is 30 inches with a compressed image file size less 2 Mbytes.

** If all data fields are 0000, auto-cropping is selected if the *Digital Science* Image Manager is installed and enabled. If the *Digital Science* Image Manager is not installed, 0000 should not be used.

NOTES:

- Leading zeros are required. All values entered should be decimal values, to the nearest 0.01-inch (i.e., if the start location is to be 2 ¾ inches from the left margin, enter 0275). The scanner automatically rounds each value entered to the nearest 0.08-inch (xs, xl and ys fields) or to the nearest 0.08-inch plus one line for the yl field.
- The sum of xs and xl cannot exceed 1200.
- Document length checking (see the User's Guide) is not available for lengths greater than 20 inches.

BX/Y/Z — Scan resolution

The BX/Y/Z command defines scanning resolution for the current mode.

Data Field	Command Field	
res	B	X/Y/Z

Data Field	Description	Value(s)
res	scan resolution in dots per inch	70 to 300*

* Values must be specified in increments of 10 dpi. If not, values will be rounded to the nearest 10 dpi by the scanner.

NOTE: Leading zeros are not permitted.

CX — Clear buffers

The CX command resets the image buffer and initializes the Sequential ID Number to 1. This command is intended for use only during integration testing and should **not** be used in a production scanning application.

IMPORTANT: *Executing the CX command may cause images in the buffer to be lost. Similarly, if the command is executed while there are documents in the transport, the new images may also be lost.*

Data Field	Command Field	
none	C	X

DC — Sequential ID initiator

The DC command is used to set the Sequential ID Number (document count).

Data Field		Command Field	
cnt	level	D	C

Data Field	Description	Value(s)
cnt	image number value	0–999999999
level		9

The following example shows how the DC command could be used:

The host application wants the starting image Sequential ID Number (document count) to be 101.

The Sequential ID Initiator command must enter a value one less than the desired starting value (to start with 101, the cnt value must be 100).

HEX	31	30	30	39	44	43
CHAR	1	0	0	9	D	C

DX — No scan

The DX command enables or disables scanning for the current mode.

Data Field	Command Field	
stat	D	X

Data Field	Description	Value(s)
stat	no scan off (scanning enabled)	0
	no scan on (scanning disabled)	1

EX — Bit order

The EX command defines the bit order within a byte of image data.

Data Field	Command Field	
order	E	X

Data Field	Description	Value(s)
order	• most significant bit (msb) to the right • least significant bit (lsb) to the left	0
	lsb | | | | | | | msb	
	• most significant bit (msb) to the left • least significant bit (lsb) to the right	1 (default)
	msb | | | | | | | lsb	

FX/Y/Z — Compression

The FX/Y/Z command defines the compression for the current mode. It allows the optional specification of a K-factor for Group III, two-dimensional compression.

Data Field		Command Field	
cmp	K-factor (opt)	F	X/Y/Z

Data Field	Description	Value(s)
cmp	uncompressed	0
	Group III compression (one-dimensional)	1
	Group III compression (two-dimensional)	2
	Group IV compression	3
K-factor	K-factor only has meaning when using Group III, two-dimensional compression. If Group III, two-dimensional is specified without a K-factor, the K-factor will default to 4.	000 (infinity) to 255

NOTE: Leading zeros in the K-factor data field are required.

GC — Last image address

The GC command requests return of the last scanned document's image address to the SCSI host.

Data Field	Command Field	
none	G	C

The information returned is in the following format:

Data Field			Command Field	
	Image Address		G	C

Data Field	Description	Value(s)
Image Address	Image address of the last scanned document image	see NOTE

NOTE: The current application mode determines the image address format.

GX — End of job

The GX command initiates the scanner End of Job sequence. This sequence includes:

- turning off the feeder
- flushing the transport
- turning off the transport
- disabling scanning

NOTE: The image buffer is not cleared.

Data Field	Command Field	
none	G	X

HA — Set mode

The HA command changes the current scanner configuration to the configuration defined by the specified application mode.

Data Field	Command Field	
mode	H	A

Data Field	Description	Value(s)
mode	mode number	1–18

NOTE: Only one Set Mode command may be sent with each SCSI Send command.

HC — Next image address

The HC command sets the image address for the next document.

Data Field			Command Field	
STX	image address	ETX	H	C

Data Field	Description	Value(s)
STX	start of transmission indicator	02H
Image Address	the image address which is to be assigned to the next document	see NOTES
ETX	end or transmission indicator	03H

NOTES:

- The image address format must be compatible with the current application mode. It must be sent to the scanner as if it were entered on the scanner operator control panel. It should only be sent when the scanner is idle.
- STX and ETX are optional when specifying numeric-only image addresses. If the image address contains upper-case alphabetic characters, STX and ETX must be used.

JA — Define mode

The JA command alters the preprogrammed application mode by storing the current operating mode in its place. After the current operating mode has been stored as one of the 18 application modes, it can be selected in one of two ways: the operator can select it by entering function code **F01** on the scanner operator control panel; or the scanner-unique Set Mode (HA) command may be used.

Data Field	Command Field	
mode	J	A

Data Field	Description	Value(s)
mode	mode number	1–18

JA command Example 1:

- Mode 4 is the current application mode.
- The host executes the following FX command to disable compression:

HEX	30	46	58
CHAR	0	F	X

- The host executes a JA command, specifying Mode 4:

HEX	34	4A	41
CHAR	4	J	A

When Mode 4 is selected from the scanner operator control panel, all of the features of the mode that were available prior to the execution of the FX command described above remain unchanged, except compression (which is now disabled).

If the host had not executed the JA command following the FX command, when the operator selects Mode 4 from the operator control panel, ALL features of the mode that were available prior to the execution of the FX command described above would remain unchanged, including compression.

JA command Example 2:

- Mode 4 is the current application mode.
- The host executes the following FX command to disable compression:

HEX	30	46	58
CHAR	0	F	X

- The host executes a JA command, specifying Mode 3:

HEX	33	4A	41
CHAR	3	J	A

When Mode 3 is selected from the scanner operator control panel, all of the features of Mode 4 that were available prior to the execution of the FX command described above remain unchanged, except compression (which is now disabled); these values are assigned to Mode 3.

The Mode 3 definition has been overwritten by execution of this command. When the operator selects Mode 4 again, all of the features of Mode 4 that were available prior to the execution of the FX command described above remain unchanged.

JX/Y/Z — Scan threshold

The JX/Y/Z command defines the threshold used for the current mode.

Data Field	Command Field	
thresh	J	X/Y/Z

Data Field	Description	Value(s)
thresh	scan threshold ranging from 0 (lightest) to 255 (darkest)	0 to 255

NOTE: Leading zeros are not permitted.

KX/Y/Z — Scan contrast

The KX/Y/Z command defines the contrast used for the current mode.

NOTE: A contrast of 0 results in a fixed threshold.

Data Field	Command Field	
cont	K	X/Y/Z

Data Field	Description	Value(s)
cont	scan contrast ranging from 0 (fixed thresholding) to 100 (fully adaptive)	0–100

NOTES:

- Leading zeros are not permitted.
- If multi-level screening is enabled (LX/Y/Z ≠ 0), this command is used to enable/disable Error Diffusion.

LX/Y/Z — Dither pattern (screen)

The LX/Y/Z command selects one of the eight screens for the current mode.

Data Field	Command Field	
screen	L	X/Y/Z

Data Field	Description	Value(s)
screen	2-level screen (no screen) 16-level screen 32-level screen 64-level screen 3-level screen 4-level Bayer Dither 16-level Bayer Dither 64-level Bayer Dither	0 1 2 3 4 5 6 7

NOTE: Level is defined as the levels of gray simulated by the screen.

MC — Count Only mode

The MC command enables or disables Count Only operation. The image address does not change and no images are stored when using Count Only mode.

Data Field	Command Field	
stat	M	C

Data Field	Description	Value(s)
stat	disables Count Only mode	0
	enables Count Only mode	1

MX/Y/Z — Image enhancement filter

The MX/Y/Z command selects an Image Enhancement filter for the current mode.

Data Field	Command Field	
filter	M	X/Y/Z

Data Field	Description	Value(s)
filter	no filter (all pass)	0
	halftone removal	1
	no filter (all pass)	2
	no filter (all pass)	3

NF — Level of next document

The NF command sets the document image level for the next scanned document.

Data Field	Command Field	
level	N	F

Data Field	Description	Value(s)
level	sets Image Level of next document to Level 0	0
	sets Image Level of next document to Level 1	1
	sets Image Level of next document to Level 2	2
	sets Image Level of next document to Level 3	3

NX/Y/Z — Noise filter

The NX/Y/Z command selects the Noise filter for the current mode.

Data Field	Command Field	
filter	N	X/Y/Z

Data Field	Description	Value(s)
filter	noise filter disabled	0
	remove lone pixels enabled	1
	majority rule enabled	2

SX/Y/Z — Reverse image

The SX/Y/Z command changes the white/black polarity for the current mode.

Data Field	Command Field	
rev	S	X/Y/Z

Data Field	Description	Value(s)
rev	white/0 black/1	0
	white/1 black/0	1

TX — Simplex/duplex status

The TX command directs a duplex scanner to scan either one or both sides of the document(s) for the current mode.

Data Field	Command Field	
side	T	X

Data Field	Description	Value(s)
side	transmits only one side (simplex/front only)	1
	transmits two sides (duplex/front and rear)	2

NOTE: Defaults to hardware configuration (simplex machine defaults to single-sided; duplex machine defaults to double-sided).

YX/Y/Z — Border Reduction

If auto-cropping is off (see AX, Y, Z command), the Y command removes borders on sides of documents.

Data Field	Command Field	
Border	Y	X/Y/Z

Data Field	Description	Value(s)
Border	Border Reduction disabled	0
	Border Reduction enabled	1

NOTE: If auto-cropping is on, and this command is sent, the machine will store the last commanded state of the Y command. This state becomes effective if auto-cropping is turned off.

WX/Y/Z — Skew Correction

The W command enables or disables document skew correction.

