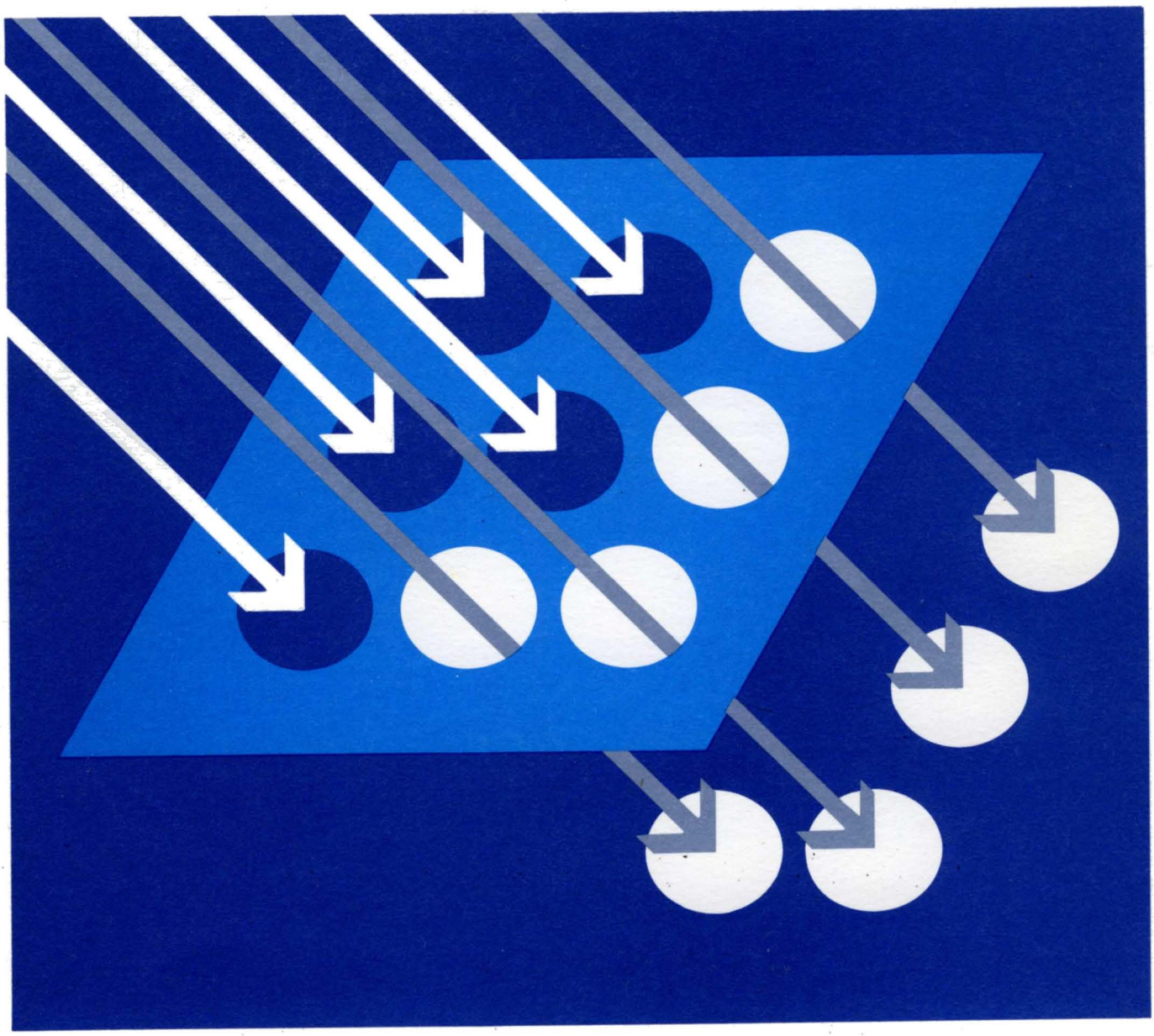
# Host Programmer's Guide

## For the Sentry™ 3000 Scanner



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NATIONAL COMPUTER SYSTEMS

## PREFACE

This Host Programmer's Guide describes what is needed for the scanner and the host computer (and auxiliary device if used) communicate successfully. In addition it explains the scanner records and the functions that must be performed by the host application program. Other user manuals relating to the Sentry™ 3000 scanner are:

| Title | NCS Part Number |
|---|---|
| Operator's Guide | 202-151-981 |

The Operator's Guide provides information on the Sentry™ 3000 scanner parts, how to operate the various programs, and error messages and recovery procedure.

| | |
|---|---|
| Installation and Maintenance Guide | 202-151-999 |

The Installation and Maintenance Guide provides information on how to install, maintain, and repair the Sentry™ 3000 scanner.

| | |
|---|---|
| Scanner Commands for the Sentry PLUS | 202 151 957 |

The Scanner Commands manual describes how to use the optional Scanner Commands software in the host program for the IBM Personal Computer. This manual is intended as a supplement to the Host Programmer's Guide.

Scanner Commands for the Sentry™ 3000/Apple II 202 151 965

The Scanner Commands manual describes how to use the optional Scanner Commands software in the host program for the Apple II Personal Computer. This manual is intended as a supplement to the Host Programmer's Guide.

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## INTRODUCTION

This manual is presented in three sections and two appendices. The first section describes the relationship between the scanner and the host computer and identifies which characteristics of the host must be known to interface with the scanner successfully. Section Two describes the characteristics of the scanner that are "configured" into the scanner to make the scanner compatible with the components of the existing system. Section Three describes the records transmitted by the scanner and outlines the steps involved in processing scanner records. Cabling is discussed in Appendix A. Appendix B is provided for users who have Sentry™ 70 tabletop scanners already in their operating system.

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# INTRODUCTION TO COMMUNICATIONS

## INTRODUCTION

This section describes the relationship between the scanner and the host computer and identifies which characteristics of the host must be known in order to interface successfully with the scanner.

## OVERVIEW: COMMUNICATIONS

This section introduces the components and the characteristics of communications, particularly those aspects of communications the reader must understand to connect the Sentry™ 3000 scanner to a host computer or other data collection device.

## EXPLANATION: SYSTEM COMPONENTS

The components of the Sentry™ 3000-to-host computer communications system may include:

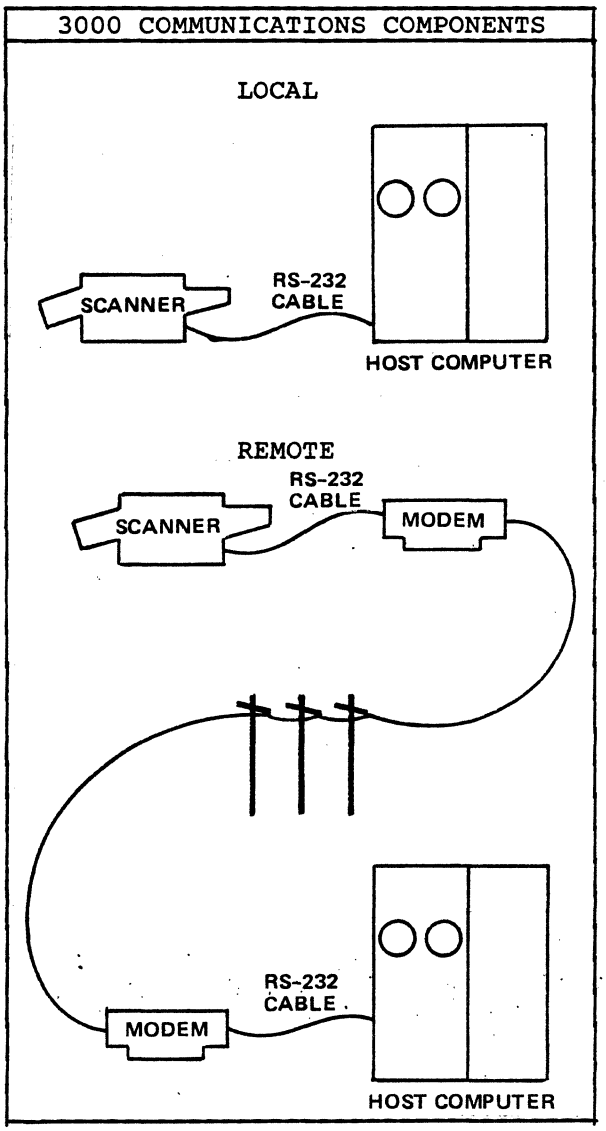
- 3000 Scanner
- Cables
- Modems
- Communications Lines
- Host Computer

### Sentry™ 3000 Scanner

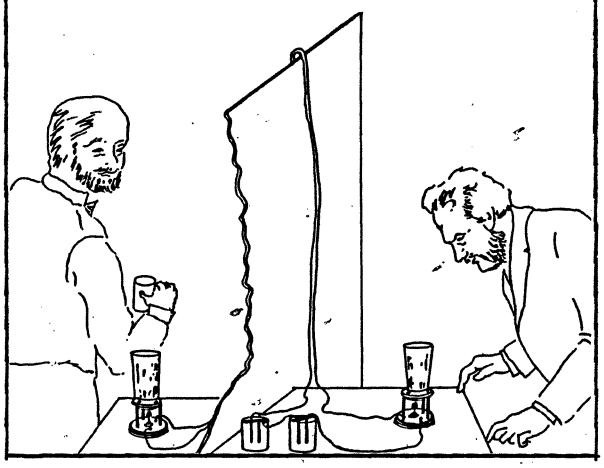
The Sentry™ 3000 scanner reads pencil marks on forms and translates them into electronic signals which are sent to a host computer for processing.

### Scanner-to-Host Connection

The scanner may be connected to the host computer locally or remotely by means of a RS-232C cable. The connection is local when the cable from the scanner is attached to the host computer directly and is less than 50 feet from the host. When the connection cannot be made directly because of distance, a pair of modems, a modem emulator, or limited-distance data sets must be provided to maintain data integrity.



BELL'S COMMUNICATION SYSTEM



"WatsoncomehereIneedyou."

## Host Computer

The host computer (or other data collection device) receives the scanner's transmissions and processes them according to the instructions of its program. The host computer may also regulate a variety of scanner functions such as when the scanner reads forms.

## EXPLANATION: DATA EXCHANGE

While it is easy to see how the system components are connected in order to transfer data from the scanner to the host computer, there are other factors in communications that are not so easily seen. Other factors involved in data exchange include:

- Baud Rate
- Mode
- Code
- Protocol
- Interface Levels

To illustrate these factors, we can use the example of the first message ever sent over communications lines: "Mr. Watson, come here! I need you," spoken by Alexander Graham Bell.

## Baud Rate

What if Mr. Bell had said rapidly, "WatsoncomehereIneedyou," speaking all of his words in less than a second? Watson probably would not have understood because the information rate was wrong. In communications terms, the "baud rate" was too fast. The "baud" is the unit of measurement of transmission speed. The Sentry 3000 scanner can operate at one of seven baud rates.

## Mode

Although Mr. Bell probably never thought of it in these terms, his system was a full-duplex system; that is, his microphone and speaker arrangement acts as sender and receiver simultaneously. Most telephone calls today are full-duplex: if a friend is talking to you, you can talk to him at the same time. Occasionally, however, you may receive a long-distance call which is set up so that whoever talks first gets the line and you can't break in until your friend finishes speaking. This is a half-duplex mode; that is, both ends can transmit but not at the same time. The 3000 scanner operates in half-duplex mode.

## Code

What if Mr. Bell had said, "Monsieur Watson, venez ici!" Mr. Watson might have been happy that something came out of his speaker but he wouldn't have understood a single word if he didn't know how to speak French. Thinking in terms of our Sentry 3000 communications system, we see that the host computer must speak in the same code as the scanner (ASCII code).

"Monsieur Watson, venez ici!"

## Protocol

In half-duplex mode, it is important that there be some understanding between the two ends as to who has use of the line at any one time, and when one party is relinquishing the line to the other. In our everyday telephone conversations the understanding works something like the following conversation:

## Protocol (cont.)

The answering party says "Hello" to indicate that someone is there and also to signal for the other party to speak. The caller will send some information and then usually will ask a question. This is the signal that the other party should talk. It continues back and forth for a while, until one party says something like, "Well, it was good talking with you. Good-bye." Then the other replies, "Yeah. Good-bye," and both hang up.

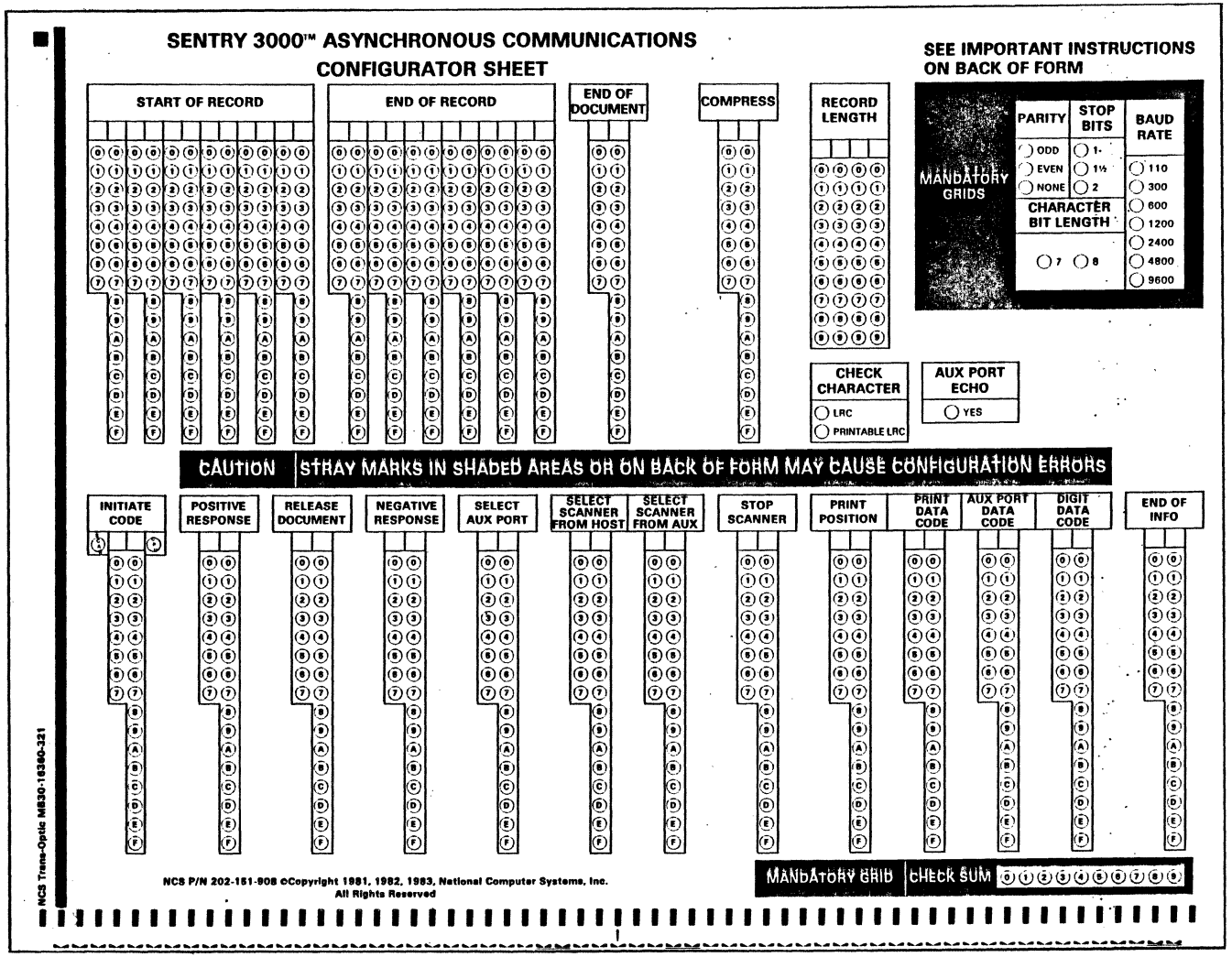
This understanding between the two parties is the protocol, which is a telephone procedure we learn from observation and experience, but which must be defined in absolute terms for computer communications.

## Interface Levels

One last point that is important but not readily apparent from our model has to do with interface levels and signals. Knowing how inefficient Bell's system was, we can be sure that whatever Bell said into his sender, he said it loudly. If he had whispered, Watson would never have heard him. Also, the lines would have had to be hooked up correctly or the signal would never have been received at the other end.

The interface levels and signals in the Sentry 3000 communications system conform to one standard, the Electronic Industries Association RS-232-C. Pin assignments for the 3000 cable and cables available through National Computer Systems are shown in Appendix A.

ASYNCHRONOUS COMMUNICATIONS
CONFIGURATOR SHEET



## OVERVIEW: CONFIGURATION

As discussed above, the scanner communicates asynchronously, in ASCII code, and in half duplex mode. Other characteristics of communications include:

- Baud rate
- Data character format
- Record format
- Control codes

These characteristics are programmed into the scanner by marking and scanning the Sentry 3000 Asynchronous Communications Configurator Sheet. This is called configuration. The scanner is configured to be compatible with the characteristics of the host computer and other system components.

In order to configure the scanner, you will need to determine the characteristics of the system components. These may be determined by one or more of the following:

- Switch settings on equipment
- Hardware limitations of equipment
- System software

This section describes the aspects of your system which you will need to know to configure the scanner. (Section Two describes scanner configuration and how the scanner's protocol works.) As you read through each aspect, fill out the appropriate sections of the worksheet on page 1-17. This will provide you with the information needed before configuration. For help in determining your host characteristics that affect configuration, consult with your Systems Analyst and vendor manuals.

| BAUD RATE OPTIONS |
|---|
| 110 |
| 300 |
| 600 |
| 1200 |
| 2400 |
| 4800 |
| 9600 |

CHARACTER FORMAT

| 1 Start Bit | Optional Parity Bit | 7 or 8 bits for Character | 1, 1-1/2, or 2 Stop Bits |
|---|---|---|---|

## EXPLANATON: BAUD RATE

The Sentry 3000 scanner can operate at one of seven baud rates. The baud rate selected for the scanner must be equal to the baud rate of the system components to which the scanner will be connected. This ensures that all devices in the system receive and transmit data at the same rate.

## EXPLANATION: DATA CHARACTER FORMAT

In asynchronous communications, each data character transmitted must be of a predefined number of bits and must be framed by start and stop bits. All systems automatically transmit one start bit. The number of stop bits may be one, one and one half, or two bits. The number of bits defining a data character may be seven or eight. This does not include the start or stop bits or parity bit if used.

Each data character transmitted by the scanner may be accompanied by a parity bit if required. The parity bit provides a means of ensuring the integrity of transmission of each character. Your system may be designed to look for either odd or even parity. In NCS communications, the parity bit is not considered to be one of the seven or eight data bits described above.

## EXPLANATION: RECORD FORMAT

When a form is scanned, a series of data characters representing the entire form is stored in the scanner's memory. This may be transmitted in its entirety as one record or it may be transmitted as several smaller records if required.

EXPLANATION: RECORD FORMAT (cont.)

| NOTE |
| --- |
| Throughout this manual, the term "record" refers to one transmission - whether it contains all data or part of the data from a single form. |

Record Length

Your host computer may have a limitation on the number of characters that can be accepted in one transmission. For instance, it is not uncommon for 80 characters to be the maximum record length since some systems are set up to receive 80-column card input. The scanner may be configured to limit the maximum number of data characters sent in one record.

Record Envelope

Your system's hardware and/or software may require certain characters to mark the beginning and/or end of transmission of a record. Most systems do utilize an end-of-transmission (end-of-text) character. NCS communications calls this the End of Record character(s). Start of Record characters are not as common. The scanner can be configured to append these characters to the beginning and/or end of every record sent to the host. These codes also have to accompany data messages from the host to the scanner. In addition to this, you may configure the scanner to send another code which indicates to the host that all data from a single form has been transmitted. NCS calls this the End of Document code.

## Check Character

Your system may calculate a Longitudinal Redundancy Check (LRC) for every transmission received. The LRC is a check sum which is calculated on the group of characters comprising the record and used by the host's software for checking records for transmission errors. The scanner can be configured to calculate and transmit the LRC.

## EXPLANATION: CONTROL CHARACTERS

Your system may also utilize control characters. A control character is one which carries no information but rather causes some action on the communications line or at the terminal. Common control codes include a positive acknowledgment to prompt the input device (in this case the scanner) to transmit and negative acknowledgment to prompt a retransmission of the previous record. NCS communications calls these codes Positive Response and Negative Response respectively.

You must know which codes are used in your system and what purpose they serve. This information is critical for configuring the scanner so that data exchange will occur as expected.

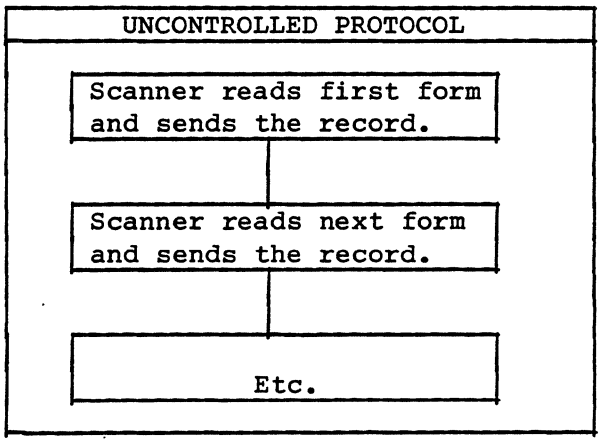
There are several control codes that may be defined in the configuration of the scanner that will result in scanner actions such as printing host messages directly on forms and activating an auxiliary device attached to the scanner. The roles of control codes are illustrated below in four types of interchanges between the host and the scanner. The first interaction illustrates an uncontrolled interchange which occurs if no control codes are defined. The second interaction uses a controlled protocol. The

EXPLANATION: CONTROL CHARACTERS (cont.)

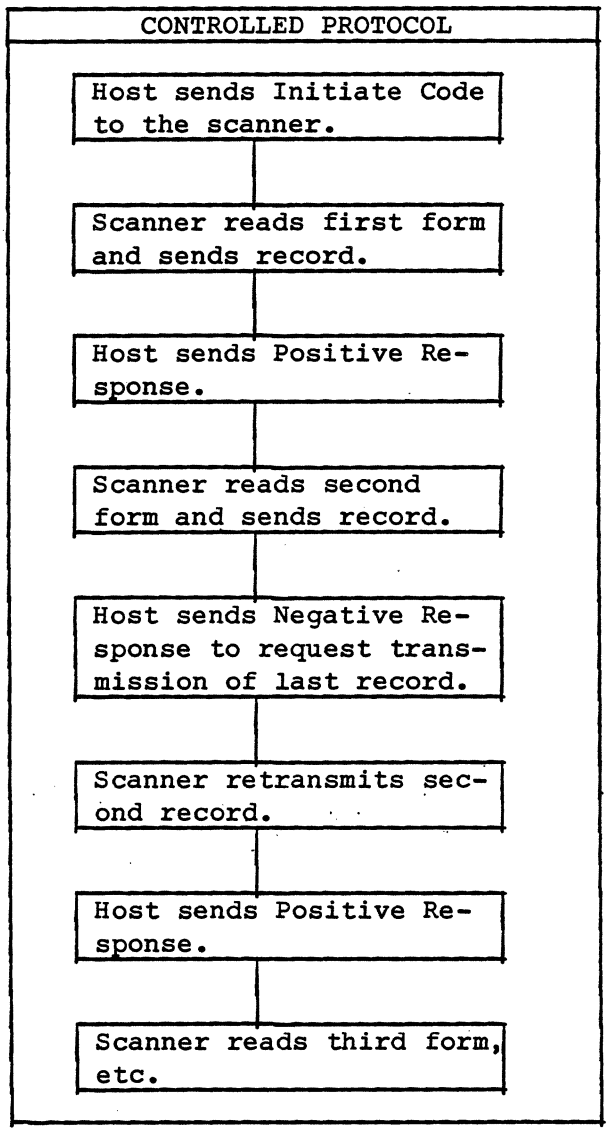
third and fourth illustrations also use a controlled protocol to show how control codes activate the scanner's optional printer and its auxiliary device capability.

## Uncontrolled Protocol

Protocol is uncontrolled when the transmission characteristics (baud rate, character format, and record format) are defined but control characters are not defined. (The End of Record and Start of Recrd codes may be defined in an uncontrolled protocol.) In an uncontrolled protocol, the Sentry 3000 scanner will transmit a record to the host computer as soon as it has one to send. It will not respond to or expect prompts or any other type of interaction from the host.




| CAUTION |
| --- |
| With an uncontrolled protocol, you will not be able to use the optional printer, auxiliary device, or send data to the scanner display. Also, if transmission errors occur, there is no retransmission recovery. |




EXPLANATION: CONTROL CHARACATERS (cont.)

Controlled Protocol

The scanner-host protocol is controlled when the codes for initial prompt (Initiate Code) and positive acknowledgment (Positive Response) are defined in the scanner configuration. The codes allow the host computer to determine when the scanner sends data. (The example is intended only as an illustration.)

A controlled protocol must be used if your scanner-host system will want to implement the following features:

- Auxiliary device
- Printing on documents
- Host ability to stop the scanner
- Host ability to send message to the scanner's display

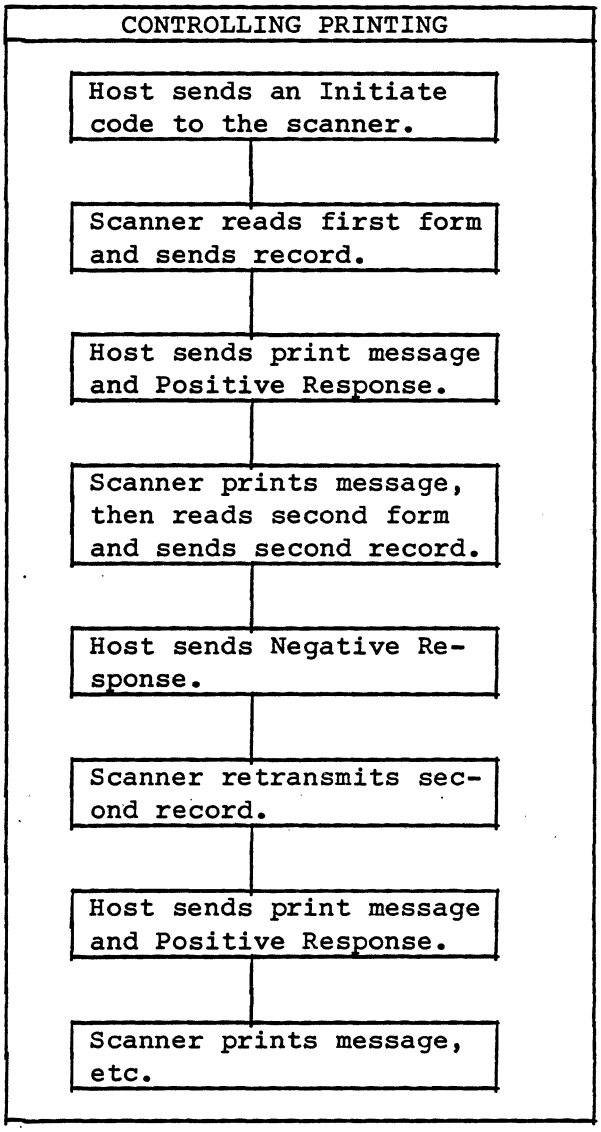
(Additional control codes must be defined in order to perform the functions listed above.)

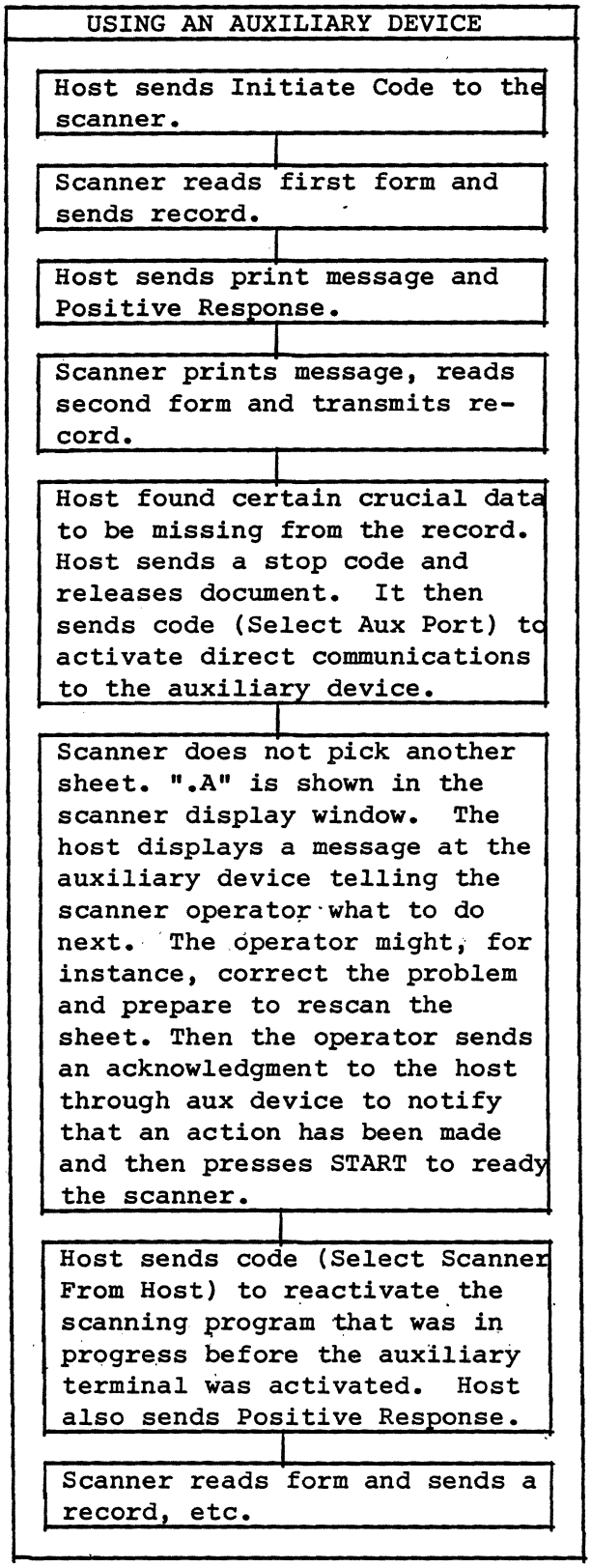
(Note that when more than one record per form must be transmitted, the scanner must receive a Positive Response between each record transmitted. When all data from the form has been sent to the host computer, the Positive Response tells the scanner to read the next form.)

EXPLANATION: CONTROL CHARACTERS (cont.)

## Printing Controls

Your scanner may have the optional printer which can print upper case ASCII characters directly on forms as they exit the scanner. A controlled protocol and definition of certain other control codes are required in order for the host to send messages to be printed on forms during scanning. This illustration is intended only as an example of how the printer might be used in your system. (More detail is provided in Section 2.)






EXPLANATION: CONTROL CHARACTERS (cont.)

Auxiliary Device

Your scanner may have an auxiliary device such as a CRT/keyboard attached to it. Again, a controlled protocol and definition of certain other control codes are required to utilize the auxiliary device. This illustration is intended only as an example of how the device might be used in your system. (More detail is provided in Section 2.)

SYSTEM CHARACTERISTICS WORKSHEET

BAUD RATE

___110
___300
___600
___1200
___2400
___4800
___9600

DATA CHARACTER FORMAT:

Stop Bits (check one):
___1 ___1-1/2 ___2

Character Bits (check one):
___7 ___8

Parity Bit (check one):
___Odd ___Even ___None

CONNECTION: ___Local ___Remote

RECORD FORMAT

Record Length Maximum (if any): _____ characters

Start of Record: ___Yes ___No If Yes, which characters?_____
(Maximum of 6)

End of Record: ___Yes ___No If Yes, which characters?_____
(Maximum of 6)

Check Character(s): ___Yes ___No

CONTROL CHARACTERS

Function

Initial Prompt: ___Yes ___No If Yes, from host or scanner?_____
and which character?_____

Positive Acknowledgment: ___Yes ___No If Yes, which character?_____

Negative Acknowledgment: ___Yes ___No If Yes, which character?_____

COMMENTS:

2

# CONFIGURING THE SCANNER

## INTRODUCTION

The protocol to be observed in communications between the host computer and the scanner is established within the scanner by marking and scanning an Asynchronous Communications Configurator Sheet. This process is called "configuration." This section describes the protocol characteristics and how to fill out and scan the sheet.