Data Field	Command Field	
Skew Correction	W	X/Y/Z

Data Field	Description	Value(s)
Skew correction	Skew correction enabled	1
	Skew correction disabled	0

Scanner-unique command samples

There are several ways to alter the default image processing parameters:

- temporarily override an individual parameter
- temporarily override a group of parameters
- permanently change an individual parameter
- permanently change a group of parameters

Temporary individual parameter overrides are performed by sending a single scanner-unique command using a single SCSI Send command. The temporary parameter change remains in effect until one of the following occurs:

- a new value for the same parameter is sent
- the parameter value(s) are saved to a mode
- change to another mode
- a SCSI or power-on reset occurs

The following table illustrates how the use of a single scanner-unique command can temporarily override a current mode parameter:

	RESULT	
ACTION	**Compression**	**Resolution**
Scanner is in Mode 1	3*	200*
Host executes SCSI Send command with 2FX	2	200*
Host executes SCSI Send command with 4HA	3*	200*
Host executes SCSI Send command with 1HA	3*	200*

*Parameter default value.

Temporarily overriding a group of parameters

Temporary group parameter overrides are performed by sending a string of scanner-unique commands using a single SCSI Send command. The temporary parameter changes remain in effect until one of the following occurs:

- an individual parameter value is sent (changing only that parameter value)
- the parameter value(s) is saved to a mode, or you change to another mode
- a SCSI or power-on reset occurs

The following table illustrates how the use of a string of scanner-unique commands can temporarily override current mode parameters:

ACTION	RESULT	
	Compression	Resolution
Scanner is in Mode 1	3*	200*
Host executes SCSI Send command with 2FX300BX	2	300
Host executes SCSI Send command with 4HA	3*	200*
Host executes SCSI Send command with 1HA	3*	200*

*Parameter default value.

Permanently changing individual parameters

A permanent change to an individual parameter is performed by temporarily overriding a single parameter and then sending a scanner-unique Define Mode (JA) command to save the values to a specified mode.**

The following table illustrates how the use of a scanner-unique JA command can be used to permanently change a current mode parameter:

ACTION	RESULT	
	Compression	Resolution
Scanner is in Mode 1	3*	200*
Host executes SCSI Send command with 2FX	2	200*
Host executes SCSI Send command with 4JA		
Host executes SCSI Send command with 4HA	2	300
Host executes SCSI Send command with 1HA	3*	200*

* Parameter default value.

** The value(s) may be saved to the current mode or any of the other modes.

Permanently changing a group of parameters

A permanent change to a group of parameters is performed by temporarily overriding a group of parameters and then sending a scanner-unique Define Mode (JA) command to save the values to a specified mode.**

The permanent parameter changes remain in effect until a SCSI or power-on reset occurs.

The following table illustrates how the use of a scanner-unique JA command can be used to permanently change a group of current mode parameters:

	RESULT	
ACTION	**Compression**	**Resolution**
Scanner is in Mode 1	3*	200*
Host executes SCSI Send command with 2FX300BX	2	300
Host executes SCSI Send command with 4JA		
Host executed SCSI Send command with 4HA	2	300
Host executes SCSI Send command with 1HA	3*	200*
Scanner is in Mode 1	3*	200*
Host executes SCSI Send command with 2FX300BX4JA	2	300
Host executed SCSI Send command with 4HA	2	300
Host executes SCSI Send command with 1HA	3*	200*

* Parameter default value.

** The value(s) may be saved to the current mode or any of the other modes.

Recommended usage of scanner-unique commands

The recommended method of downloading and saving image processing parameters, when using scanner-unique commands, is to use a SCSI Send command to transmit all desired parameter changes, and a Define Mode (JA) command to permanently store the parameter changes in a specified mode. This method significantly reduces SCSI overhead.

For example:

Using one SCSI Send command:
250BX1FX180JX60KX5LX1NX2TX1JA

will:

- set the scan resolution to 250 dpi
- set the compression to Group III, one dimensional
- set the threshold to 180
- set the scan contrast to 60
- set the dither pattern to a 4-level Bayer dither
- set the noise filter to remove noise reduction
- set the simplex/duplex status to two-sided
- save the parameter values in Mode 1

7 The Diagnostic Interface (J45/COIN3)

This chapter describes the communications between the scanner and an RS-232 terminal, which may used to receive diagnostic information.

Usage

The diagnostic interface (also referred to as COIN3) may be used to receive diagnostic messages. This interface may be used as a diagnostic tool during product development and integration.

The diagnostic port is labeled J45 on the rear panel of the scanner.

Protocol

The RS-232 communications protocol is:

- 9600 baud without the Image Manager accessory
  19,200 baud with the Image Manager accessory
- 8 bits
- 1 start/stop bit
- No parity
- No handshake on DTR/CTS

A standard RS-232 interface is used

Pinouts

The diagnostic port (J45) has the following pinouts (25-pin female DB 25 Connector):

Pin (J45)	Signal(s)
2	T x D
3	R x D
5	CTS
7	GND
20	DTR

Sample interfaces

This section illustrates the connection between the scanner diagnostic port (J45) and the serial port of a personal computer.

FROM Scanner (25-pin male)	TO PC serial port (9-pin female)	FROM Scanner (25-pin male)	TO PC serial port (25-pin female)
8	1	1	1
2	2	3	2
3	3	2	3
6	4	5	4
7	5	3	5
20	6	20	6
5	7	7	7
4	8	6	20
22	9		

Appendix A Glossary

Batch

A number of documents to be scanned as a group.

Bi-tonal image

An unscreened image that consists of pixels which are either black or white (1 bit/pixel), as opposed to gray scale (screened) images which consist of pixels which are assigned a value based upon a range of gray shades.

Calibration

An operation that determines any system nonuniformity for which the scanner must compensate during scanning. The unit must be calibrated at least once a day or after power has been turned on.

Charge-coupled device (CCD)

A light-sensitive, solid-state device used to convert image information (light) to electrical signals as a document is scanned.

Compression

Compression is used to reduce the number of bytes needed for scanned document images, thus saving storage space and/or transmission time. This is accomplished with special algorithms that use run-length encoding.

Continuous tone images

Images, such as photographs, which can assume all possible shades of gray.

Cropping

Technique used to capture a desired portion of an image. Allows the entire document to be scanned without all document data being stored.

Digitized image

Image data represented by binary ones and zeros.

Document image level

Rank associated with a type of document. Up to four levels — Level 3, Level 2, Level 1, and Level 0 — can be used. The level can be set automatically using a Patch Reader accessory, manually by pressing the Footswitch, by pressing a Level key on the control panel, or by sending a scanner-unique Level of Next Document command.

Error diffusion mode

Compromised between binary thresholding and screening; used for documents containing both continuous tone photographic and text information. It simulates gray scale while retaining text readability.

Gray scale image

Refers to a processed image that consists of pixels which are assigned values based upon a range of gray shades, as opposed to thresholded images in which each pixel is either black or white.

Gray levels

Discrete shades of gray.

Halftone image

Refers to a printed image that simulates a continuous tone image. The simulation is achieved by using a series of dot patterns. Newsprint pictures are an example of halftoned images.

Header

Contains information associated with the raster image file. Consists of fixed fields (provided by the host computer) and scanner-determined dynamic fields (image sequence number, image size in bytes, image level).

Image address

Contains fixed and dynamic information which can be used for image retrieval.

Initiator

A SCSI device (usually a host) that requests an operation to be performed by another SCSI device.

Multilevel indexing

A method of organizing documents in a structured manner when one type of document is associated with a particular level and another type of document is associated with another level of greater or lesser importance. For example, an insurance application with batches associated with Level 3, claims associated with Level 2, and claim attachments associated with Level 1.

Noise

Small dots or specks that appear in the background of an image. These specks increase file compression size and usually contain no image information.

Noise filter

Reduces random noise on bi-tonal images by converting a black pixel surrounded by white pixels to white, or a white pixel surrounded by black pixels to black.

Patch

A coded grouping of wide and narrow bars that are preprinted on documents. Patches are read by an optional Patch Reader and signal a level change for that document or the next document. See *Multilevel indexing*.

Pixel

A picture element. A binary or multi-bit value which represents a spot on a target document. The more pixels, the higher the resolution.

Point

The basic unit of type measurement which determines the character height. 1 point = 1/72 of an inch.

Point Size	Font
4	*Kodak Digital Science*™ Document Scanner Products
6	*Kodak Digital Science*™ Document Scanner Products
7	*Kodak Digital Science*™ Document Scanner Products
9	*Kodak Digital Science*™ Document Scanner Products
10	*Kodak Digital Science*™ Document Scanner Products
12	*Kodak Digital Science*™ Document Scanner Products

Scaling

Method used to obtain output resolutions other than the base resolution of the scanner. Can be done only from a higher resolution to a lower resolution.

Scanner-unique command

Allows the host computer and the scanner to communicate with each other. Scanner-unique commands must be in the format described in this manual.

Screening

Creates a pseudo gray-scale image and the electronic equivalent of the technique newspapers use to print pictures. Recommended for continuous tone photographic images. Also referred to as an 'ordered dither.'

Seed

A Sequential ID Number, sent from the host to the scanner, which will be used as the first number for the document image number.

Small computer-system interface (SCSI)

Evolving industry ANSI standard that facilitates communication between computers and their (SCSI) intelligent peripherals. The scanner transmits digitized image data to the appropriate host subsystem via the SCSI bus. The interface supports two-way command/data communication between the scanner and the host. The SCSI-2 command set is supported as well as a set of scanner-unique commands.

Thresholding

The conversion of a gray scale image into a bi-tonal (1 bit/pixel) image. Thresholding techniques include fixed, adaptive, screen and mixed.

Appendix B Reference Materials

The following publications are available for the *Kodak Digital Science* Document Scanner 9500.

A-61092 User's Guide

A-61124 Integrator's Guide

A-61094 Installation Planning and System Maintenance Guide

A-61097 Installation Questionnaire Instructions/Mode Setup Software

Accessory-specific

A-61099 Bar Code Made Easy

A-61599 Patch Code Information for *Kodak Digital Science* Products

Ordering publications

United States and Canada

Provide the quantity, publication name and number, name and phone number of caller, purchase order number, billing address and ship-to address.