## OVERVIEW: CONFIGURATOR SHEET

Configuration is the process of marking and scanning the Sentry 3000 Asynchronous Configurator Sheet. Configuration establishes the transmission characteristics of the scanner and defines control characters that affect the scanner's activities.

## EXPLANATION: CHOOSING CODES

The only rule that applies to the selection of control characters is that control characters must be defined as the hexadecimal equivalent of characters in the ASCII code set. Other considerations are as follows:

- Define unique characters for each code
- Define only those codes that will be used.
- Parity, if configured, is added automatically by the scanner's software.

HEX-ASCII CONVERSION CHART

| 1st Hex Digit | | | | | | | | 2nd Hex Digit |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| NUL | DLE | SP | 0 | @ | P | ` | p | 0 |
| SOH | DC1 | ! | 1 | A | Q | a | q | 1 |
| STX | DC2 | " | 2 | B | R | b | r | 2 |
| ETX | DC3 | # | 3 | C | S | c | s | 3 |
| EOT | DC4 | $ | 4 | D | T | d | t | 4 |
| ENQ | NAK | % | 5 | E | U | e | u | 5 |
| ACK | SYN | & | 6 | F | V | f | v | 6 |
| BEL | ETB | ' | 7 | G | W | g | w | 7 |
| BS | CAN | ( | 8 | H | X | h | x | 8 |
| HT | EM | ) | 9 | I | Y | i | y | 9 |
| LF | SUB | * | : | J | Z | j | z | A |
| VT | ESC | + | ; | K | [ | k | { | B |
| FF | FS | , | < | L | \ | l | \| | C |
| CR | GS | - | = | M | ] | m | } | D |
| SO | RS | . | > | N | ^ | n | ~ | E |
| SI | US | / | ? | O | - | o | DEL | F |

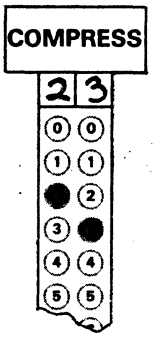
## EXPLANATION: MARKING THE SHEET

Follow these rules when filling out the Sentry 3000 Asynchronous Configurator Sheet:

- One and only one mark must be made in each of the MANDATORY GRIDS (Baud Rate, Parity, Character Bit Length, Stop Bits, and Check Sum)
- To mark the CHECK SUM grid, count the number of marks on the sheet and enter the ones position of the total

EXAMPLE

If the "#" character is to be selected for a code, 23 would be marked in the grid.



EXPLANATION: MARKING THE SHEET (cont.)

- If an entry is made in a two-column grid, both columns must contain a mark (e.g.: code a "#" by marking 2 in the first column and 3 in the second column
- If the RECORD LENGTH grid is to be marked, each of the four columns must contain one and only one mark. Fill in leading zeros if needed (e.g.: code 0080 for 80).
- Fill in the START OF RECORD and/or END OF RECORD grids (if desired) starting from the left. If one character is desired, make one mark in each of the left-most two columns. If two characters are desired, make one mark in each of the first four columns.

The following rules apply to making marks:

- Use a black lead (No. 2) pencil
- Do not use ink or ballpoint pens
- Make heavy black marks that fill the circle completely
- Erase cleanly any mark you wish to change
- Do not make any marks in the shaded areas of the form or on the back of the sheet. Stray marks could result in configuration errors

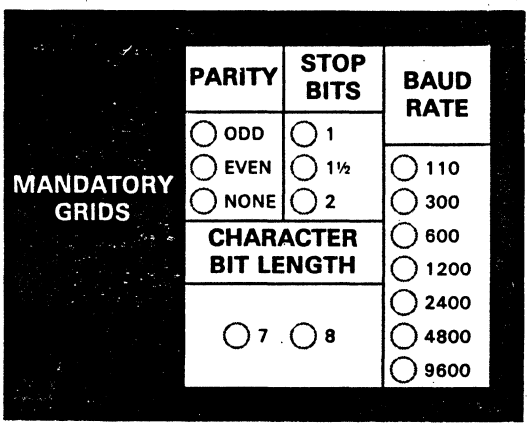
## OVERVIEW: TRANSMISSION CHARACTERISTICS

As discussed in Section 1, the transmission characteristics of baud rate, character format, and record format are determined by the host software and hardware characteristics. The scanner is configured to match these characteristics as described in the following pages.

## EXPLANATION: BAUD RATE

The baud rate selected must be the same as that of every component in the system. The baud rate is the rate of transmission in number of signal events per second. The scanner may be configured for one of the seven available baud rates shown.

BAUD RATE AND CHARACTER FORMAT:




## EXPLANATION: CHARACTER FORMAT

### Character Bit Length

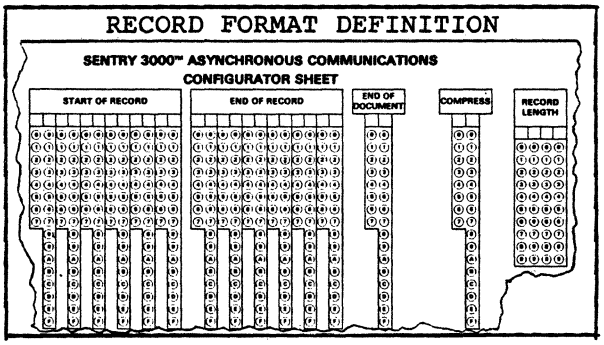
The number of bits used to transmit a single data character may be specified as 7 or 8. This number does not include the start, parity, or stop bits and only applies to the data bits.

### Stop Bits

The configuration may specify one, one and a half, or two bits for terminating transmission of each character.

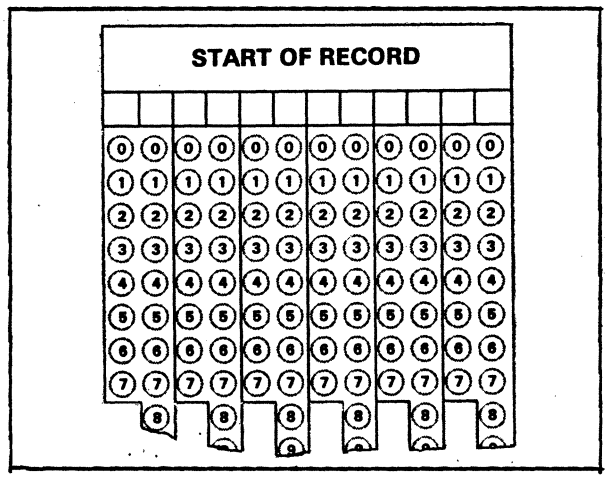
### Parity

Each data character transmitted by the scanner may be accompanied by a parity bit if desired. The parity bit provides a means of ensuring the integrity of transmission of each character.



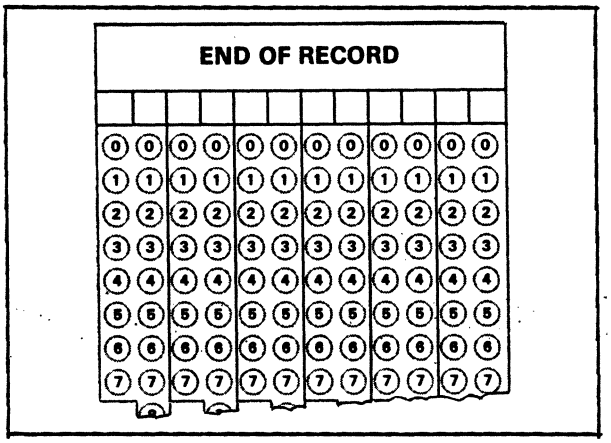

## EXPLANATION: RECORD FORMAT

If needed, the scanner has the ability to add specified control characters to the beginning and end of each data record, to add a check character to the record, to limit its record length, and to compress the record.



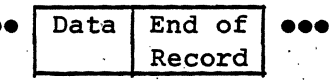

### Start of Record

This sequence of control characters, if defined, will be appended to the beginning of every record from the scanner and must also be at the beginning of every transmission containing data from the host. The sequence may be one to six characters long.


### End of Record

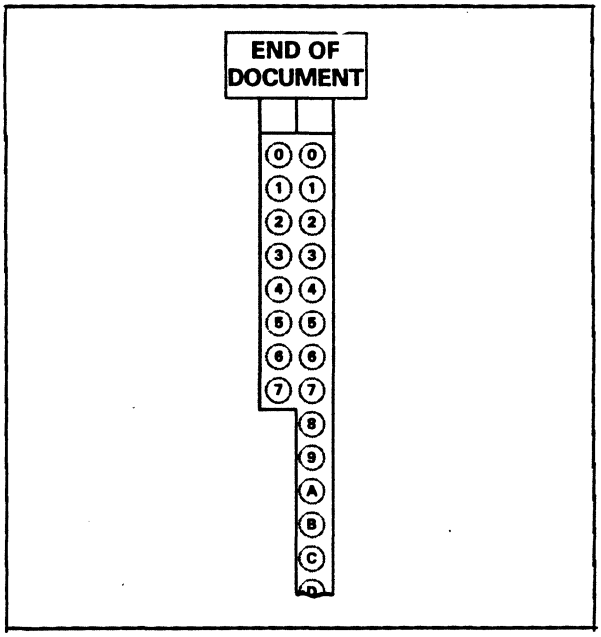
This sequence of control characters, if defined, will be appended to the end of every record from the scanner and must be at the end of data messages from the host. The code may be one to six characters long.



EXPLANATION: RECORD FORMAT (cont.)

End of Document

Another optional code called the End of Document code is used by the scanner to mark the end of data from a single form. This code might be useful if data from a single form will be transmitted to the host in more than one record (that is, if the record length is defined to be shorter than the data from a form) or if the data record will be compressed for transmission (so that variable record lengths are transmitted). If defined, the code will be appended to the end of the last record from a single form. It will precede the End of Record code.



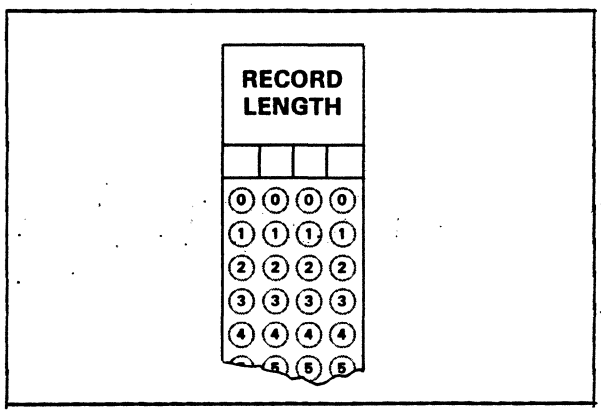

| ••• | Data Record | End of Document | End of Record | ••• |
|---|---|---|---|---|

Considerations: End of Document Code

- The character chosen must be a character different than ASCII 0-7 (30-37).
- This code is implemented when the scanner is running the ".C", scanning to communications, program.

Record Length

The RECORD LENGTH grid, if coded, determines the number of data characters (not including control characters) that are transmitted to the host one at a time. If the data from a form is shorter than the specified length, it will be a short record. If the data is longer than the specified length, the data will be transmitted in records each of which is the specified length. The last record may be a short record.



EXPLANATION: RECORD FORMAT (cont.)

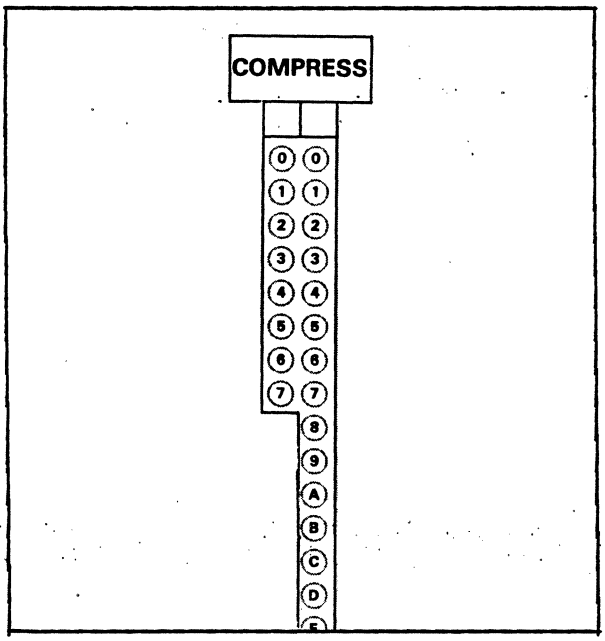
Record Length (cont.)

If the RECORD LENGTH grid is not marked, the scanner will transmit all data from a form in a single record. The maximum possible number of data characters for a single form is 48 times the number of timing marks on the form.

Considerations: Record Length

The number of control characters added to the record by the scanner must be considered when defining record length. For example, if two End of Record characters are the only characters which will be appended to the scanner record and the host can accept only 80 characters, specify the record length as 78.

Compressing Data




If desired, scanner records can be "compressed" for transmission to the host computer. Where the record contains four or more identical characters in a row, the characters will be compressed and transmitted as a three-character sequence.

The first character is a control character which notifies the host computer that a compression sequence is coming. This character will be the code entered in the COMPRESS grid on the Configurator Sheet. The second character is the number of times the compressed character appeared in the record before it was compressed. The third character in the sequence is the character that was compressed.

EXPLANATION: RECORD FORMAT (cont.)

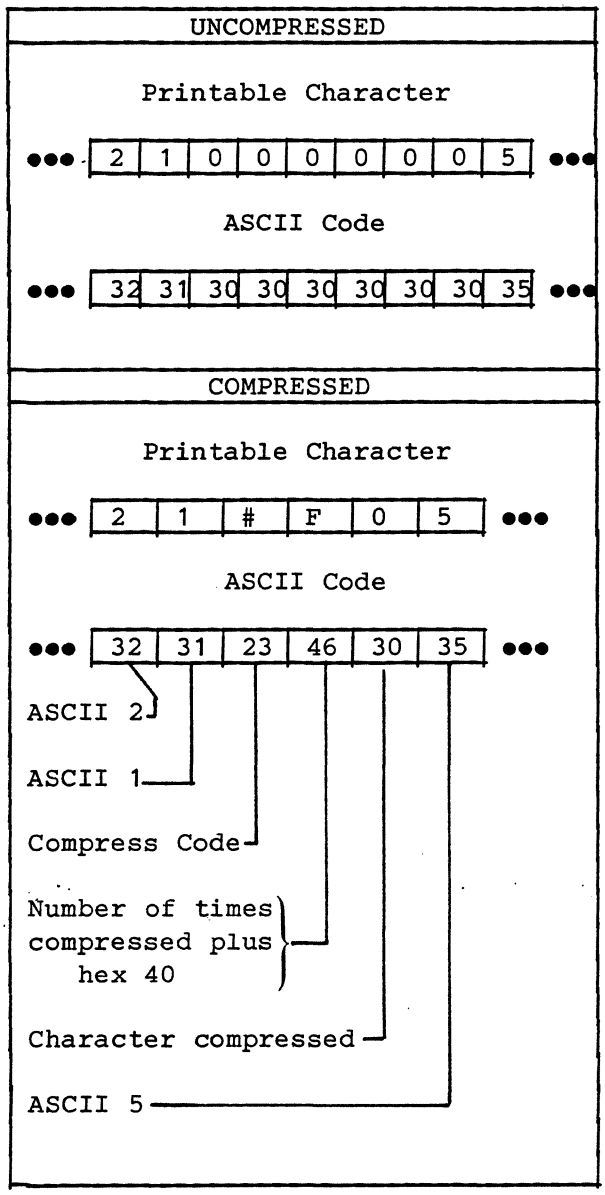
Compression Example

To illustrate how the scanner compresses data in the record, nine characters from an imaginary record are shown uncompressed and compressed.