- Place telephone requests (toll-free) between 8:00 AM and 8:00 PM (EST) Monday through Friday: 1 (888) 247-1234.
- Facsimile requests should be sent: 1 (800) 535-4622

All other regions

Parts, tools, and publications are available through local channels.

Appendix C Assigning Image Addresses

An image address may contain up to 15 characters, consisting of a maximum of 12 digits and a maximum of 3 delimiters.

You must define the following four fields:

- Field A represents Level 1. Its value is incremented when a document is assigned Level 1.
- Field B represents Level 2. Its value is incremented when a document is assigned Level 2. In addition, the value of Field A is reset to zero.
- Field C represents Level 3. Its value is incremented when a document is assigned Level 3.
- Fixed Field contains fixed information, typically, the date.

  Example: 0301.02.001.000 where:

  Field A contains 000
  Field B contains 001
  Field C contains 02
  Fixed Field contains 0301

The image address field lengths depend upon the Index Format you select:

- Single Level Format

  Field A is defined as having a field length greater than zero.
  Field B is defined as having a field length of zero.
  Field C is defined as having a field length of zero.
  Fixed Field may be defined, if desired.

  Example: FFFFFF.AAAAAA

- Two Level Offset Format

  Field A is defined as having a field length of zero
  Field B is defined as having a field length greater than zero.
  Field C is defined as having a field length of zero.
  Fixed Field may be defined, if desired.

  Example: FFFFFF.BBBBBB

- Two Level Format

  Field A is defined as having a field length greater than zero.
  Field B is defined as having a field length greater than zero.
  Field C is defined as having a field length of zero.
  Fixed Field may be defined, if desired.

  Example: FFFFFF.BBB.AAA

- Three Level Offset Format

  Field A is defined as having a field length of zero.
  Field B is defined as having a field length greater than zero.
  Field C is defined as having a field length greater than zero.
  Fixed Field may be defined, if desired.

  Example: FFFFFF.CCC.BBB.

- Three Level Format

  Field A is defined as having a field length greater than zero.
  Field B is defined as having a field length greater than zero.
  Field C is defined as having a field length greater than zero.
  Fixed Field may be defined, if desired.

  Example: FFFF.CC.BBB.AAA

Appendix D Image Processing Parameter Defaults

Image processing parameters

Image processing parameters are fine-tuned during integration for each application/document type, with the goal of optimizing document image quality.

At the beginning of the optimization process, the default image processing parameter settings should be used as a base when fine-tuning the image processing parameters:

- Set each of the image processing parameters to the recommended settings for your application/document type (not necessary if the default settings are used).
- Scan several samples of the application documents.
- Evaluate the document images.

If the quality of the document image is not satisfactory, change one or more of the parameter settings slightly and scan the sample application documents again. Continue this process until the desired image quality is obtained.

In addition to the default and recommended image processing parameter settings, sample image processing parameters are provided in *Appendix E, Image Processing*. The sample image processing parameter settings may be used as guidelines when establishing the desired image processing parameter settings if your application/document type is similar to the sample images.

Table D-1 — Scanner 9500 with the Image Manager
Default image processing parameters

Parameter	Command	Modes 1,5,9,	Modes 13,17	Modes 2,6,10	Modes 14,18	Modes 3,7,11,15	Modes 4,8	Modes 12,16
Scan (X & Y) Resolution	BX/Y/Z	200	200	200	200	200	300	300
Cropping Parameters	AX/Y/Z	auto crop		auto crop		auto crop		auto crop
x start =		0	170	0	170	0	170	0
x length =		0	864	0	864	0	864	0
y start =		0	0	0	0	0	0	0
y length =		0	1104	0	1104	0	1104	0
Threshold	JX/Y/Z	90	90	90	90	90	90	90
Contrast	KX/Y/Z	62	62	62	62	62	62	62
Screen (Dither Pattern)	LX/Y/Z	0 (2-level)	0 (2-level)	0 (2-level)	0 (2-level)	2 (32-level)	3 (64-level)	0 (2-level)
Enhancement Filter	MX/Y/Z	0 (no filter)	0 (no filter)	1 (halftone removal)	1 (halftone removal)	0 (no filter)	0 (no filter)	0 (no filter)
Compression Type	FX/Y/Z	Group IV	Group IV	Group IV	Group IV	Group IV	Group IV	Group IV
Noise Filter	NX/Y/Z	0 (no filter)	0 (no filter)	1 (noise reduction)	1 (noise reduction)	0 (no filter)	0 (no filter)	0 (no filter)
Reverse Image	SX/Y/Z	0 (white/0)	0 (white/0)	0 (white/0)	0 (white/0)	0 (white/0)	0 (white/0)	0 (white/0)
Skew Correction	WX/Y/Z	1 (on)	0 (off)	1 (on)	0 (off)	1 (on)	0 (off)	1 (on)
Border Reduction	YX/Y/Z	0 (off)	0 (off)	0 (off)	0 (off)	0 (off)	0 (off)	0 (off)

Table D-2 — Scanner 9500
Recommended Image processing parameters

Document Type	**Threshold (JX/Y/Z)**	**Contrast (KX/Y/Z)**	**Screen (LX/Y/Z)**	**Image Enhancement Filter**	**Noise Filter (NX/Y/Z)**	**Compression**
All Text Documents (ATP enabled)	90 (default)	62 (default)	2-level	None	On	On
Continuous tone* (photographic) (standard IP enabled)	100-120 <100, >120	0 Not used	Any–Multi-Level	Any	Off	Off
Pictorial Halftones* (standard IP enabled)	100-120 <100, >120	0 Not used	2-level	Halftone Removal	Off	Off
Continuous tone* photographic) with text (7-point type or larger) (standard IP enabled)	100-120 (Error Diffusion)	>0 (Error Diffusion)	Any–Multi-Level	None	Off	Off

* ATP is standard in the Scanner 9500. However, standard image processing modes are reserved for continuous tone or halftone documents by selecting any multi-level screen as shown above.

Table D-3 — Scanner 9500 without the Image Manager
Default image processing parameters

Parameter	Command	Modes 1,5,9,13,17	Modes 2,6,10,14,18	Modes 3,7,11,15	Modes 4,8,12,16
Scan (X & Y) Resolution	BX/Y/Z	200	200	200	300
Cropping Parameters	AX/Y/Z				
x start =		170	170	170	170
x length =		864	864	864	864
y start =		0	0	0	0
y length =		1104	1104	1104	1104
Threshold	JX/Y/Z	90	90	90	90
Contrast	KX/Y/Z	62	62	62	62
Screen (Dither Pattern)	LX/Y/Z	0 (2-level)	0 (2-level)	2 (32-level)	3 (64-level)
Enhancement Filter	MX/Y/Z	0 (none)	0 (none)	0 (none)	0 (none)
Compression Type	FX/Y/Z	Group IV	Group IV	Group IV	Group IV
Noise Filter	NX/Y/Z	0 (no filter)	1 (lone pixels)	0 (no filter)	0 (no filter)
Reverse Image	SX/Y/Z	0 (white/0)	0 (white/0)	0 (white/0)	0 (white/0)

NOTE: The following commands are not available without the Image Manager:

- WX/Y/Z Skew Correction
- YX/Y/Z Border Reduction
- AX/Y/Z The special case of the Cropping command to enable/disable auto-cropping is not available.

Appendix E Image Processing

This appendix provides an overview of image processing capabilities which are controlled by the host computer using scanner-unique commands and guidelines for evaluating scanned images.

This information pertains to the following:

- *Kodak Digital Science* Scanner 9500 series
- *Kodak Digital Science* Scanner 5500 and 7500 series
- *Kodak Digital Science* Document Scanner/Microimager 990

NOTE: For the purpose of this appendix, when referring to the scanner and the scanner/microimager the term "*scanner*" will be used. Any specific differences between the Document Scanner 9500, 5500, 7500 series and the Scanner/Microimager 990 will be noted.

Terminology

The following terms are used when describing the image processing capabilities of the scanner.

Adaptive Threshold Processing — separates the foreground information in an image from the background information.

Bi-tonal image — an unscreened image that consists of pixels which are either black or white (1 bit/pixel).

Continuous tone image — an image, such as a photograph, which can assume all possible shades of gray.

Digitized image — an image made up of pixels represented by binary ones and zeros.

Gray levels — discrete shades of gray.

Gray scale images — an image that consists of pixels which are assigned values based upon a range of gray shades.

Halftone images — the simulation of a continuous tone image by a printing process. The simulation is achieved by using a series of dot patterns. Newspaper photographs are an example of halftone images.

Noise (background noise) — small dots or specks that appear in the background of a scanned image. These specks increase file compression size and usually contain no image information.

Pixel — a single picture element of a digitized image. Pixels can be binary (1 bit/pixel) or gray (multiple bits).

Image processing capabilities

This section describes the standard capabilities of the scanner. Refer to the end of this section for information on how to use the Adaptive Threshold Processor accessory.

Cropping

Cropping is a method of capturing a portion of the total document being scanned. The host computer provides the scanner with the following information that defines which portion of the document is to be captured:

- **Left margin** — the left-most point is 6 inches (152.4 mm) from the feeder/transport centerline. The left margin is defined as the distance from this point.
- **Width** — the distance from the left margin.
- **Top margin** — the distance from the leading edge of the document.
- **Length** — the distance from the top margin.

Refer to Chapter 6*, Scanner-unique Commands* for a description of the AX/Y/Z command.

Auto-cropping

This option is only available for Document Scanners with the Kodak Digital Science *Image Manager accessory installed (not the Scanner/Microimager 990).*

The Image Manager provides border detection for use with auto-cropping. Auto-cropping locates the edges, in both the x and y direction of documents and outputs the actual size of the document that was scanned.

Reverse imaging

The host computer provides information to the scanner defining whether the image should be stored in standard or reverse polarity.

Default polarity is black on a white background. (white = 0) Reverse polarity is white on a black background (white = 1).

Refer to Chapter 6*, Scanner-unique Commands* for a description of the SX/Y/Z command.

Simplex/duplex selection

The host computer provides information to the scanner defining whether to scan one or both sides of the document(s). Simplex indicates only one side (the front side) of the document(s) will be scanned, creating a single image header and a single page image. Duplex indicates both sides of the document(s) will be scanned, creating two image headers and two-page images.

Refer to Chapter 6*, Scanner-unique Commands* for a description of the TX command.

Compression

Compression is used to reduce the number of bytes needed for scanned document images, thus saving storage space and/or transmission time. This is accomplished with special algorithms that use run-length encoding.

The scanner allows one of three types of compression:

- TSS Group III, one-dimensional
- TSS Group III, two-dimensional
- TSS Group IV

NOTE: There are several standard options for Group III, one-dimensional compression. The scanner always utilizes the optional EOL (End of Line) and RTC (Return to Control) codes. These codes are always padded so the code ends on a byte boundary.

Results vary, depending upon image content; the more non-standard run length that exists in the image, the less effective the compression. A compressed document image may be 5 to 15 times smaller than the original document image; however, the compressed image can also be up to 5 times larger than the original document image for documents that contain large numbers of non-optimum run-length (i.e., scanned or halftone documents).

Compression is expressed in terms of a ratio. The ratio is a measure of how well a digitized image can be compressed. A compression ratio of 10:1 indicates a large reduction in file size after compression. A compression ratio of 1:1 indicates no reduction in file size after compression.

NOTE: Compression is recommended for all documents. However, negative compression (less than 1:1) can occur; it is most likely when screening or mixed mode/error diffusion is enabled.

Refer to Chapter 6, Scanner-unique Commands for a description of the FX/Y/Z command.

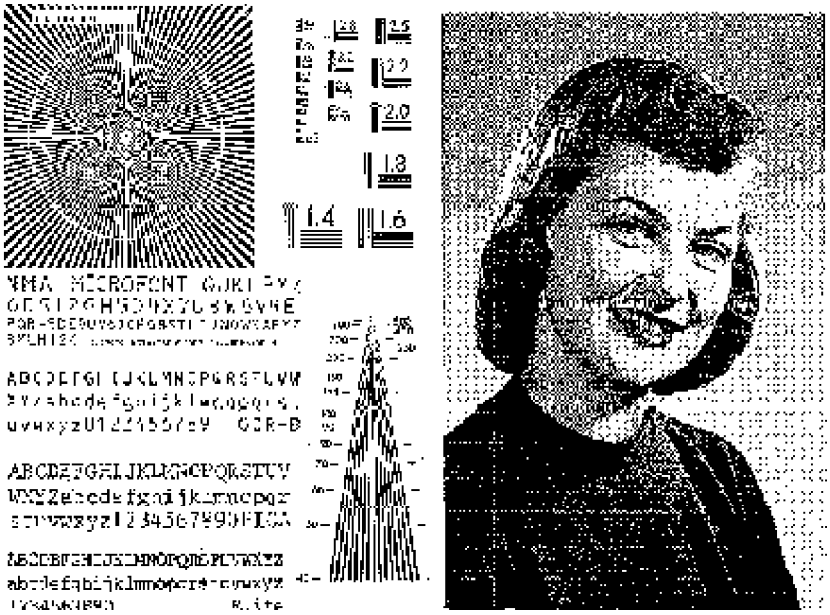
Contrast (without ATP)

Contrast determines the ability of the scanner to detect subtle differences in gray levels. It is defined as a percentage, from 0 to 100%. A high contrast value will produce a scanned output of mostly blacks and whites (only large changes in gray levels are detected). A low contrast value will produce a scanned output of mostly midtones (more subtle change in gray levels are detected).

It is recommended that a relatively high contrast value be used to optimize the quality of text.

Refer to Chapter 6, *Scanner-unique Commands* for a description of the KX/Y/Z command.

This document was scanned using a high contrast value:



This is the same document, scanned using a low contrast value:

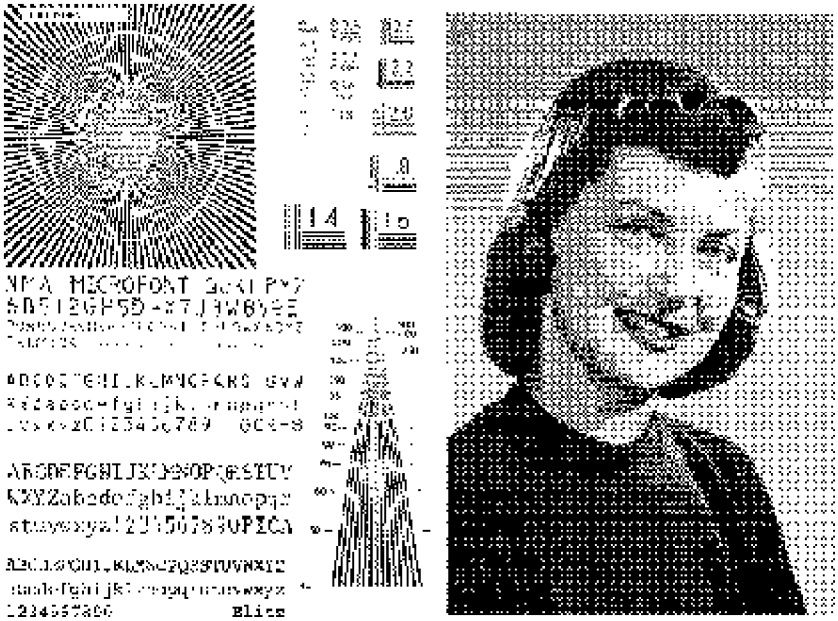


Image enhancement filters

Image Enhancement filters are used to optimize certain maximum characteristics.

The following Image Enhancement filter options are available for the scanner/microimager 990 only.

- **No (all-pass) filter** — used when no enhancement to an image is necessary.
- **Fine Line (high-pass) filter** — used to accentuate the fine details of an image. This filter is typically used to enhance the detail of an image which contains small print (i.e., point type). This filter may inadvertently accentuate background noise.
- **Text (band-pass) filter** — used to enhance text in an image. This filter is typically used when scanning documents containing fine lines or small print (4-point type). This filter effectively reduces background noise.
- **Halftone Removal (low-pass) filter** — used to enhance images containing dot matrix text and/or images printed with shaded or colored backgrounds using halftone screens. This filter effectively reduces background noise.

The following Image Enhancement filter options are available for the Document Scanners (5500, 7500, 9500) series.

- **No (all-pass) filter** — used when no enhancement to an image is necessary.
- **Halftone Removal (low-pass) filter** — used to enhance images containing dot matrix text and/or images printed with shaded or colored backgrounds using halftone screens. This filter effectively eliminates noise caused by the halftone screen.

Refer to Chapter 6*, Scanner-unique Commands* for a description of the MX/Y/Z command.

Mixed mode/Error diffusion

Mixed mode/Error diffusion processing screens photographic areas of a document to simulate gray levels, yet sharpens the edges of text. It is recommended that mixed mode/error diffusion be used when a mix of text, graphs, pictures, and colors in the documents are being scanned.

Mixed mode/Error diffusion is not directly selectable. It is the result of various image processing parameters being set at a specific value (or within a specific range of values). Refer to Appendix D, *Image Processing Parameter Defaults* for more information.

- Threshold of 100 to 120
- Contrast greater than zero
- Screen of 3, 4, 16, 32, or 64
- Any of the Image Enhancements filters
- Noise filter disabled

NOTE: When mixed mode/error diffusion and Compression are used together, negative compression (less than 1:1) is more likely to occur.

Noise filter

The scanner uses two types of Noise filters: Remove Lone Pixel and Majority Rule. Use the Noise filter to increase the compression ratio and improve the appearance of document images.

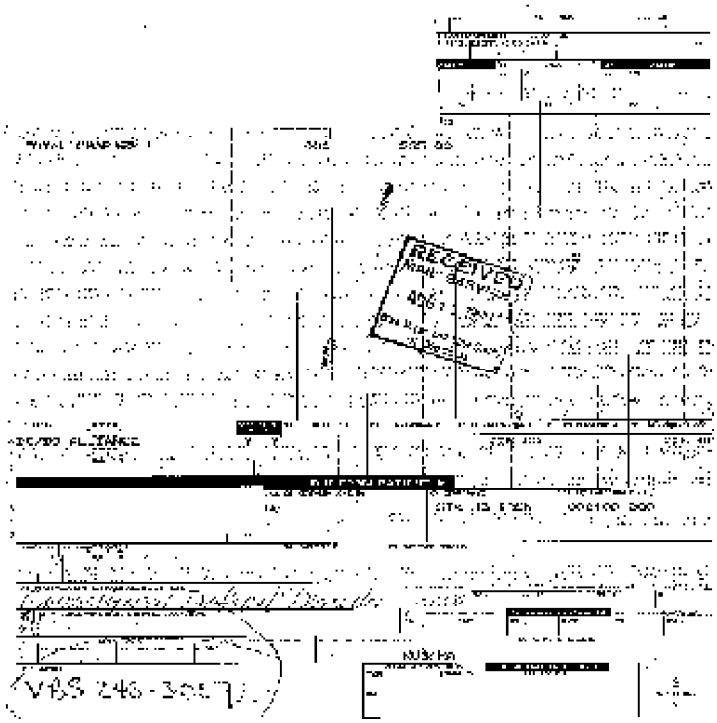
- **Remove Lone Pixel** — reduces random noise on bi-tonal images by converting a single black pixel surrounded by white to white or by converting a single white pixel surrounded by black to black.
- **Majority Rule** — sets the central pixel value in a matrix according to the majority of white or black pixels in a matrix.