Since there is an uninterrupted series of six zeros, the zeros will be compressed into a three-character sequence for transmission. The first character in the compression sequence will be an ASCII # (23) because 23 was marked in the COMPRESS grid on the Configurator Sheet in this example. This character cues the host to interpret the next character as the number of times the third character in the sequence appeared in the record before compression.

The second character in the compression sequence is an ASCII F (46). This is computed by adding a 06 (number of times the character appears) to a 40 in order to make the value an ASCII code for transmission.

The third character in the compression sequence will be an ASCII character between 0 and 7 (30-37), representing read values 0 through 7. (See Section 3 for more on read values.)




Considerations: Data Compression

- The COMPRESS control character must not be an ASCII character between 0 and 7 (30-37).
- Data compression will not be implemented when transmitting records using the scoring (".S") program.

EXPLANATION: RECORD FORMAT (cont.)

Considerations: Data Compression (cont.)

- If the COMPRESS code is defined, the records will be of variable length.

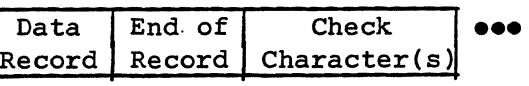
- The maximum value for the second character is 7F, representing a compression of 63 like characters. The minimum value is 44, representing a compression of 4 characters.

EXPLANATION: RECORD FORMAT (cont.)

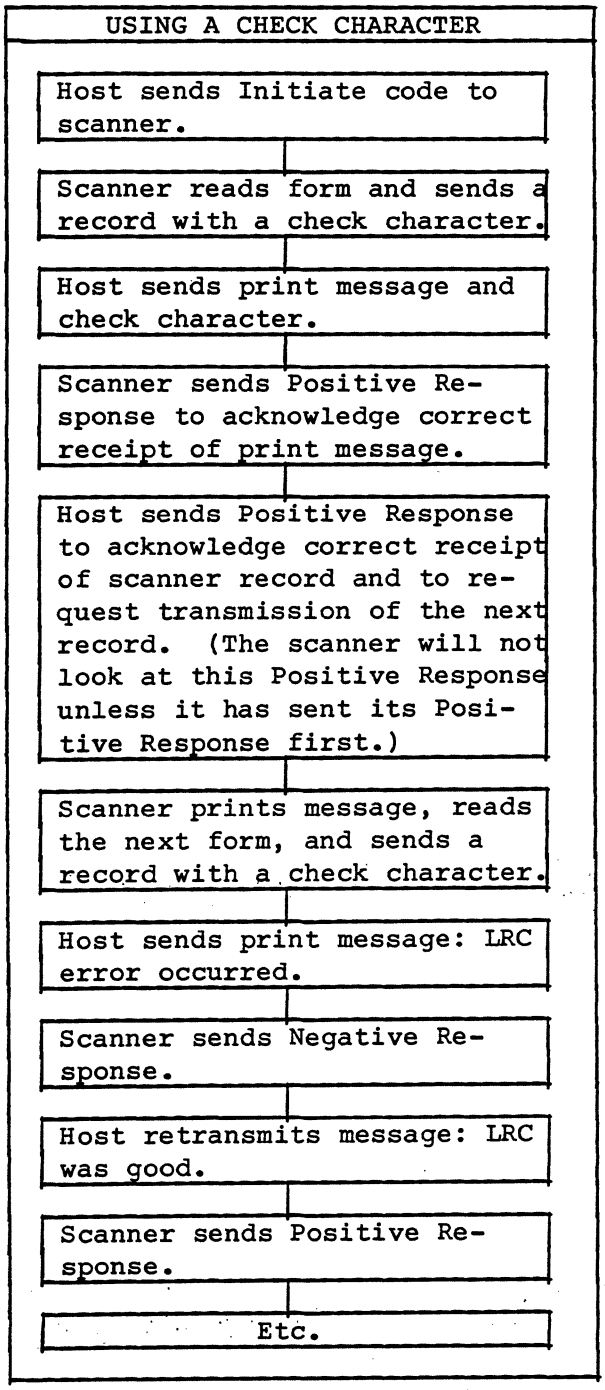
Check Character

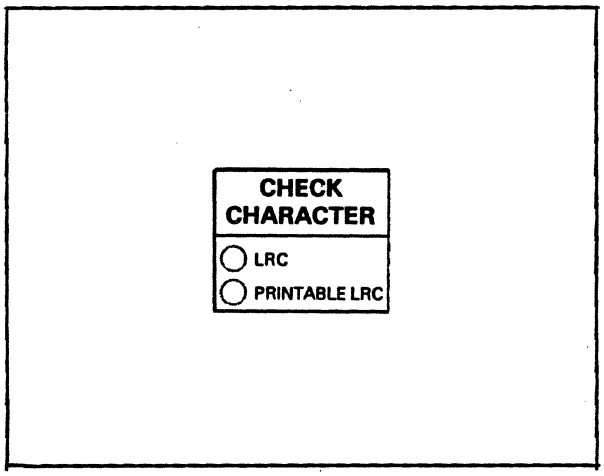
If desired to further ensure data transmission integrity, the scanner can be configured to calculate one or two block check character(s) (Longitudinal Redundancy Character (LRC)).

One character will be sent if LRC is marked on the Configurator Sheet, or two characters if PRINTABLE LRC is marked. The character(s) will be the last character(s) of every transmission of data from and to the scanner.




When a check character is defined, the device that receives data will be expected to acknowledge proper receipt of the message or request retransmission of it. In the illustration to the right, the host sends a print message to the scanner. A similar interchange would occur if the host were to send a character to the scanner's display or a message to the auxiliary device. Note the difference between this sequence and that shown on page 1-15.






EXPLANATION: RECORD FORMAT (cont.)

Check Character (cont.)

The check character(s) will be calculated on all characters and codes after the Start of Record code up to and including the End of Record code(s).

The LRC is calculated by taking the binary sum without carry (exclusive OR). To make the check character printable, it is transformed into two characters in the ASCII code set. For example, a check character of hex A4 is transformed into two characters as follows:

Check Character

1010 0100 (hex A4)

First Character

0000 1010 (hex 0A)
0100 0000 (hex 40)
0100 1010 (hex 4A)

Second Character

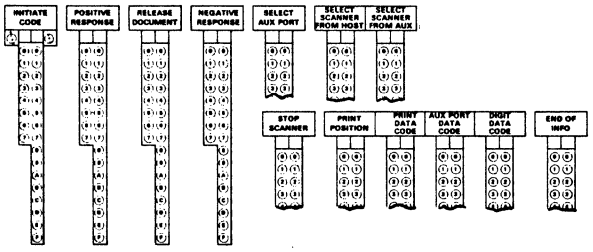
0000 0100 (hex 04)
0100 0000 (hex 40)
0100 0100 (hex 44)

## OVERVIEW: CONTROLLED PROTOCOL

The following pages describe optional control codes which must be defined in order for the host computer to control certain scanner actions. Scanner actions and the codes needed to control them are listed on the right.

If the protocol is to be controlled (that is, any of the codes listed are to be defined), then the Positive Response must be defined.

CONTROL CODES

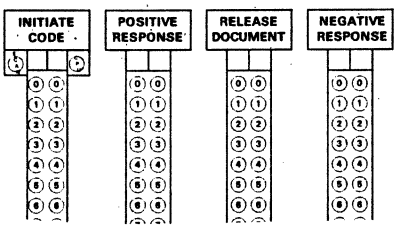


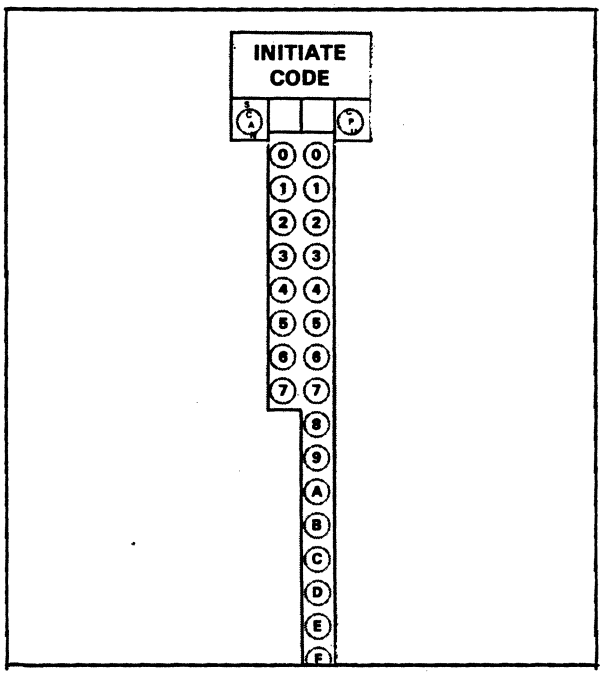

| CLASSIFICATION OF CONTROL CODES |
|---|
| Record Transmission<br>INITIATE CODE<br>POSITIVE RESPONSE<br>RELEASE DOCUMENT<br>NEGATIVE RESPONSE |
| Using the Auxiliary Device<br>SELECT AUX PORT<br>SELECT SCANNER (FROM HOST or FROM AUX) |
| Stopping the Scanner<br>STOP SCANNER |
| Printing on Forms<br>PRINT POSITION<br>PRINT DATA CODE<br>END OF INFORMATION |
| Displaying a Message at Aux. Device<br>AUX PORT DATA CODE<br>END OF INFORMATION |
| Displaying a Character at the Scanner<br>DIGIT DATA CODE<br>END OF INFORMATION |

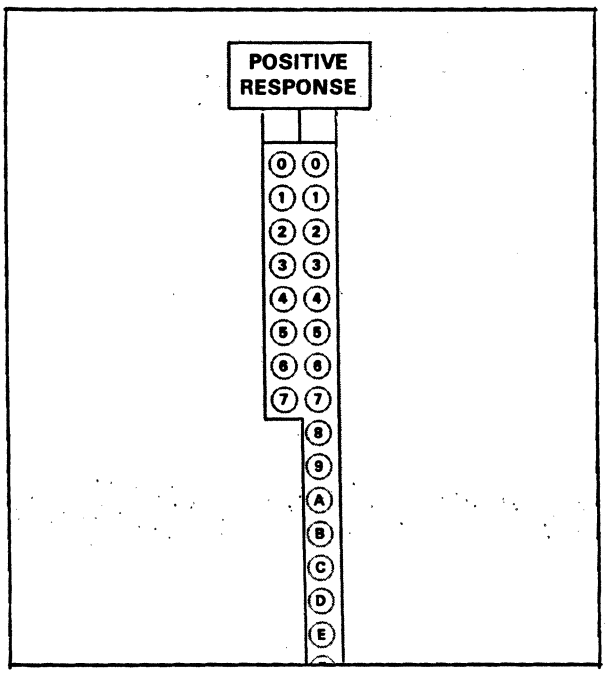
## EXPLANATION: RECORD TRANSMISSION

Four control codes can be configured for regulating when the scanner sends records to the host computer. The Positive Response code is required in order to define and use any of the other control codes.

PROMPT CODES






## EXPLANATION: RECORD TRANSMISSION (cont.)

### Initiate Code

If an Initiate code is used, the Initiate code will be the first transmission after the scanner operator starts a program that transmits records to the host. Before the first sheet is scanned, the code will be sent by the host if CPU is marked or by the scanner if SCAN is marked. If the Initiate code comes from the scanner, it will be repeated every three seconds until a Positive Response is received by the scanner. The scanner will not recognize any other transmissions after the Positive Response until it has sent the first record for a sheet. If the Initiate code comes from the host, the scanner will not recognize anything after the Initiate code until it sends its first record. (If no Initiate code is defined, the scanner's first record will be transmitted as soon as it exists.)

### Positive Response

The Positive Response code, if defined, is used by both the host and the scanner. The Positive Response code is sent by the host to acknowledge correct receipt of the last transmission and to request transmission of the next record. If all records from the current form have been transmitted, the code will cause the scanner to scan the next sheet.

The scanner will send the Positive Response code (if defined) to the host when a check character is being used and the host sends data (PRINT DATA CODE, DIGIT DATA CODE, or AUX PORT DATA CODE) to the scanner.

This code is usually defined to be the same character as the Initiate code but you may define it differently, if desired.

Release Document

The Release Document code terminates transmission of the current form, clears the communications buffer, and releases the document to the output stacker.

Negative Response

The host and the scanner use the Negative Response code to request retransmission of the last transmission.

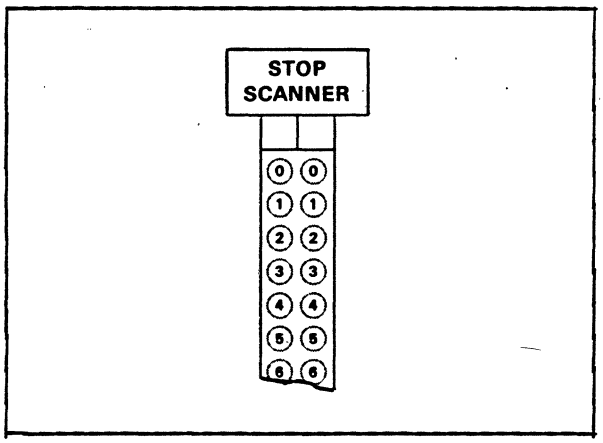
CONSIDERATIONS: TRANSMISSION

There is a built-in delay of 200 milliseconds in the scanner between receipt of any transmission from the host and transmission of data from the scanner. This is normally noticeable only when transmitting more than one record per sheet.

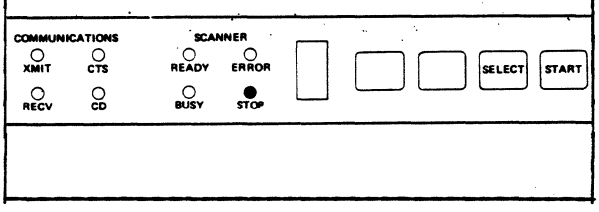
EXPLANATION: STOPPING THE SCANNER

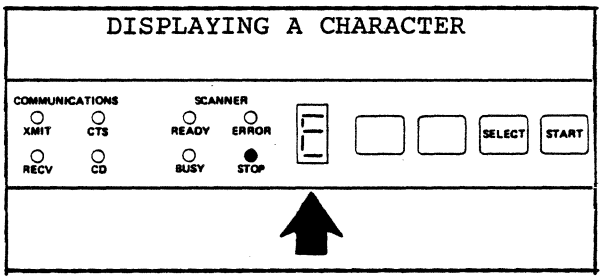
If the host is to have the capability of stopping the scanner, the Stop Scanner code must be defined. When the host sends the optional Stop Scanner code, the Stop light on the scanner's operator panel comes on and no new sheet may be picked by the scanner. The host might use this code in conjunction with the Digit Data code or Aux Port Data code to send operator messages for editing forms during scanning.

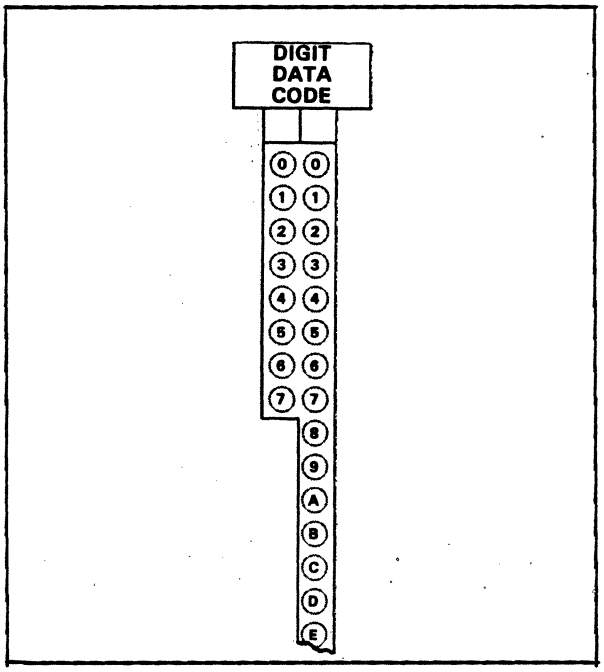
(To continue scanning, two things must occur. The scanner must receive a Postive Response or Release Document code and then the operator must press START.)