NOTES:

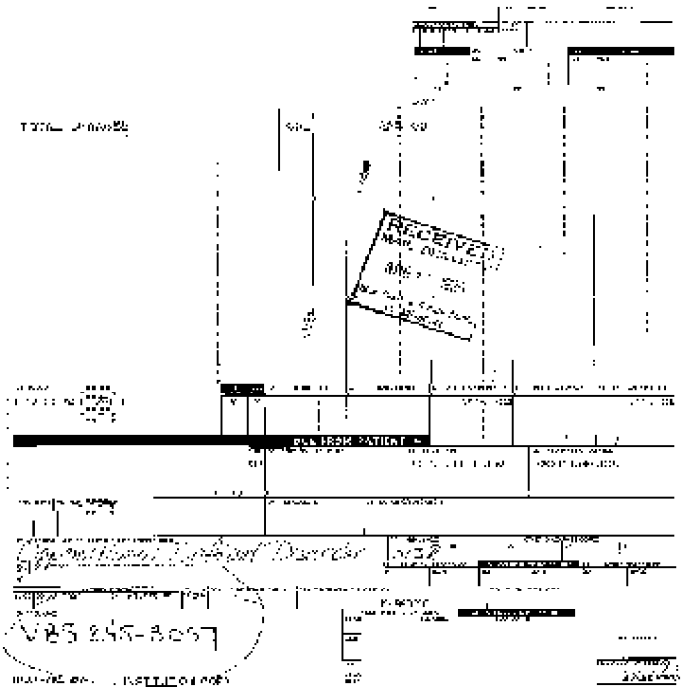
- Using the Noise filter on documents containing very fine detail (e.g., the dot on an "i" in 4-point type) may cause information to be lost. It is recommended that you do not use the Noise filter when scanning documents with text smaller than 7-point type.
- Using the Noise filter in conjunction with an appropriate threshold value will optimize the appearance of images.
- Do not use the Noise filter with screening or error diffusion/mixed mode.

Refer to Chapter 6, *Scanner-unique Commands* for a description of the NX/Y/Z command.

This document has a significant amount of background noise:



This is the same document, using the Remove Lone Pixel Noise filter to suppress the background noise:



Resolution

The resolution of a scanned image is defined by the number of pixels-per-inch (also known as dots-per-inch or dpi) that are used to create the image.

The scanner is capable of producing document images of varying resolutions.

For example, if the desired resolution is 100 dpi, and the scanner uses a base resolution of 200 dpi and the desired (100 dpi) resolution is achieved by scaling down from 200 dpi.

There is at least one base resolution for the scanner. The base resolution is scaled down to achieve all other resolutions.

Product	Resolution (dpi)	Base Resolution
Document Scanner 9500	70 to 200* 210 to 300*	200 300
Document Scanner 5500	70 to 200 210 to 300	200 300
Document Scanner 7500	70 to 200 210 to 300	200 300
Document Scanner/ Microimager 990	67 to 200	200

* Actual resolution will be rounded to the nearest 10 pixels per inch. For example, if 67 dpi is requested, the scanner rounds the resolution to 70 dpi. If 202 dpi is requested, the scanner rounds the resolution to 200 dpi.

NOTE: An Image Enhancement filter may only be specified when using a base resolution. If any other resolution is used, the Image Enhancement filter is automatically set to option 1 - Halftone Removal (low pass filter).

Refer to Chapter 6, *Scanner-unique Commands* for a description of the BX/Y/Z command.

Screening/Dithering

Screening (dithering) is a method used to simulate gray levels. Screening is expressed in terms of levels, ranging from 2-level to 64-level, with several levels in between.

Screening is a process that groups neighboring pixels together into a super-pixel. The size of the super pixel is determined by the screening level chosen (i.e., when a 64-level screen is chosen, the super-pixel contains 64 pixels; the super-pixel is 8 pixels wide and 8 pixels high). Each pixel within the super-pixel is assigned a value; either black or white. It is the ratio of black pixels to white pixels within the super-pixel which simulates varying gray levels. The smaller the screening level, the smaller the super-pixel, resulting in higher resolution; similarly, the higher the screening level, the larger the super-pixel, resulting in lower resolution.

NOTES:

- Screening is effective for documents containing only photographic images. Mixed mode/error diffusion is recommended for documents containing both text and photographic images. Screening tends to decrease the quality of scanned text.
- Do not use the Noise filter with screening.
- When screening and compression are used together, negative compression (less than 1:1) is more likely to occur.

Refer to Chapter 6, *Scanner-unique Commands* for a description of the LX/Y/Z command.

Thresholding

Thresholding is used to convert a gray scale image into a bi-tonal (1 bit/pixel) image. The thresholding value ranges from 0 to 255. A low threshold value will produce a lighter image, and can be used to subdue backgrounds and subtle, unneeded information. A high threshold value will produce a darker image, and can be used to help pick up faint images.

Refer to Chapter 6*, Scanner-unique Commands* for a description of the JX/Y/Z command.

Two thresholding options are available — fixed thresholding and adaptive thresholding.

- **Fixed thresholding** — is used for black-and-white and other high-contrast documents. A single level is set to determine the black-and-white transition. This threshold is programmable over the entire density range.

  Fixed thresholding may be applied by setting the contrast to zero.

- **Adaptive thresholding** — automatically adjusts the threshold level as the background level of the document(s) changes. Use of adaptive thresholding improves low contrast images and suppresses background. Edges within an image and other fine details are emphasized as the contrast level is increased.

  The scanner uses two-dimensional adaptive thresholding; the threshold for a particular pixel is determined by comparison to neighboring pixels (pixels that are located perpendicular and parallel to the paper path).

  Use adaptive thresholding to enhance:

  ◊ documents printed on colored paper

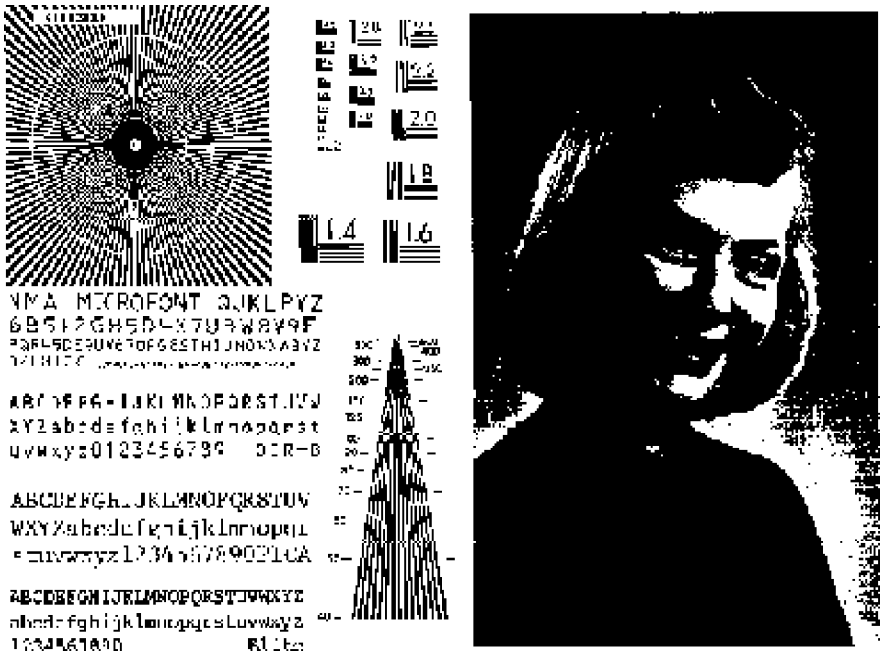
  ◊ documents containing colored or multi-colored areas

  ◊ low contrast documents

  ◊ fine-line documents

  Adaptive thresholding may be applied by setting the scan contrast to a value greater than 0, the Dither Pattern (Screen) to 2-level, and the Image Enhancement filter to 0 (no filter).

This document was scanned using a (high) threshold value of 170:



This document was scanned using a (low) threshold value of 85.

Adaptive Threshold Processor (ATP) accessory

The Adaptive Threshold Processor separates the foreground information in an image (i.e., text, graphics, lines, etc.) from the background information (i.e., white paper background).

The Adaptive Threshold Processor performs adaptive thresholding on gray scale scanned images and outputs a binary electronic image. The processor's strength lies in its ability to separate the foreground information from the background information even when the background color or shading varies, and the foreground information varies in color quality and darkness. Different types of documents may be scanned using the same scanner mode and result in excellent scanned images. If mixing documents of different colors, paper qualities and textures, and print quality, the Adaptive Threshold Processor features optimize each image automatically.

Image processing settings for the ATP

Since the ATP can adapt readily to different document types, backgrounds and print qualities, use the default settings for contrast and threshold for the majority of your applications. For special applications, change the contrast and threshold settings to optimize image quality. Examples are provided below.

ATP Contrast settings

The contrast feature enhances the edges contained in an image. Edges typically represent transitions between foreground and background information, such as the transition from background to faint text.

Contrast can have a value between 0 and 100, with a default value of 62. The higher the contrast level, the more the enhancement of the image edges. For example, you may want to increase the contrast on a document that has a light gray background and light pencil marks.

Image A was processed using a contrast value of 50. Image B was processed using a contrast value of 80. Compare the two images. Notice the word "four" in blocks 5, 6, 7 and 8 was not visible in Image A, but is visible in Image B. Thus, the increased contrast value provided more legible text.

Image A

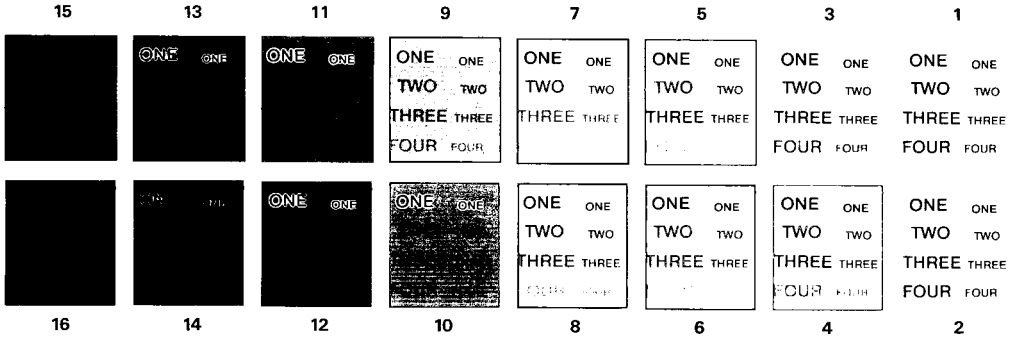
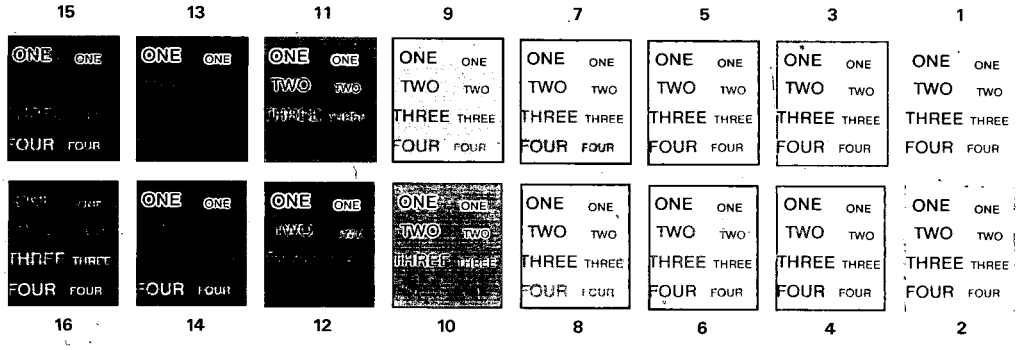


Image B



ATP Threshold settings

The threshold parameter controls the lightness and darkness of the background in an image. Threshold can have a value between 0 and 255, with a default value of 90. As the threshold is increased, more of the darker grays in the image will become black. As the threshold is decreased, fewer of the darker grays will turn black.

Image C was processed with default settings, and threshold set to 60. Image D was processed with the threshold set to 110. Notice that blocks 8, 9, 10 and 11 have a black background in image D and a white background in image C. Since image D has a higher threshold than image C, and the background grays in blocks 8, 9, 10 and 11 are not above the threshold 110, the pixels are black. In image C, the background grays in the same blocks are above the threshold of 60, so these pixels are white.

Image C

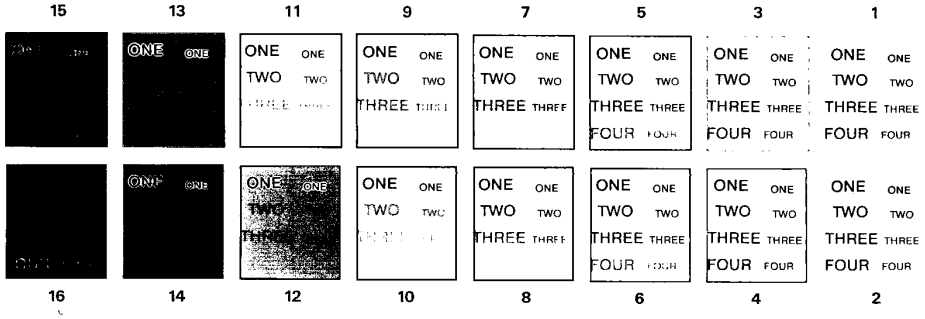
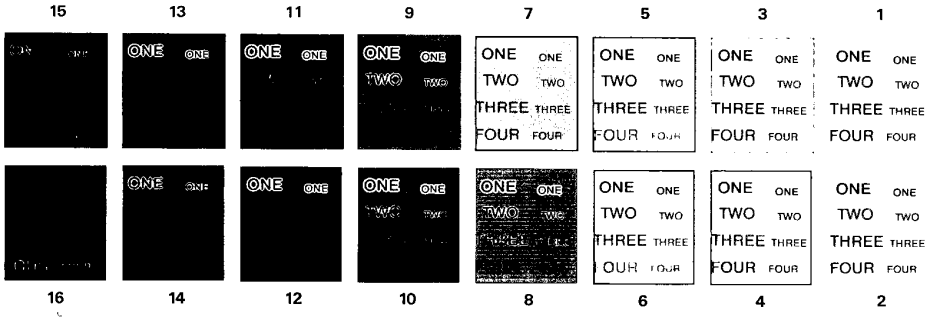


Image D



NOTES:

- Threshold and contrast work independently and have no effect on each other.
- When using the ATP accessory, mixed mode/error diffusion and screening are not available. When using the ATP accessory, the results, when using the Image Enhancement or Noise filter, may vary from the results obtained with standard image processing.

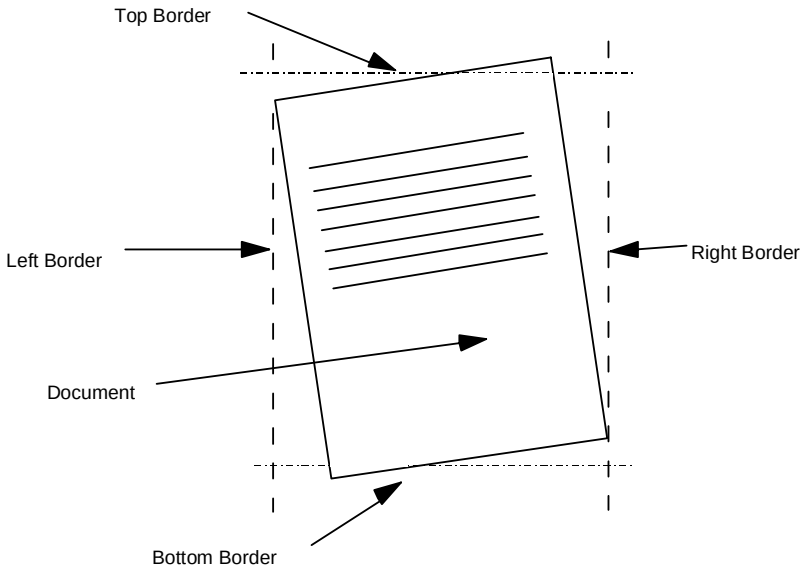
Image Manager capabilities

The *Kodak Digital Science* Image Manager accessory provides skew detection and correction, auto-cropping and border reduction. ***This accessory is not available on the Scanner/Microimager 990.***

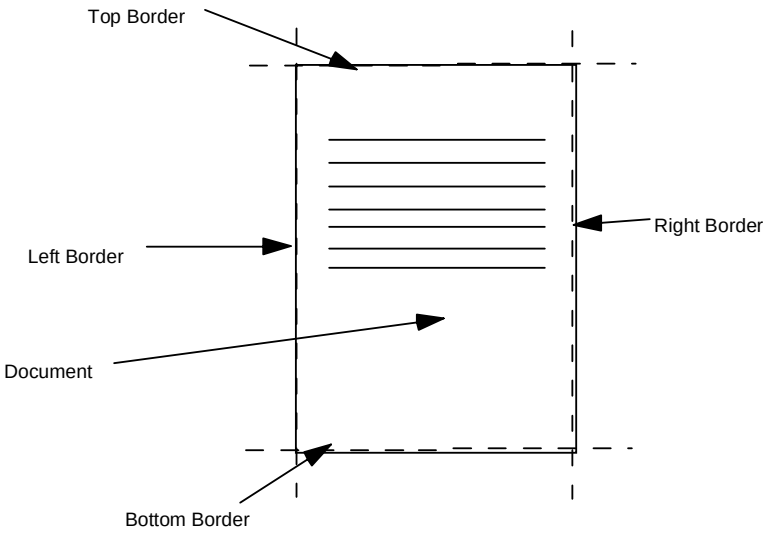
Skew Detection and Correction

The Image Manager provides skew detection and correction. Skew detection can detect up to a 45-degree skew and correct up to a 24-degree skew angle at 200 dpi or a 10-degree skew angle at 300 dpi. When a skewed document is detected, the Image Manager will correct the skew to within ±0.3 degrees of the document's leading edge.

Skewed Document



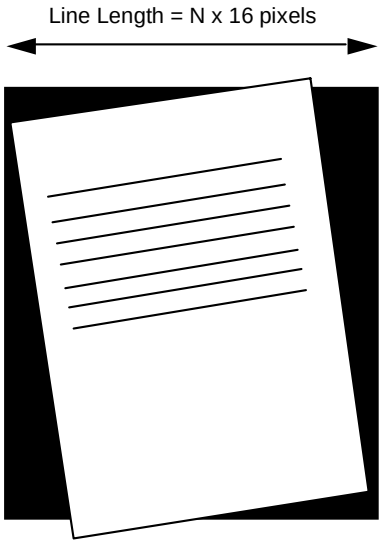
Skew Corrected Document



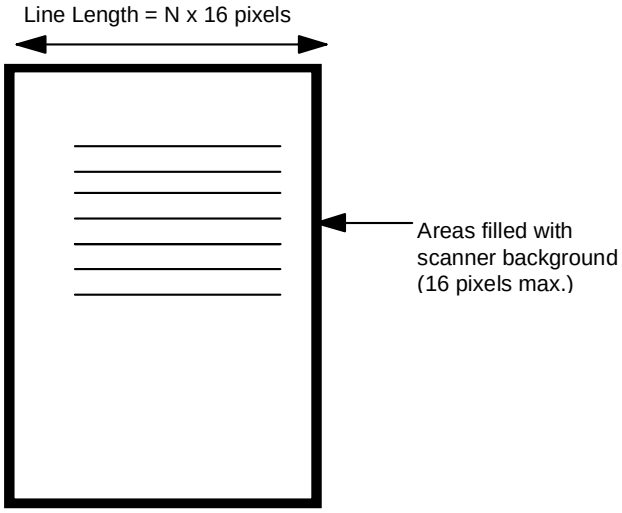
Auto-cropping

When auto-cropping is turned on, it detects and crops the borders of a document and outputs the actual size of the document that was scanned. The following illustrates how skew correction and auto-cropping work.