STOP LIGHT ON OPERATOR PANEL






| | | | |
|---|---|---|---|
| Print Position Code | Position | EOI | ●●● |
| Print Data Code | Data | EOI | ●●● |
| Digit Data Code | Digit | EOI | ●●● |
| Aux Port Data | Data | EOI | ●●● |

## EXPLANATION: DISPLAYING A CHARACTER

If the host needs to be able to send a character(s) to the display of the scanner's operator panel, then the Digit Data code and End of Information code must be defined.

### Digit Data Code

The Digit Data code will precede one character (an ASCII-coded 0-9, A-F) which in turn is followed immediately by the End of Information code. Additional characters, if desired, must be sent one at a time with the Digit Data and End of Information codes with a delay in between to provide time for the operator to see each of the characters. Note that the letter "B" will be displayed as "b" and the letter "D" as a "d".

| | | | |
|---|---|---|---|
| Digit Data Code | ASCII-coded Character | End of Information Code | ●●● |

Be sure to envelop the message with the start- and end-of-record codes, if defined.

### End of Information Code

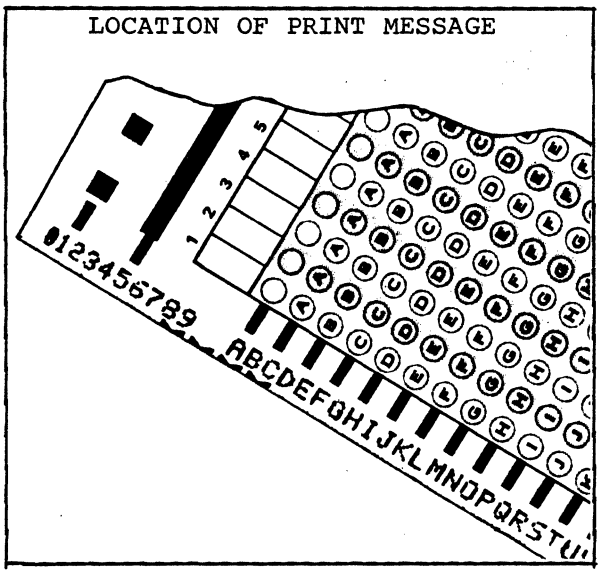
This code must be defined if any of the following codes are defined:

- Print Position code
- Print Data code
- Digit Data code
- Aux Port Data code

The codes envelop data transmitted to the scanner. For example, in order to send print data to the scanner, the data must be preceded by the Print Data code and followed by the End of Information code.

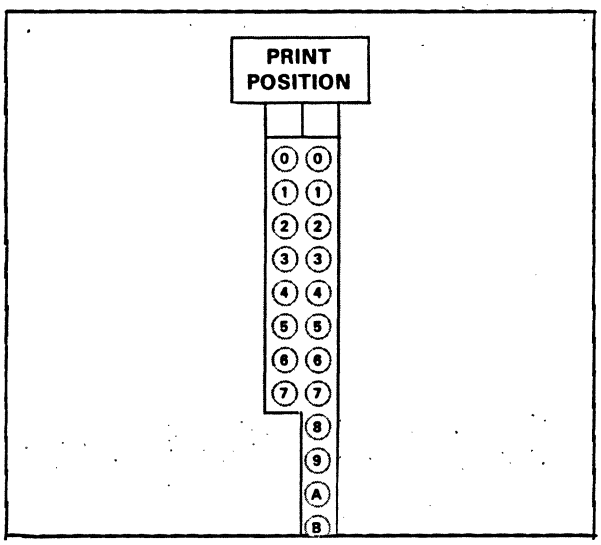
EXPLANATION: PRINTING ON FORMS

If your scanner has the optional printer, it is possible for the host to send messages to the scanner that will be printed in a specified location on the form. Up to 110 characters may be printed on a 12-inch long form and the printing is located between the timing track and the guide edge. The message sent from the host must be preceded by a Print Data code and followed by an End of Information code. In addition, it is possible for the host to define where on the form the printing will begin. To do this the host sends a Print Position code, the printing start position, and an End of Information code. If no print position is defined, printing begins at the leading edge of the form. The print message will be printed once the host program releases the document. A Positive Response or Release Document code will perform this function.

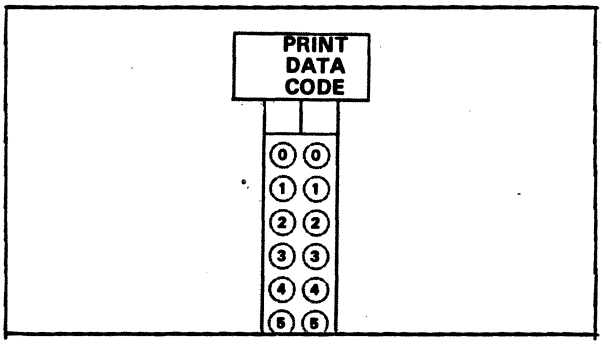



Print Position Code

The Print Position code, if defined, precedes one, two, or three ASCII-coded characters that specify the position on the form where the print message is to begin. The characters indicating the position must be terminated by the End of Information code. The position might be specified as an ASCII-coded 1 to indicate the message should begin at the leading edge of the form as shown on page 2-15 or any number up to 110 to indicate a location near the end of the form. If the print position is not specified, the message will begin in the first position.



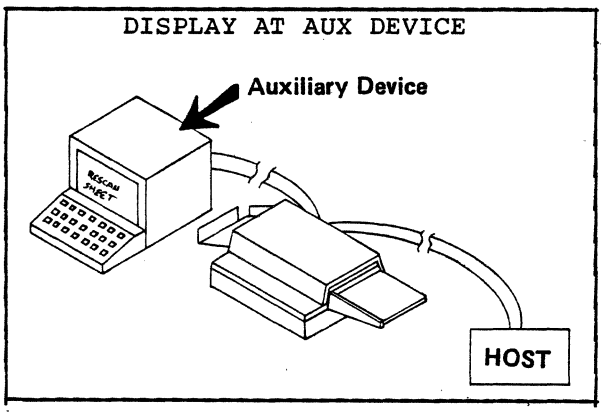

| Print Position code | ASCII-code character(s) | End of Information |
|---|---|---|




## Print Data Code

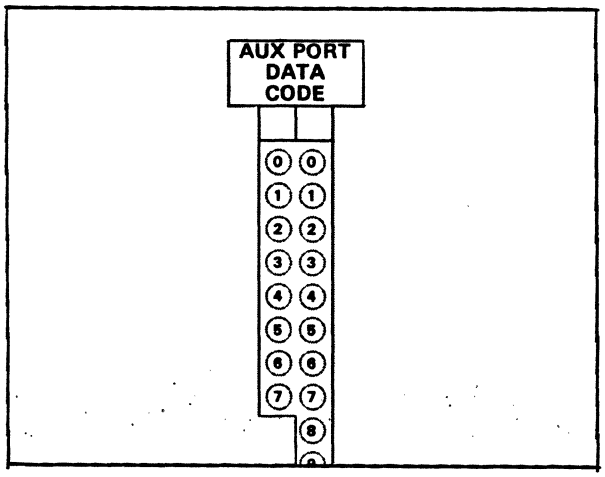
The Print Data code must be defined in order for the host to send messages to the scanner's optional printer. If used, this code precedes the ASCII-coded print message. The print message may contain up to 110 characters and must be terminated by the End of Information code.

| Print Data code | ASCII-coded characters | End of Information code |
|---|---|---|




## EXPLANATION: DISPLAY AT AUX DEVICE

If your scanner has an auxiliary device attached directly to the scanner, certain codes must be defined to implement the device to display (or print) records or messages for the scanner operator. (Note the difference between this and the discussion on page 2-19, "Using the Auxiliary Device.")




## Aux Port Data Code

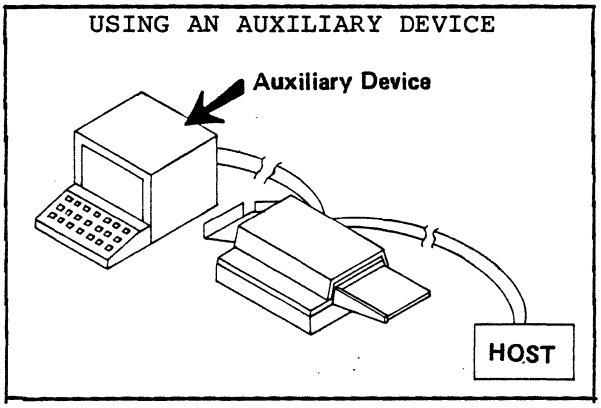
The Aux Port Data code is used to precede the characters to be displayed (or printed) at the auxiliary device. The message must be made up of ASCII-coded characters and must be terminated by the End of Information code.

When the message is received by the scanner, it will be displayed on the auxiliary device.

| Aux Port Data code | ASCII-coded message | End of Information |
|---|---|---|

## EXPLANATION: USING THE AUX. DEVICE

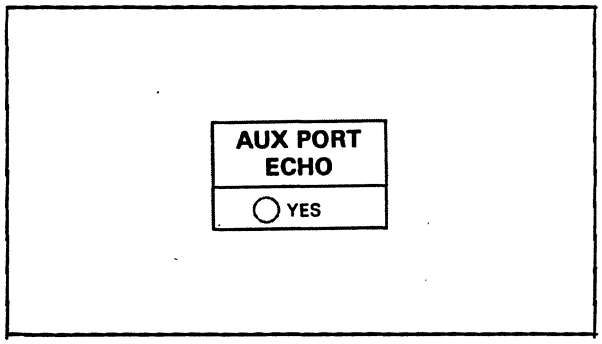
If your scanner has an auxiliary device attached to the scanner, certain control codes will open a direct communications link between the host computer and the auxiliary device and deactivate the scanner.




### Aux Port Echo

When the scanner operator enters data at the auxiliary device, the characters will be displayed on the terminal if:

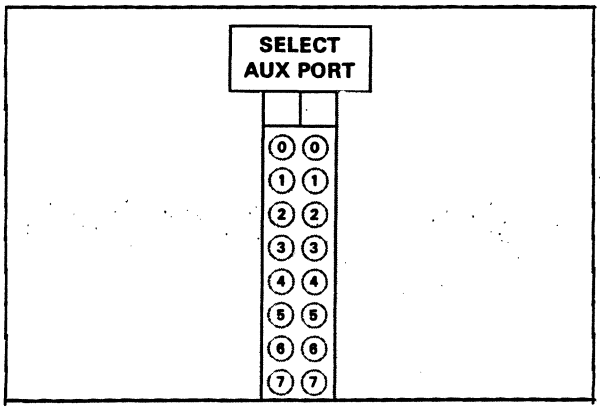
- The host computer echoes the data back to the terminal automatically, or
- The scanner is configured for Aux Port Echo




If the host computer does not echo back the data and if you desire to see the characters displayed on the terminal, mark YES in the AUX PORT ECHO grid of the Configurator Sheet.

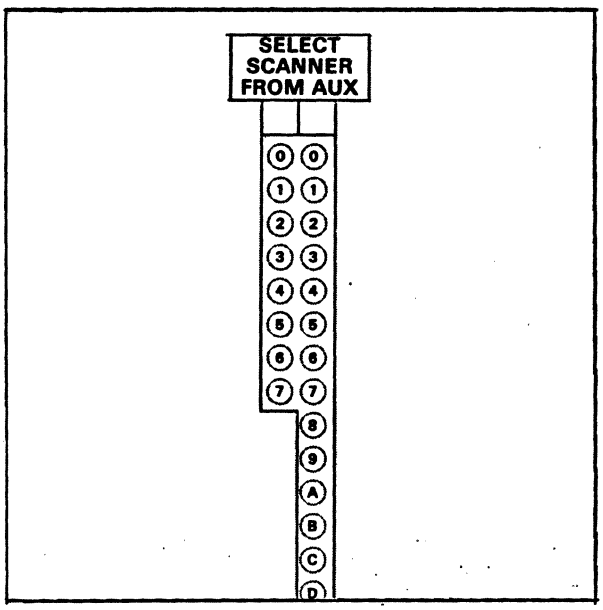
### Select Aux Port

If desired, the auxiliary device may be activated by the host computer using the Select Aux Port code. The scanner must transmit a record to the host computer before it will recognize the Select Aux Port code. This code disables the scanner and causes an ".A" to be displayed on the operator panel. All further output from the host is directed to the auxiliary terminal and input from the terminal



Select Aux Port (cont.)

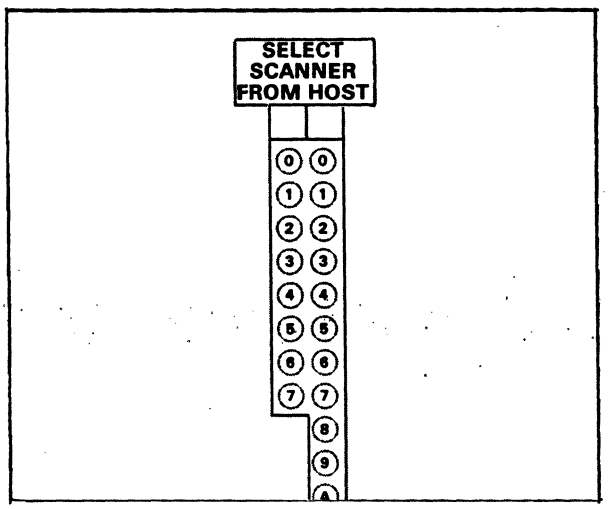
is sent directly to the host. No formatting of data is performed in either direction. The scanner remains disabled until a Select Scanner From Aux code or Select Scanner From Host code is sent over the scanner's communications line.




Select Scanner From Aux

This code, if defined, is sent by the auxiliary device to the scanner to re-enable the scanner after a direct interchange between the host and the device is completed. The scanner's display will be returned to the program that was active when ".A" appeared. Once this code is received by the scanner, the direct communications link between the host and the auxiliary terminal is disabled. This code is transmitted to the host computer.

Note that this code will not re-enable the scanner if the aux device was selected by the operator from the scanner's control panel.




Select Scanner From Host

This code is sent by the host computer to the scanner to re-enable the scanner after a direct interchange between the host and the auxiliary device is completed. The ".A" in the scanner's display will be replaced by the program that was active when ".A" appeared.

Note that this code will not re-enable the scanner if the aux device was selected by the operator from the scanner's control panel.

## OVERVIEW: CONFIGURATION

Once the Sentry 3000 Asynchronous Communications Sheet has been filled out, the sheet must be scanned and the menu of system programs defined.

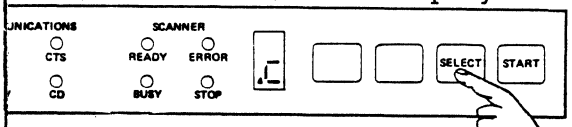
## EXPLANATION: SCANNING THE SHEET

To scan the sheet, press and hold SEL for 10 seconds until ".c" (calibration) is displayed on the operator panel. Then, release and press SEL within 3 seconds to display ".d" (define configuration). Press START within 3 seconds or you will have to repeat this procedure.

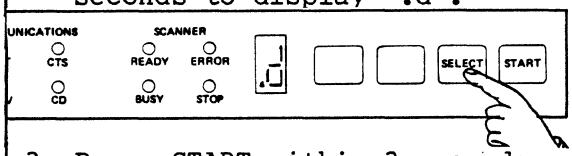
Then feed the Sentry 3000 Asynchronous Communications Configurator Sheet into the scanner. The sheet is fed into the scanner with the timing track (column of small black rectangles) on the left side of the sheet. Be sure the left edge is completely against the guide rail of the input tray.