Skewed document with auto-cropping and skew correction turned off

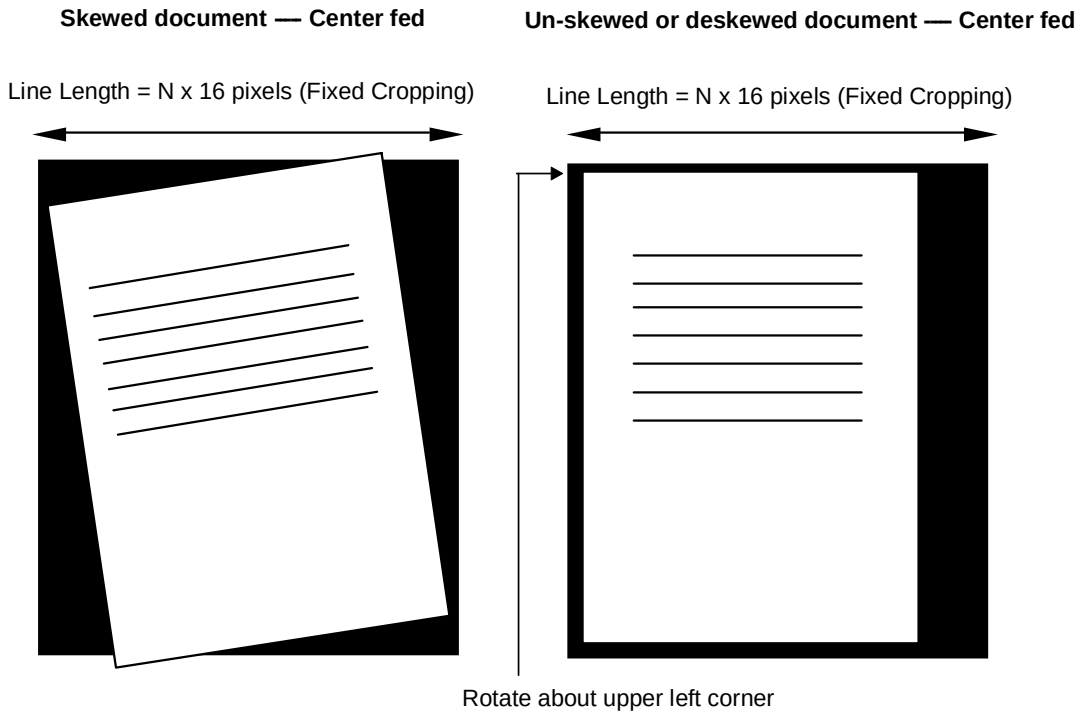


Same skewed document with auto-cropping and skew correction turned on

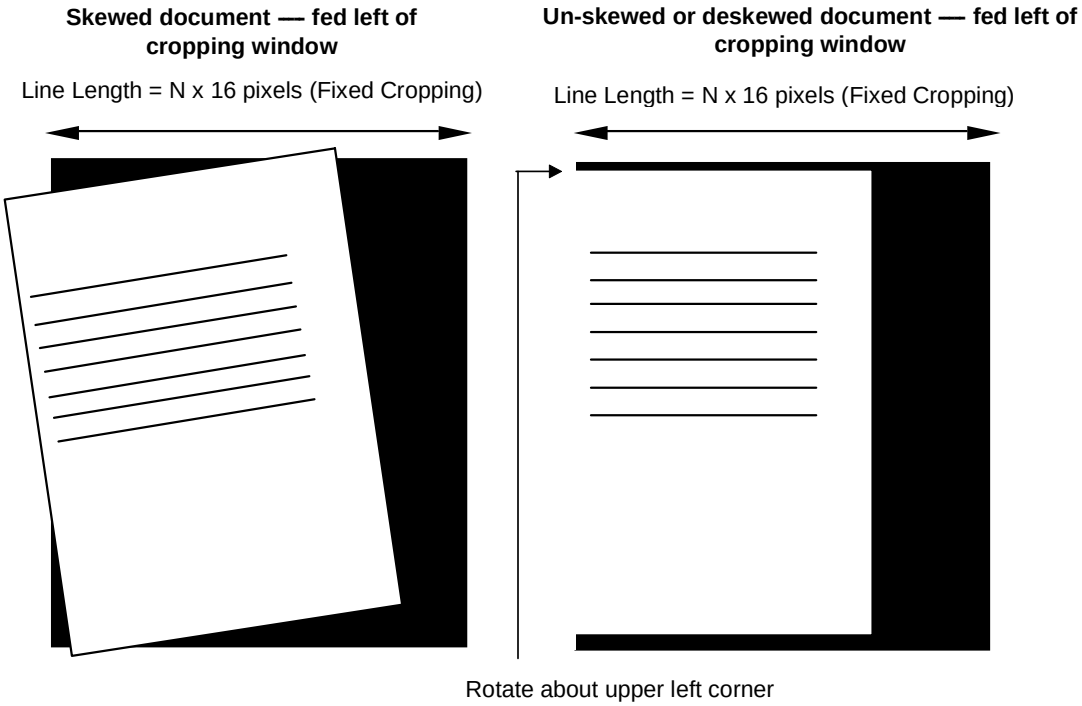


The illustrations that follow show examples of skew correction in fixed cropping mode.

Example 1



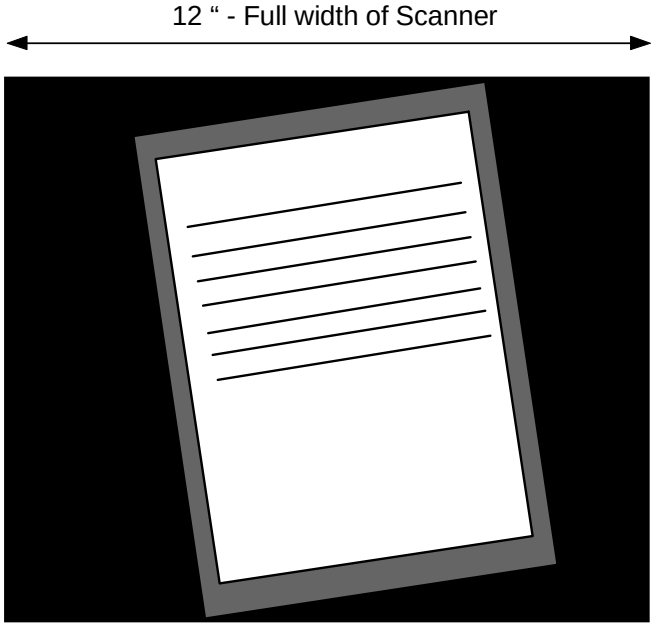
Example 2



Example 3

If the entire image border is almost as dark as the scanner background (i.e., black or dark blue), deskew, auto-cropping and border reduction may not work properly. The resulting image will not be deskewed or auto-cropped, as shown in the example below.

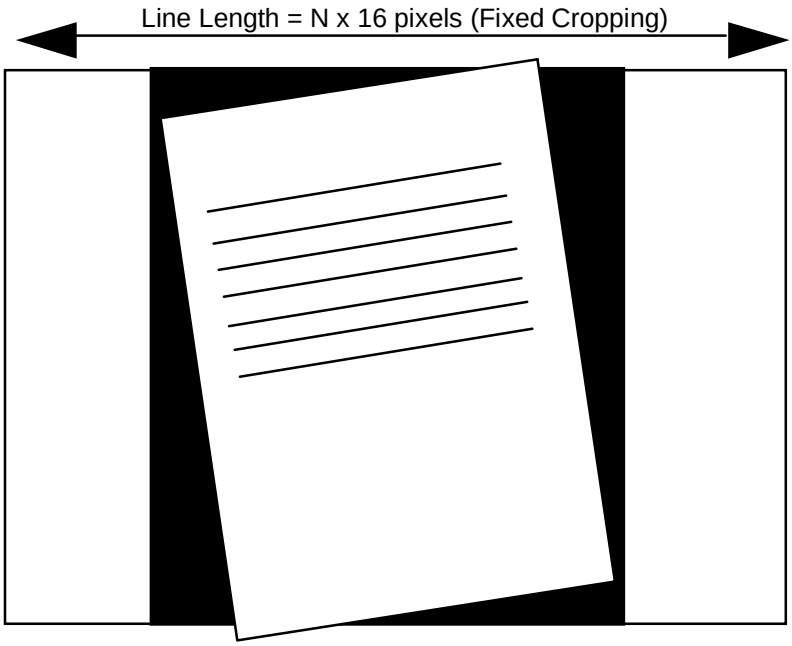
Possible result of deskew/auto-cropped image with black/dark border



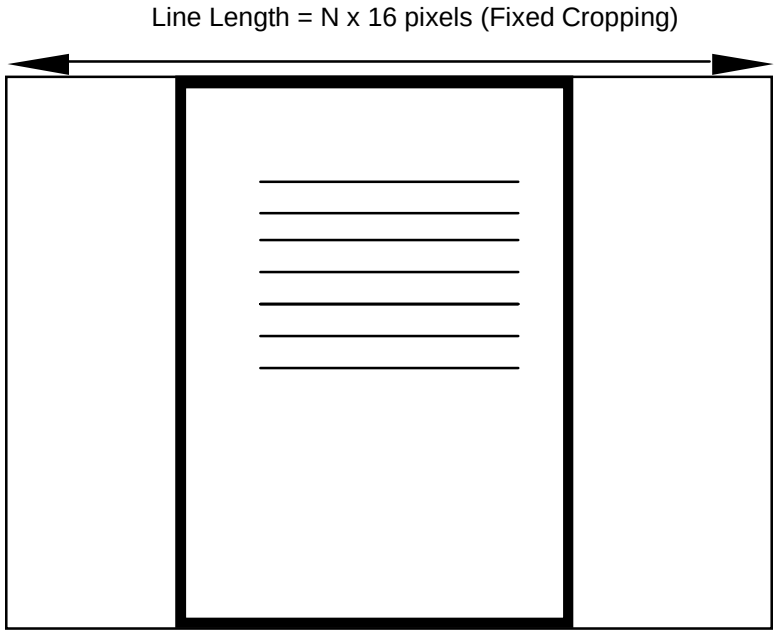
Border reduction

The border reduction feature only works when auto-cropping is turned off. Border reduction fills the area outside of the document edges with a white background within the fixed cropping width. The following illustration shows the effects of border reduction.