### PROCEDURE SUMMARY

1. Press and hold SEL for 10 seconds until ".c" is displayed.

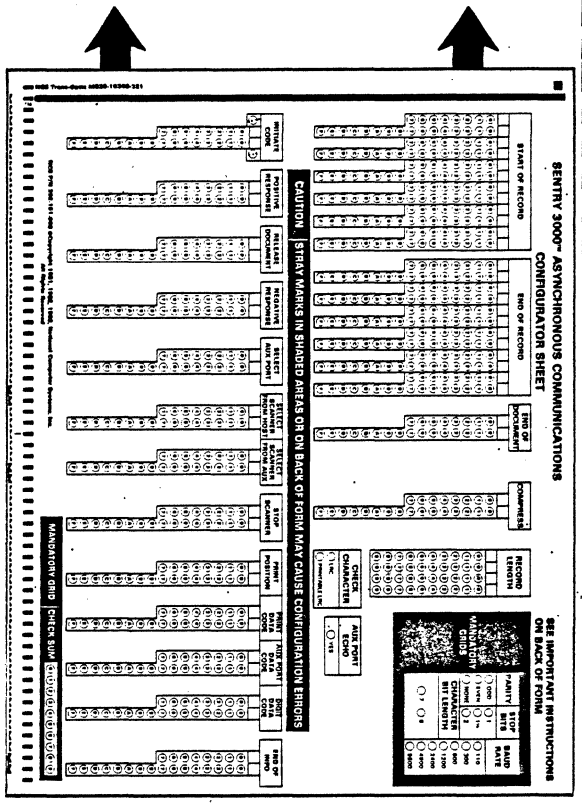



2. Release and press SEL within 3 seconds to display ".d".




3. Press START within 3 seconds and feed the sheet. The sheet must be fed into the scanner as shown below.

DIRECTION INTO SCANNER



| ERROR MESSAGE | GRID WITH ERROR |
|---|---|
| .d00 | Sheet not recognized |
| .d01 | START OF RECORD |
| .d02 | END OF RECORD |
| .d03 | INITIATE CODE |
| .d04 | INITIATE CODE (SCAN or CPU) |
| .d05 | POSITIVE RESPONSE |
| .d06 | RELEASE DOCUMENT |
| .d07 | NEGATIVE RESPONSE |
| .d08 | SELECT AUX PORT |
| .d09 | SELECT SCANNER FROM HOST |
| .d0A | SELECT SCANNER FROM AUX |
| .d0b | STOP SCANNER |
| .d0C | PRINT POSITION |
| .d0d | PRINT DATA |
| .d0E | AUX PORT DATA |
| .d0F | DIGIT DATA |
| .d10 | END OF INFORMATION |
| .d11 | END OF DOCUMENT |
| .d12 | COMPRESS |
| .d13 | RECORD LENGTH |
| .d14 | CHECK CHARACTER |
| .d15 | AUX PORT ECHO |
| .d16 | PARITY |
| .d17 | STOP BITS |
| .d18 | CHARACTER BIT LENGTH |
| .d19 | BAUD RATE |
| .d1A | CHECK SUM |

## EXPLANATION: RECONFIGURATION

Configuration parameters may be changed by marking and scanning a new Sentry 3000 Asynchronous Communications Configurator Sheet. Any parameters may be changed as long as they are consistent with the requirements of the scanner, the host computer, and all other system components. The rules for reconfiguration are the same as those presented in the preceding pages.

## EXPLANATION: CONFIGURATION ERROR MESSAGES

The list to the left shows the three-digit error messages that will be displayed if the coding of the specified grids is not correct. The error message will be a repeating sequence of the three digits. The message will be displayed on the scanner's operator panel when the feed bed motor stops and the ERROR light is lit.

If no error occurs when the sheet is scanned, the first menu item (.C, .A, or .S) will automatically be displayed after the sheet is read.

## CONSIDERATIONS: CONFIGURATION

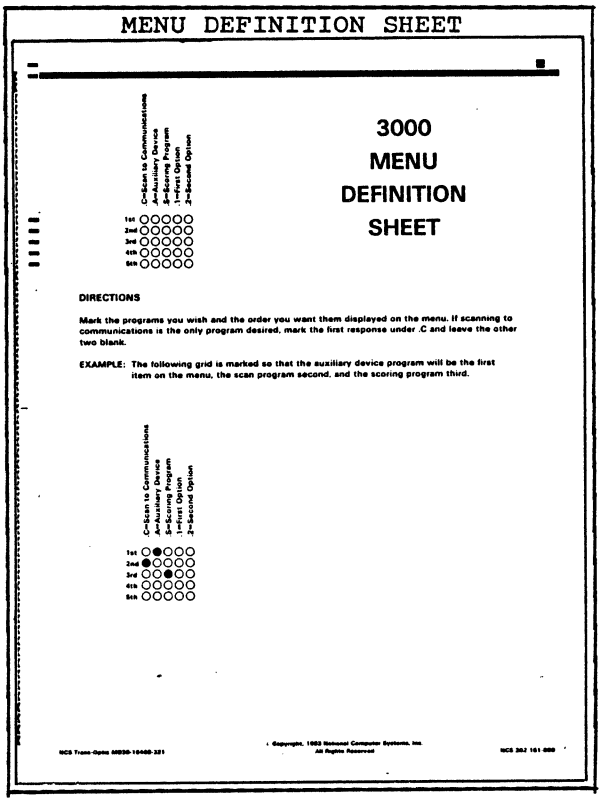
- When the Configurator Sheet has been scanned successfully, store it in a protective covering in the front pocket of the Sentry 3000 loose-leaf binder.

## EXPLANATION: MENU DEFINITION

The ".d" (define) program also scans the Menu Definition Sheet. The Menu Definition Sheet determines the order in which the scanner programs are listed in the display. The scanner programs are:

- .C = Communications
- .S = Scoring
- .A = Auxiliary Device

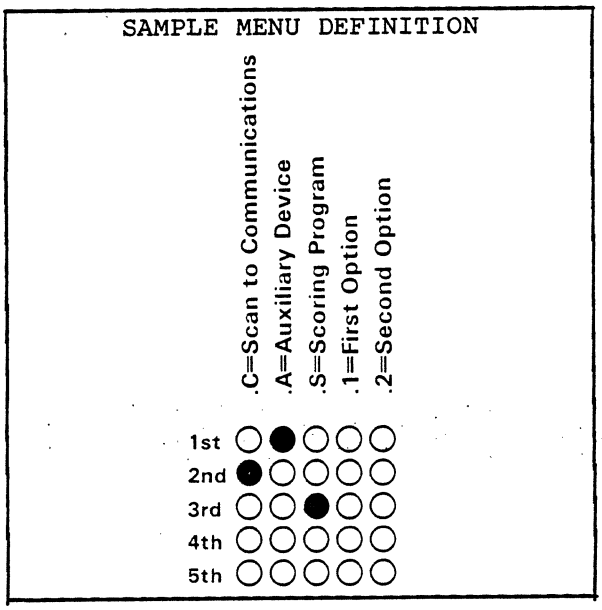
MENU DEFINITION SHEET

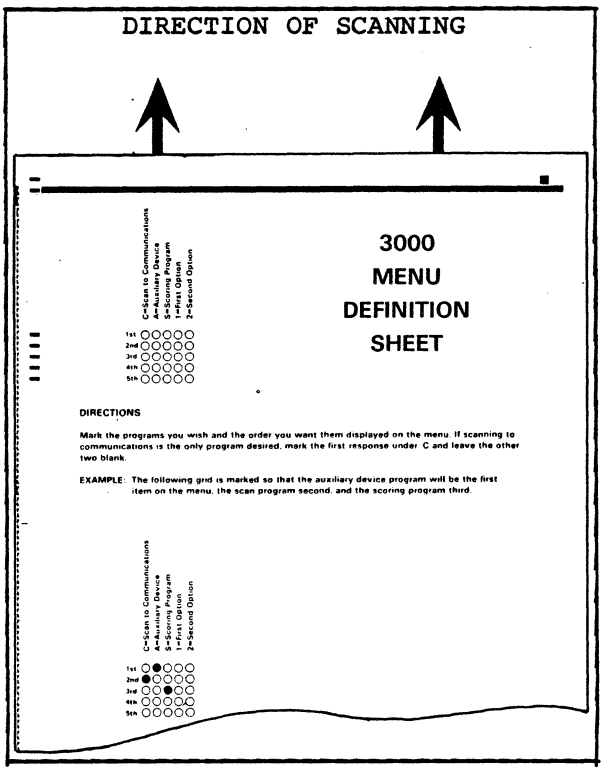



The sheet must be marked so that there is one and only one mark in the row labeled "1st." If a second program is desired, then there must also be one and only one mark in the row labeled "2nd," etc. In the illustration shown, the sheet has been marked so that:

- ●.A = the first menu program
- ●.C = the second menu program
- ●.S = the third menu program

SAMPLE MENU DEFINITION






| ERROR MESSAGE | ERROR |
|---|---|
| .d00 | Sheet not recognized |
| .d20 | Grid coded incorrectly |

EXPLANATION: MENU DEFINITION (cont.)

The procedure for scanning the sheet is the same as for the Configurator Sheet. The orientation of the sheet as it is fed into the scanner is shown here. Be sure the left edge is completely against the guide rail of the input tray.

Once the sheet has been scanned successfully, the display will show the letter specified as "1st" on the Menu Definition Sheet. Press SEL to display the second item and press it again to display the third item (if specified on the sheet).

The error codes to the left show the three-digit mesages that will be displayed if the sheet was scanned incorrectly, if the wrong sheet was scanned, or if the grid was filled out incorrectly. The error message will be a repeating sequence of the three digits. The message will be displayed on the scanner's operator panel when the feed bed motor stops and the ERROR light is lit.

CONSIDERATIONS: MENU DEFINITION

- Do not define the menu to include programs that will not be used. For example, if the scanner will be used for scoring only, define ".S" as the first and only menu item.

CONSIDERATIONS: MENU DEFINITION (cont.)

oIf ".A" (auxiliary device) is defined to be the first program in the menu, the communications link between the host computer and the auxiliary device will be activated automatically when the scanner is powered ON.

oThe first program in the menu is activated automatically when the scanner is powered ON.

HOTLINE ASSISTANCE

For assistance in defining and configuring communications for your system, call the 3000 Hotline, 1-800-328-3518. In Minnesota, call 830-7600 and ask for the 3000 Hotline.

3

# INTERPRETING THE SCANNER RECORD

## INTRODUCTION

This section describes the records transmitted by the scanner to the host computer and the functions that must be performed by the host application program. The scanner record sent to the host computer depends on the scanner program used to create the record. The ".C" (communications) program of the scanner transmits a series of read levels. These read levels are then interpreted by the host application program.

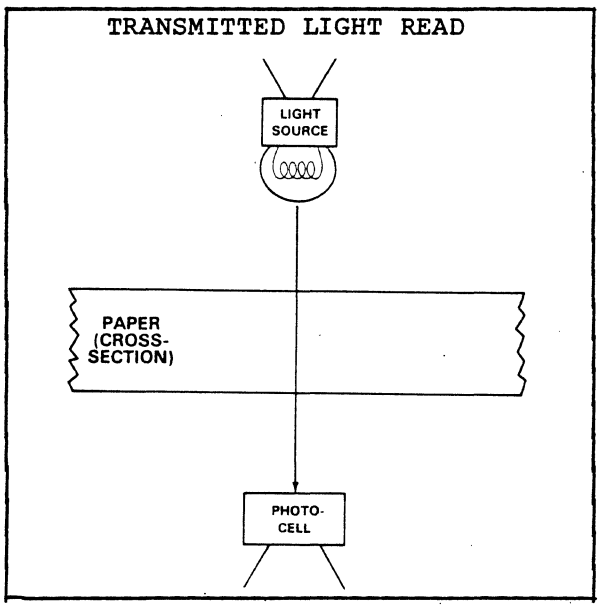
The ".S" (scoring) program reads, processes, and scores one particular form (the Classroom Answer Sheet). When scanning sheets using the ".S" program, the scanner transmits organized records to the host.

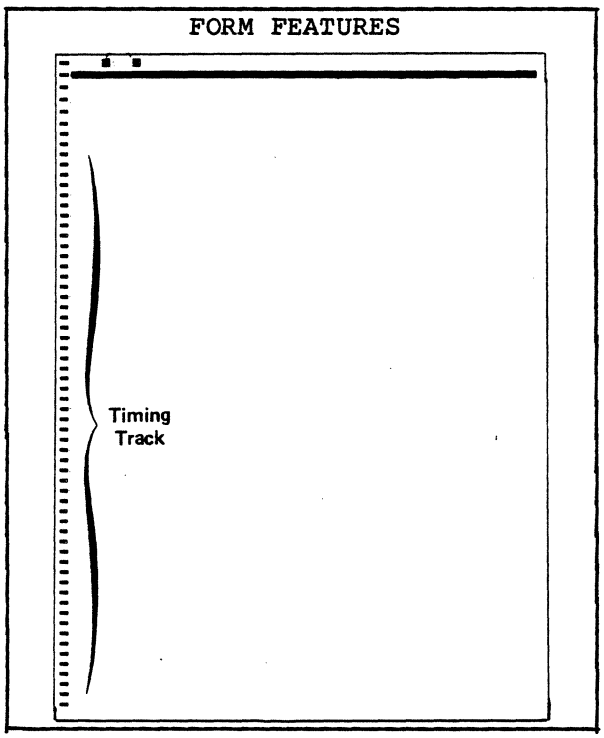
## OVERVIEW: ".C" PROGRAM RECORDS

The ".C" program scans sheets and transmits a series of read levels to the host computer. The following paragraphs describe how the read levels are generated and how they comprise an image of the sheet.

## EXPLANATION: READ TECHNIQUE

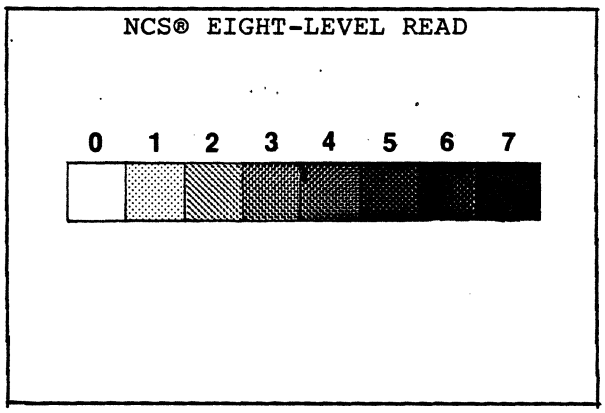
To understand the record generated by the ".C" program, the scanner's read technique must first be understood. The Sentry™ 3000 scanner detects marks on forms using the "read head" which is a collection of 48 light sources above the form and 48 photocells below the form. Each of the 48 light sources beams light through the form and each photocell records the amount of light that passes through the form. In this way, the scanner reads both sides of the form at one pass through the scanner. This is called "transmitted light read."






EXPLANATION: TIMING MARKS

Special features of the form called "timing marks" cue the scanner's read head to read across the form. The column of timing marks is called the "timing track." The timing track is read by the photocell closest to the front of the scanner. This is why forms must always be fed into the scanner with the timing track on the left side ("guide edge") of the form.




EXPLANATION: READ LEVELS

A read level is an ASCII-coded character (0,1,2,3,4,5,6, or 7) which indicates the amount of light blocked at one position on the form. If no mark is present on the form in a particular position, the scanner will report a read level of 0 or 1. When a dark mark made with a No. 2 lead pencil is scanned, a value of 6 or 7 is assigned. Smudges and erasures will be reported by values of 1,2, or 3. Light marks will be reported as 4 or 5.

Each time the read head encounters a timing mark as the form passes through the scanner, 47 read levels plus one special value are stored in the scanner's buffer. The 47 read levels correspond to the 47 positions across an 8-1/2 inch form. The 48th value is

EXPLANATION: READ LEVELS (cont.)

the number of times that the line was scanned as the form passed under the read head.

The first read level from the form corresponds to the position on the form that is closest to the first timing mark on the leading edge of the form. The second value corresponds to the second possible response position away from the first timing mark, the third value to the third possible position, and so on.

Each time a new timing mark is read, 48 more values are added to the scanner's buffer for that form.

When the whole form has been read then the record can be transmitted to the host computer for processing.

CONSIDERATIONS: MARK READING

- 48 values are assigned even when the form is not 8-1/2" (47 response positions) wide.

## OVERVIEW: HOST PROGRAMMING

As discussed in Sections 1 and 2, the host can control the scanner by sending programmer-defined codes to the scanner. But in order to process scanner records, the host application program should be designed to:

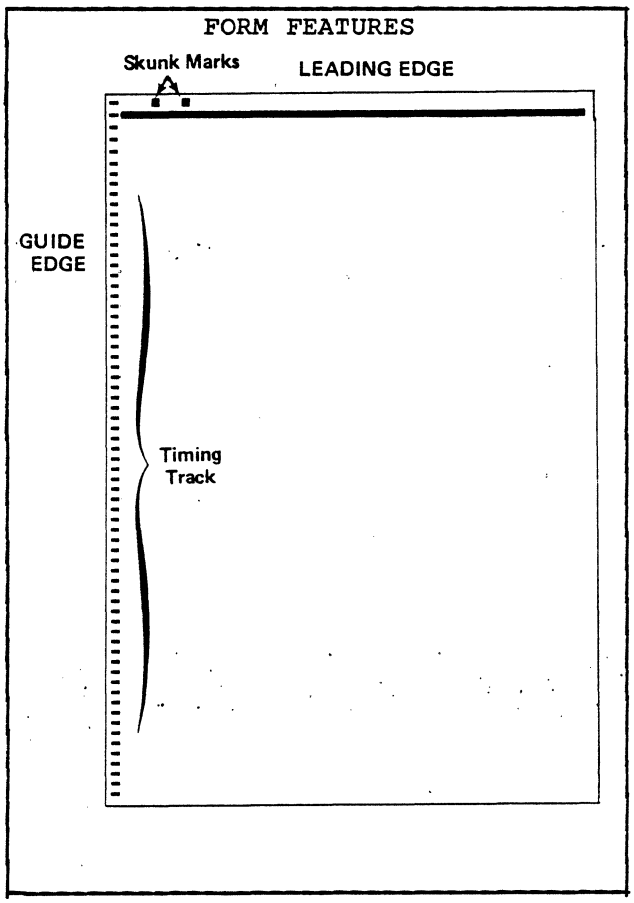
- Recognize forms
- Expand compressed data to full sheet image record
- Evaluate read levels to select marks
- Discriminate between intended marks and erasures
- Identify multiple marks and absence of marks
- Flag or correct incomplete records

(Note that users who have other NCS scanners in their operating system should refer to Appendix B for special programming considerations.)

## EXPLANATION: FORMS RECOGNITION

Before the program performs any data processing, it should first identify the form. This is done using the marks, called "skunk marks", that are located at the leading edge of the form. Each form will have a different configuration of skunk marks. Therefore, the program can verify if the form is the one it expects by matching the unique skunk mark configuration.

The next task the program should perform is to verify that the length of the form is what the program expects. This is done using the "timing marks" marks that signal the scanner to read across the form. The scanner's hardware reads 47 data bubbles across the



EXPLANATION: FORMS RECOGNITION (cont.)

form and one timing mark so that 48 characters are transmitted for each timing mark on the form (even if the form is less than 8-1/2 inches wide). The program should count the total number of characters in the scanner record to ensure that it is the correct multiple of 48 (the expected number of timing marks times 48). This process will also ensure that the entire sheet has been read.

EXPLANATION: DATA DECOMPRESSION

When the scanner communciations have been configured for data compression, the scanner record must be restored to the full sheet image record by the host program before grid resolution. To do this, the host program must look for the compress code, determine the number of times the character was compressed, and the character that was compressed. After the compress code is identified, it must strip off the upper two bits of the second character of the compression sequence. This is the number of times the character has been compressed. The host then determines the character compressed from the third character in the compress sequence (hex 30-37 for 0-7) and restores that character into the appropriate serial positions of the record.

EXPLANATION: GRID RESOLUTION

Just as response positions on a form are grouped together into grids, the host application program will compile data from the scanner record in groups. To do this, the host program must be able to identify the positions in the

EXPLANATION: GRID RESOLUTION (cont.)

record that correspond to the position on a form which are associated in a grid. This is called "grid resolution." The application program will perform a series of grid resolutions to locate the data in all grids on a form.

Where the response positions in a grid are uniformly spaced, resolution can be accomplished by a single looping routine that describes where the associated responses are positioned within the record. (See the sample program later in this section.)

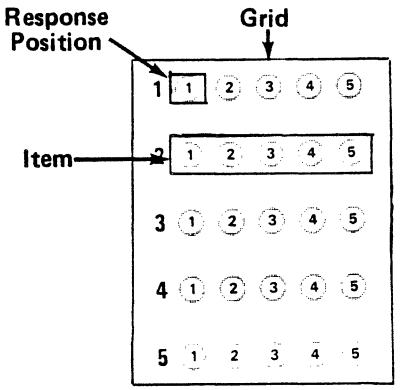
The resolution of a grid involves the following steps:

1. Locating the first position of the first item in the grid.

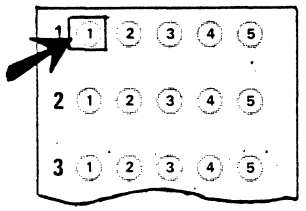
2. Skipping a specified number of characters in the scanner record to get to successive positions in the item.

3. Comparing the read levels of all positions in the item to identify the position of the darkest mark(s) (if there is one).

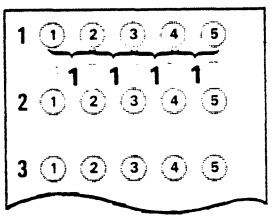
FEATURES OF A UNIFORM GRID



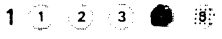

FIRST GRID POSITION



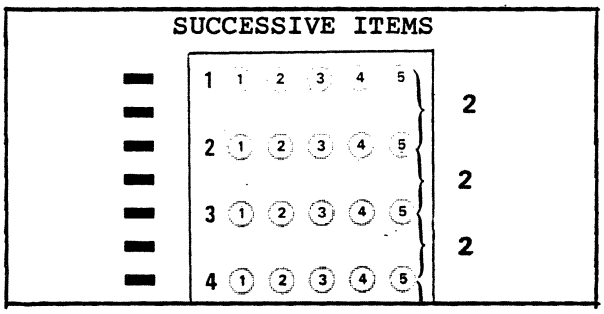
DISTANCE TO NEXT POSITION



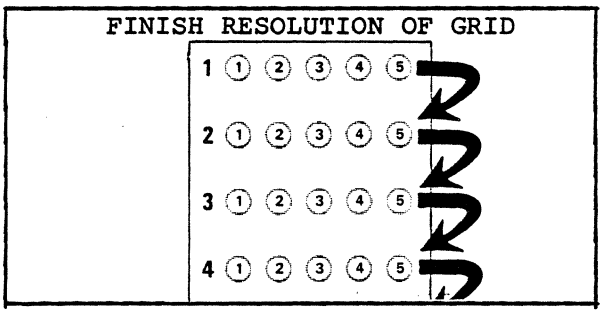
FINDING DARKEST MARK



EXPLANATION: GRID RESOLUTION (cont.)



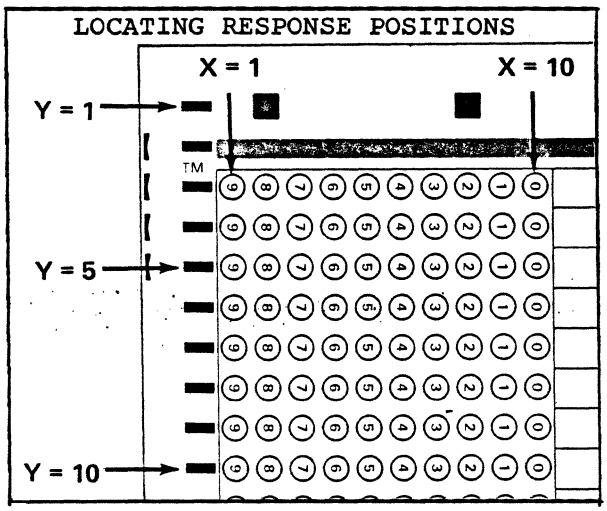

4. Skipping a specified number of characters to get to the first position of successive items in the grid.




5. Performing this process until every position in every item of the grid has been evaluated.

A looping routine that accomplishes these steps will 'resolve' a grid that is uniformly spaced and that has the same number of response positions in each item of the grid. Such a grid is called a uniform grid. Non-uniform grids may also be resolved but must be resolved position by position.

EXPLANATION: LOCATING RESPONSE POSITIONS




The read level value for a position on the form is located by its serial position in the output record. A formula for calculating the serial position is:

POSITION = 48(Y-1) + X

where:

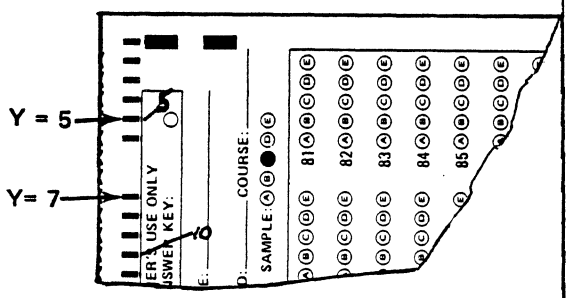
Y = the timing mark corresponding to the position

X = the number of positions away from the timing track

EXPLANATION: LOCATING RESPONSE POSITIONS (cont.)

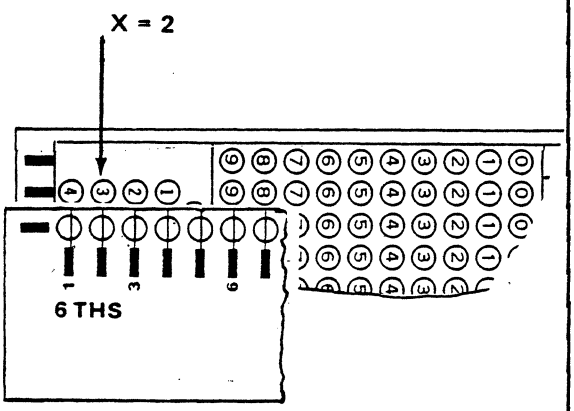
When determining the Y value for a response position, count the number of timing marks from the leading edge of the form (the edge with the skunk marks). Marking the value of every fifth timing mark on the form avoids recounting for every position.

Y-VALUE OF RESPONSE POSITION



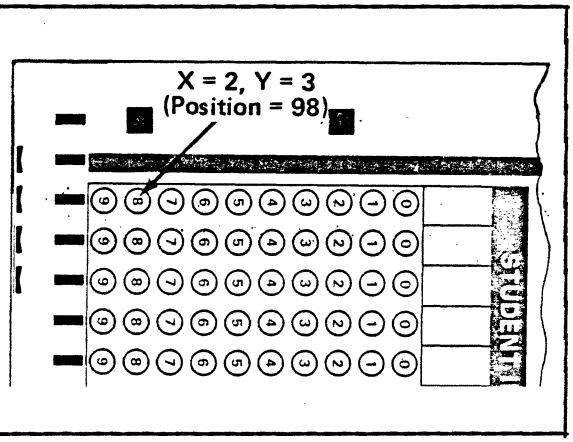

When determining the X value for a response psition, the NCS Sheet Compile Ruler will be of help. To use the ruler, place the edge of the ruler marked "6ths" on the form parallel to the leading edge. Match the timing mark on the ruler with the timing mark on the form. The position on the form will match the numbered circles on the ruler.

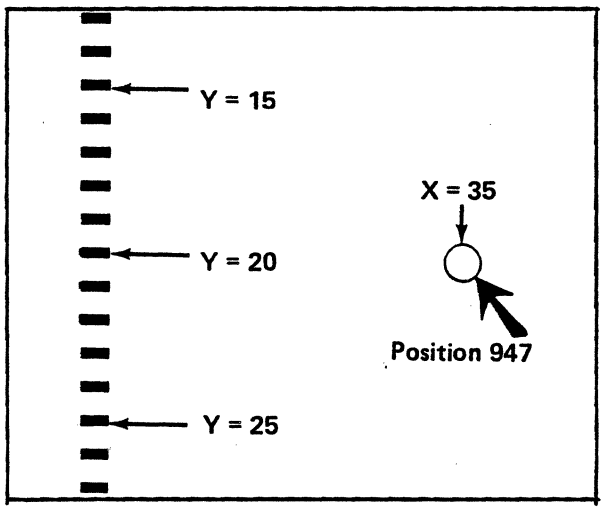
X-VALUE OF RESPONSE POSITION




Once the x and y values of a response position are determined, use the formula above to determine the serial position of a response in the record. For example, the second position on the third timing mark on the form would be the 98th data character of the scanner record.

POSITION = 48(3-1) + 2
POSITION = 98





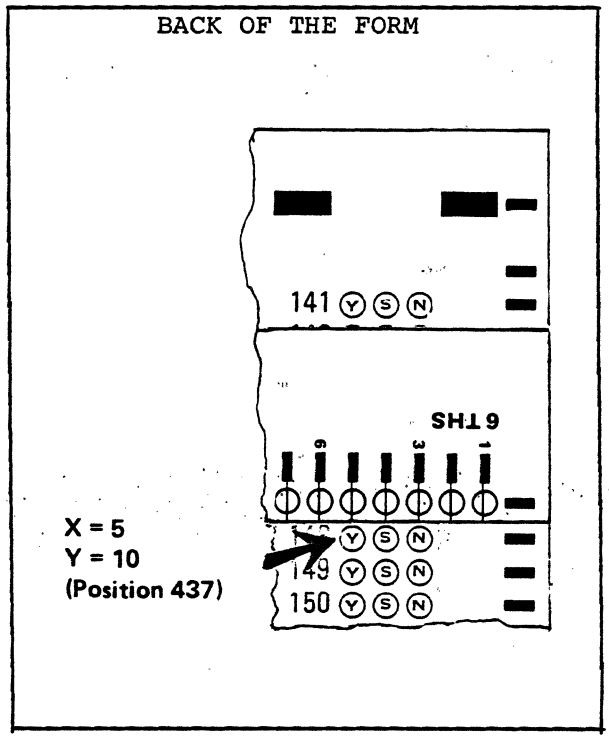

EXPLANATION: LOCATING RESPONSE POSITIONS (cont.)

For another example, the location of the 35th position on the 20th timing mark would be calculated as follows:

POSITION = 48(20-1) + 35
POSITION = (48 x 19) + 35
POSITION = 912 + 35
POSITION = 947

CONSIDERATIONS: RESOLUTION

- Remember that the 48th position and every 48th position after that in the scanner record does not contain a read level value, but the number of times the line has been scanned.

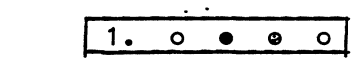



- To locate positions on the back side of the form, turn the form over so that the skunk marks are still on the top but now the timing track is on the right-hand side. The "Y" value in the equation above is still counted the same. "X=1" is still the position closest to the timing track and X=47 is still 47 positions away from the timing track.

## EXPLANATION: MARK DISCRIMINATION

In addition to locating associated response positions, the host program must discriminate intended marks from erasures and smudges. To do this, the program must compare the response positions of a single item. Usually any mark in the group that is a read level of 4 or above will be the intended mark. Sometimes, however, there will be smudges or erased marks as well as the intended answer, In this case, it is desirable to ensure that the selected mark is at least two read levels darker than the next darkest mark. This is illustrated in the sample program later in this section.

MARK DISCRIMINATION




| | |
|---|---|
| 7 | 7 |
| - 5 | - 6 |
| 2 | 1 |
| one mark | two marks |

### Consideration: Mark Threshold

While NCS recommends using a read level of 4 as the mark threshold, it is possible for the host program to establish a different threshold. One technique for determining the threshold is to take an average of the read levels on the bias bar (the bar of colored ink that extends the full width of the form). This average is the read level of paper and ink. To determine the mark threshold, add 3 or 4 to the bias bar average.

## EXPLANATION: EDITING

In addition to selecting intended marks, it is important to differentiate good data from bad data. This is called editing. The program should designate an 'omission' (question left entirely blank) or a multiple (more than one response to a question was marked when only one response was asked for) differently from single marks. The program may

EXPLANATION: EDITING (cont.)

also check data integrity by requiring that an essential grid (e.g. Social Security Number) contain one and only one response in every item, for example.

Editing for percentage of light marks and omissions is another editing function that may help determine if the form has been properly marked or properly read. To do this, the program first checks the percentage of light marks. If the percentage is greater than 70-80% the program then checks for omissions. If the percentage of omissions is also high, the form's record can then be rejected or the read level threshold can be altered to eliminate some omits.

If certain conditions are not met, the program might be designed to reject the record from that form and, perhaps, stop the scanner and notify the scanner operator to separate that form from the batch so that it may be corrected.