Skewed Document



Un-Skewed or Deskewed Document



Evaluating scanned images

This section describes methods for evaluating digitally scanned images. Evaluating scanned images requires an understanding of how scanned images are created and the types of source documents used to create these images. Image creation and source image types are also discussed in this chapter, as well as various evaluation criteria using a standard target as an example.

Scanned images

A scanned image is a digitized representation of a source image. An image is digitized by viewing the source image and determining a numeric value for each finite area (picture element or pixel) of that image.

The size of a pixel is described in dots-per-inch (dpi). As dpi increases, the ability to retain fine "spatial" detail from the source document is increased.

The numeric value assigned to a pixel is based on the number of bits-per-pixel. This value is assigned based on the tone of the source document. A black pixel will have a different value than a white pixel. When the number of gray shades increase, the scanner's ability to retain tonal information increases. For example, 8 bits-per-pixel allows 256 shades (levels) of gray.

By increasing dpi and bits-per-pixel, image quality improves, but the digitized image file size increases. In fact, most scanned images are stored as a bi-tonal (single bit-per-pixel) images. A balance must be struck between image quality and file size.

Source image types

There are many types of source documents. Three common types of documents are described in this section. An individual source document can contain more than one source image type. For example, a printed business form may contain computer-generated printing.

Printed Images

Printed images are those created by a printing press, ink-transfer process. These images contain discrete levels of tone and space. Discrete in tone means that there are a limited number of tone levels (shades of color) in the images. Discrete in space means that image elements are printed by placing ink at specific points. These may be random or patterned locations. Examples of printed images include business forms, newspapers and printed manuals.

Font size and line width largely control image quality. The use of halftone printing screens, which are printed using a series of small dots to create lighter colors, can result in scanned image degradation due to aliasing and moiré patterns. (The "Evaluation criteria" section describes aliasing and moiré).

Computer-generated images

Computer-generated images (printed by dot-matrix or laser printers) are discrete in both tone and space. Discrete in tone means the image consists of pixels on a grid.

The number of bits-per-pixel determine the number of gray levels available. The spacing between points on the grid determine the resolution of the image. Fewer bits-per-pixel or large grid spacing reduce computer-generated image quality.

Scanning computer-generated images can degrade image quality through aliasing and moiré patterns. (The “Evaluation criteria” section describes aliasing and moiré).

Photographic images

Photographic images are continuous in both tone and space. A continuous tone image can assume all possible shades of gray. Image elements are not restricted to specific points of a grid pattern.

Image quality is usually measured by gray density and resolution. Optics and illumination can degrade photographic image quality.

Scanning photographic images can result in degraded image quality due to the translation of infinite gray shades to a finite number of gray levels generated by a scanner.

Evaluation criteria

The target used is the IEEE Std 167A01987 Facsimile Test Chart. This target was chosen for its text and photographic content, as well as the assortment of resolution targets.

Target

Staircasing

Staircasing is displayed when a detail on the scanned image switches from the scan line to the next line of the grid. This is the same degradation seen on computer-generated images and is most apparent on shallow slopes and soft curves. Staircasing can be minimized by scanning at higher resolutions (more dpi).

One factor which can aggravate staircasing is skew. Unlike computer-generated images, scanned horizontal and vertical lines may not be square with the image. A slight skew when feeding the original into the scanner can cause square lines in the original to have a shallow slope on the scanned image, thus introducing staircasing.

Shallow lines with staircasing

Aliasing

If the spacing of details in an original is close to the dpi of the scanner, aliasing can occur. Aliasing causes a false image to appear over the true image which is illustrated in Figures A and B. Note the heavy diagonal bars over the narrow bars in Figure A and the cross hatch patterns in Figure B. You can reduce this problem by scanning at a much higher resolution or selecting the Screen Removal option of the Image Enhancement filter.

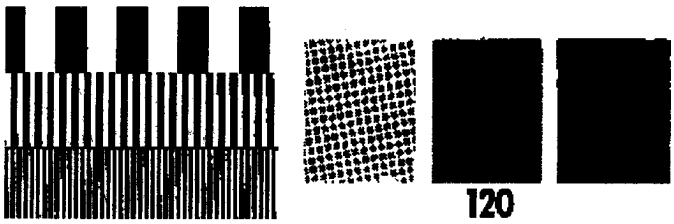


Figure A **Figure B**

Figure A Bars at 10, 50, and 96 lines-per-inch, scanned at 200 dpi with Fine Line enhancement.

Figure B 120 dpi screen, scanned at 200 dpi with Fine Line enhancement.

NOTE: 1 line-per-inch = 2 dots-per-inch

Use of the Halftone Removal option lowers the resolution of the image so it is lower than the scan resolution. The associated loss in resolution may not be acceptable for all applications. Figures C and D illustrate the effect of Halftone Removal on the aliasing patterns.

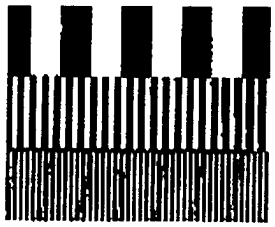


Figure C

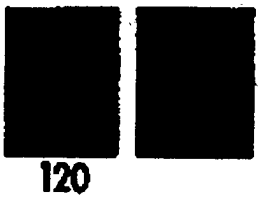


Figure D

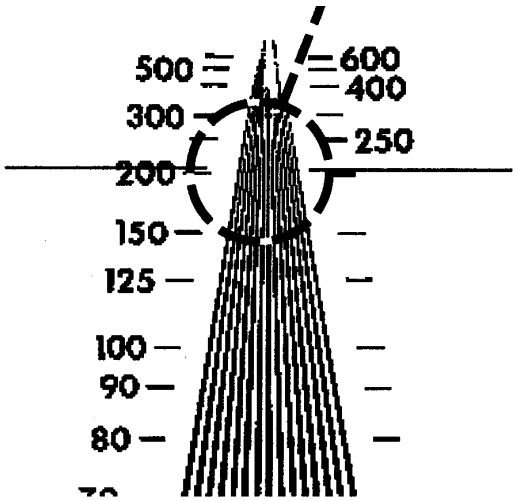
Figure C Bars at 10, 50, and 96 lines-per-inch (lpi), scanned at 200 dpi with Halftone Removal.

Figure D 120 dpi screen, scanned at 200 dpi with Halftone Removal.

NOTE: 1 lines-per-inch = 2 dots-per-inch.

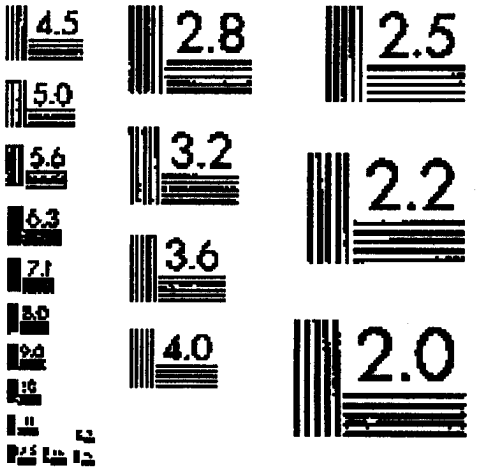
Image resolution

Resolution is the degree of sharpness of the scanned image, and is measured using a cone-shaped resolution chart. This type of chart is less susceptible to skew than traditional microcopy charts. Resolution is read at the point just before the bars of the chart either touch or break up on the same horizontal line. Shortly after they touch, they will start to diverge and fewer bars are resolved. This is most easily measured using some magnification.



Bars touch horizontally at 205 dots-per-inch.
Resolution is read as 200 dots-per-inch.

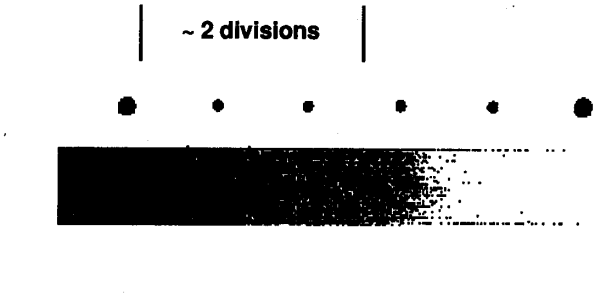
When using a traditional microcopy chart, resolution is read as the smallest target that is clearly visible, with no line loss (all five lines present).



4.0 line pairs-per-millimeter is the last target with all five lines visible.

Noise and dynamic range

Noise in the scanned image will appear as random specks. These specks may be caused by actual noise in the original (dirt or mottled colors) or introduced by the scanner. The size of the transition region from black to white on the continuous-tone wedge indicates the amount of noise in the system.



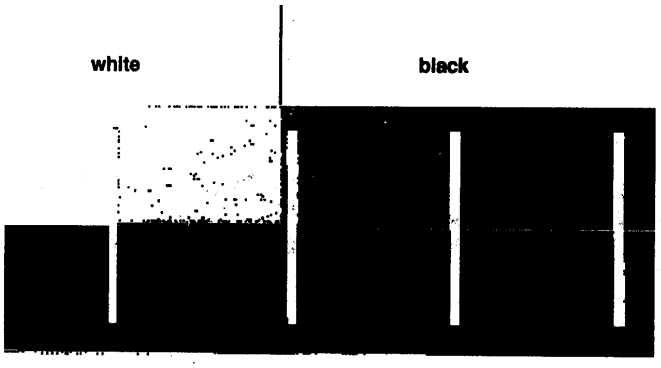
Noise tends to increase as the contrast is increased or when the Fine Line option of the Image Enhancement filter is used. These options enhance small changes in the image as well as the noise in the image.

Some of the noise from both the original and the scanner can be removed by using the Noise filter or by selecting the Halftone Removal option of the Image Enhancement filter.

In case of a dithered threshold (screen or Mixed mode/Error diffusion), the intent is to create a large, smooth transition region. In this case, the size of the transition range indicates the dynamic range of the system. This is directly affected by the screen chosen and minimally by threshold and contrast values.

Brightness

Brightness indicates that calibration is functioning correctly and is directly affected by threshold. Loss in brightness in a scanned image may indicate a need to recalibrate the scanner or to alter threshold values. Brightness is measured, using the step wedge, by counting the number of black and white steps.



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