EXPLANATION: OPERATOR INSTRUCTIONS

Operator instructions for scanning a batch of forms might include:

- Which form(s) is to be scanned
- How to initialize the job in order to be processed by the appropriate host application program
- How to indicate to the host that the last form of the batch has been scanned
- What to do with the forms after scanning
- What to do if certain error messages appear.

## Error Messages

The host application program should be designed to detect inadequate records caused by such things as scanning the wrong form or by misfeeding the form. Errors such as these can be corrected by the scanner operator during scanning if the host sends an indicator of some kind to the scanner or to the auxiliary device.

The program may use:

- DIGIT DATA CODE to send a character to the scanner's display
- AUX PORT DATA CODE to display a message at the auxiliary device without disabling the scanner
- SELECT AUX PORT to display a message at the auxiliary device (disabling the scanner) and allow the scanner operator to respond directly to the host.
- STOP SCANNER code to stop the scanner and prevent a new sheet from being picked. Often used in conjunction with DIGIT DATA or AUX PORT DATA.

Because the operator will not be able to see these messages unless scanning stops, the following sequence would be employed:

1. Host detects error
2. Host sends RELEASE DOCUMENT to send the problem form to the output stacker. This will allow the operator to discard or correct it and rescan it, if told to do so. (If any part of the record remains in the scanner, it will be discarded.)
3. Host sends STOP SCANNER to prevent the scanner from picking a new sheet.

Error Messages (cont.)

4. Host sends DIGIT DATA CODE, PRINT DATA CODE, AUX PORT DATA CODE, or SELECT AUX PORT code along with the character or message for the operator.
5. If the DIGIT DATA or AUX PORT DATA code is used, the host may then send a POSITIVE RESPONSE. Scanning will continue when the scanner operator presses START. If the SELECT AUX PORT code is used, the SELECT SCANNER (FROM HOST or FROM AUX) must be sent before POSITIVE RESPONSE is sent.
6. The operator corrects the form, places it in the output stacker, and presses START to continue scanning.

EXPLANATION: END OF JOB

It may be helpful to designate some way of marking and scanning a special form which tells the host computer that no more forms will be scanned.

EXPLANATION: SAMPLE PROGRAM

The following example illustrates grid resolution and mark selection using a "FOR-NEXT" looping routine written in the BASIC programming language. The program is not intended to be a paradigm of BASIC programming technique. Some steps are deliberately distorted in order to highlight the actions which are taken and to allow the program to be easily translated into the language used for host programming. A complete list of program parameters is found on page 3-26.

EXPLANATION: SAMPLE PROGRAM (cont.)

The elements of the program are:

- Storage Allocation
- Parameter Definition
- Outer Loop (items) (Grid
- Inner Loop (positions) Resolution)
- Mark Selection
- Mark Discrimination
- Editing

Storage Allocation

Lines 5, 10 and 15 of the sample program establish a buffer for the scanner record, a buffer for the results of grid resolution, and a buffer location pointer.

In line 5, Input Buffer (IB) allocates space for the buffer that will receive the record from the scanner. Its dimensions are determined by the size of the record from a single form. For every timing mark on the form, 48 characters are transmitted. For the sample program, the form is assumed to have 60 timing marks and so a buffer size of 2880 is allocated.

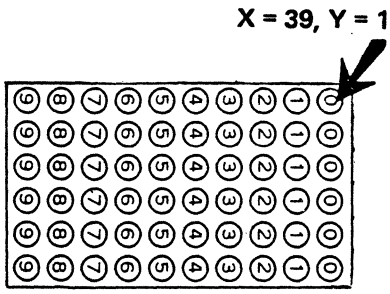
Output Buffer (OB) is the buffer where the positions of the actual marks selected from the record will be stored as results of grid resolution. The size of Output Buffer (OB) is determined by the number of positions needed to store the results of resolution. Here, it is arbitrarily set to 100 items.

Line 15 stores a Pointer (P) to the current location in the Output Buffer (OB). In this case, the starting location is set to the tenth position in the buffer.

SAMPLE PROGRAM

```
Establish storage buffer for
scanner record:

 LINE 5  DIM IB(48*60)



Establish buffer for resolved
data:

 LINE 10  DIM OB(100)



Pointer to current location in
the output buffer:

 LINE 15  LET P=10
```

SAMPLE GRID




SAMPLE PROGRAM (cont.)

```
Establish position of first re-
sponse of 1st item in grid:
Start Position

  LINE 20  LET SP = 903


Establish number of characters
in scanner record between posi-
tions in an item:  Position
Offset

  LINE 25  LET PO = -1
```

EXPLANATION: SAMPLE PROGRAM (cont.)

Parameter Definition

Lines 20, 25, 30, 35, and 40 establish the parameters that locate the characters in the scanner record that correspond to the positions on the form. These parameters will be employed by the looping routines later in the program.

The first position of the first item is established in line 20. It will be called Start Position (SP) and it is equal to 903. This was calculated from the formula given above using (X = 39, Y = 18):

$$(SP) = 48(Y-1) + X$$
$$903 = 48 \times 17 + 39$$

The next parameter is called Position Offset (PO). PO defines the number of characters in the record between any one position in the item to the next position in the item. Since the second position is one position closer to the timing mark, the character representing it will be one earlier (-1) in the scanner record.

EXPLANATION: SAMPLE PROGRAM (cont.)

Parameter Definition (cont.)

The sample program assigns a value of 48 to Item Offset (IO). This is the number of characters in the record between the first position of the first item to the first position of the next item. Since this is located directly below (one timing mark below to be specific) the first position of the first item, the character representing it will be exactly 48 characters later (48) in the record. Note that if the grid were oriented vertically, the Position Offset would be 48 and the Item Offset 1.

The number of positions per item is 10. This value is assigned the name Number of Positions (NP). The positions of the items are labeled on the form as 0,1,2,3,4,5,6,7,8,9. This parameter will determine the number of times the Inner Loop (lines 120-130) is executed.

The number of items in the grid is 6 and is designated as Number of Items (NI) in the sample program. This parameter will determine the number of times the Outer Loop is executed and the number of characters which will be placed in Output Buffer (OB).

SAMPLE PROGRAM (cont.)

```
Establish number of characters in
scanner record between items:
Item Offset

 LINE 30  LET IO = 48

Establish the number of positions
in an item:  Number of Positions

 LINE 35  LET NP = 8

Establish the number of items in
a grid:  Number of Items

 LINE 40  LET NI = 6
```

SAMPLE PROGRAM (cont.)

```
Call the inner loop as many times
as there are items.

LINE 100  FOR IP=0 TO NI-1 STEP 1



Store the darkest mark in an item.

LINE 110  LET PR=0



Flag omitted item.

LINE 115  LET OB(P+IP)="-"
```

EXPLANATION: SAMPLE PROGRAM (cont.)

The inner and outer loops handle the resolution of grids. The inner loop resolves all positions in an item. The outer loop resolves all items in a grid.

Outer Loop

Lines 100 and 110 initiate the outer loop. Line 100 will cause the inner loop to be called as many times as there are Number of Items (NI) in the grid. It will keep track of the sequential number Item Pointer (IP) of the item in the grid.

A variable called Position Remember (PR) is set to line 0 (line 110) in preparation for the inner loop. This variable is used to 'remember' the position of the darkest read level seen within a single item. By setting it to 0 before each call to the inner loop, we can be certain that if anything at all (any read level above the level of paper) is seen in the item, the position of the new darkest value will be stored at Position Remember (PR).

Line 115 stores an "omission" flag in the output buffer (OB) so that, if no marks are found in any of the positions, then flag ("-") will be left in the Output Buffer (OB). Item Pointer (IP) is the sequential number of the item in the grid and Pointer (P) is the pointer to the place in the output buffer (See line 15) where the result is to go.

EXPLANATION: SAMPLE PROGRAM (cont.)

Inner Loop

The inner loop is initiated by line 120 which will cause the loop to be performed as many times (Position Pointer (PP)) as there are Number of Positions (NP) within the single item. Line 170 will cause (PP) to increment (by 1 according to STEP 1 in line 120) before control is passed back to line 120.

Mark Selection

Line 130 is the statement which locates the read level of the position currently being examined. The read level is stored temporarily in the variable Read Level (RL). The address (serial position) of the read level in the input buffer, Buffer Position (BP), is calculated from the value of Start Position (SP), Position Pointer (PP), Position Offset (PO), Item Pointer (IP), and Item Offset (IO).

Stated in words, the address of the read level under examination at any given moment is the Starting Position (SP) plus the product of the Position Pointer (PP) times the Position Offset (PO) plus the product of the Item Pointer (IP) times the Item Offset (IO). Notice that, by calculating the address in this way, the changes to get from position to position and from item to item are automatically incorporated and accounted for so that one general-purpose statement (line 130) will retrieve the read level, no matter which position or item we are currently investigating.

SAMPLE PROGRAM (cont.)

```
Call inner loop as many times as
there are positions in an item.

LINE 120  FOR PP=0 TO NP-1 STEP 1

Locate the read level being ex-
amined.

LINE 130  RL = BP ((SP + PP * PO)
                + (IP * IO))
```

EXPLANATION: SAMPLE PROGRAM (cont.)

Mark Selection (cont.)

To illustrate, let's work out a few examples:

1. The serial location (BP address) of the read level of the first position of the first item is calculated as:

```
BP address = SP + (PP * PO)
               + (IP * IO)

           = 903 + (0 * -1)
             + (0 * 48) = 903
```

2. The read level of the second position of the first item will be found at:

```
BP address = SP + (PP * PO)
               + (IP * IO)

           = 903 + (1 * -1)
             + (0 * 48) = 902
```

3. The read level of the fourth position of the sixth item will be found at:

```
BP address = SP + (PP * PO)
               + (IP * IO)

           = 903 + (3 * -1)
             + (5 * 48) = 1140
```

EXPLANATION: SAMPLE PROGRAM (cont.)

Mark Selection (cont.)

Line 140 makes the comparison of the current Read Level (RL) with the previous darkest value, Position Remember (PR). If RL is not darker than PR, the routine jumps to line 170 to increment the sequential Position Pointer (PP) of the position in the grid. The routine then returns to line 120 to see if there are any more positions to examine in the current item. On the other hand, if Read Level (RL) is darker (higher) than Position Remember (PR), then line 150 is executed to put the new darkest value into (PR) and line 160 is executed to put the Position Pointer (PP) of the new darkest response into the Output Buffer (OB) at the proper position for this item (OB (P + IP)), where Pointer (P) is the starting location in the output buffer and Item Pointer (IP) is the sequential number of the item in the grid).

In either case, line 170 increments PP (Position Pointer) and control passes back to the start of the inner loop at line 120. If there are any more positions to examine, the inner loop is executed again. If not, line 180 is executed to increment Item Pointer (IP) and control passes back to the start of the outer loop, line 100, where, if there is another item to be examined, the Position Remember (PR) variable is set back to 0 and the inner loop is activated once again.

At the end of the routine, then, each position of the output record will contain either the position of the darkest read level seen in the group of positions for that item, or will contain an omit flag, to indicate that no valid responses were seen.

SAMPLE PROGRAM (cont.)

```
Compare current read level of an
item with previous darkest mark in
that item.

LINE 140 IF RL < = PR THEN GOTO 170

LINE 150 LET PR = RL

LINE 160 LET OB (P+IP) = STR$(PP)

LINE 170 NEXT PP

LINE 180 NEXT IP
```

SAMPLE PROGRAM (cont.)

```
Test that darkest mark in an item
is a valid mark.

LINE 135 IF RL < 4 THEN GOTO 170
```

EXPLANATION: SAMPLE PROGRAM (cont.)

Mark Selection (cont.)

As mentioned earlier, this is really not sufficient. One reason is that it accepts any mark that is darker than 0 (paper level) as a valid mark. This could result in a stray mark on the form being taken as the intended answer if there were no other marks in the response set. This problem can be remedied by adding a test to ensure that the mark is really dark enough to be considered as a valid mark. A level of 4 is generally accepted as the threshold below which marks should be disregarded, so line 135 sends all marks less than 4 to line 170 where the mark is ignored.

Mark Discrimination

It is not uncommon to have within single items two or more positions with read levels above the mark threshold (in this case 4). The best rule to follow here is to select the read level that is 2 or more levels darker (higher) than any other in the item. If there are two or more read levels of 4 and above but all are within two levels of each other, then one mark cannot safely be selected, and a flag to indicate a "multiple" answer should be stored instead of a position.

EXPLANATION: SAMPLE PROGRAM (cont.)

Mark Discrimination (cont.)

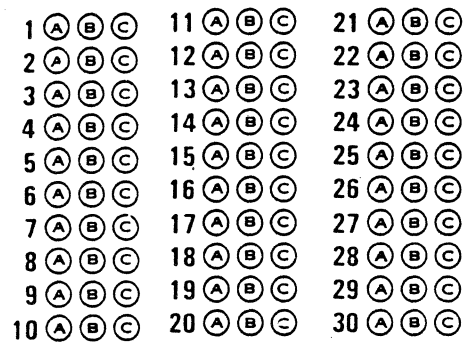
Four statements (line 136-139) in the sample program do mark discrimination. Following line 135, which eliminates read levels under 4 from consideration, line 136 compares the current Read Level (RL) to the darkest mark (Position Remember (PR)) seen in the item so far to see if RL is two or more read levels higher. If it is, Read Level (RL) replaces Position Remember (PR) (line 150). Line 137 compares Read Level (RL) and Position Remember (PR) to see if Read Level (RL) is at least two read levels lower (lighter) than Position Remember (PR) and ignores Read Level (RL) (GOTO 170) if it is.

If Read Level (RL) (current) and Position Remember PR (darkest) are within two read levels of each other, then line 138 is executed. This places a "+" in the Output Buffer (OB) instead of a position. The "+" is used here to represent a "multiple" mark (more than one dark mark in a single item).

SAMPLE PROGRAM (cont.)

```
Perform mark discrimination.

LINE 136 IF (RL - PR) > 1 GOTO 150
LINE 137 IF (PR - RL) > 1 GOTO 170

Place a "+" in the output buffer
for items with multiple responses.

LINE 138 OB (P + IP) = "+":GOTO 170
```

ARRAY




ARRAY PROGRAM STATEMENTS

Statements to be added to resolve the array:

```
45  LET CO = 5
50  LET NC = 3
 •
 •
 •
90  FOR CC = 1 TO NC STEP 1
 •
 •
 •
190 LET SP = SP + CO
195 LET P = P + NI
200 NEXT CC
```

CONSIDERATIONS: SAMPLE PROGRAM

- A grid that is a uniform series of related sets of items is called an "array." For example, the first uniform set of items is numbered 1-10, the second 11-20, and the third 21-30. The array is uniform if the spacing between the first items of each set (1,11,21) is always the same.

We can easily modify the sample program to resolve the entire array by adding a second outer FOR-NEXT loop using the following parameters:

- Column Offset (CO), defining the number of characters in the record to skip to get to the first item of the next column (set of items)
- Number of Columns (NC), defining the number of uniform sets (columns) in the array

| Parameter | | Definition |
|---|---|---|
| IB | Input Buffer | Declares size of buffer needed for sheet image record from scanner |
| OB | Output Buffer | Declares size of buffer needed for resolved data |
| P | Pointer | Pointer to current position in output buffer |
| SP | Start Position | Establishes the position in the scanner record of the first response in the first item of a grid |
| PO | Position Offset | Defines the number of characters between one position in an item to the next position in that item |
| IO | Item Offset | Defines the number of characters in the record between the first position in the first item and the first position in the next item of a grid |
| NP | Number of Positions | Defines the number of positions in one item |
| NI | Number of Items | Defines the number of items in a grid |
| IP | Item Pointer | Pointer to sequential number of the item in the grid |
| PR | Position Remember | Stores the position of the darkest read level within a single item |
| PP | Position Pointer | Pointer to the sequential number of the position within an item |
| RL | Read Level | Stores read level value of position being examined |
| BP | Buffer Position | Serial position of the read level value in the input buffer |
| CO | Column Offset | Establishes the number of characters in the serial record between the first item in one column to the first item in the next |
| NC | Number of Columns | Establishes the number of columns in an array |

## EXPLANATION: BOOKLET PROCESSING

A booklet is a set of sheets which are to be taken together to generate a single record for one respondent. In booklet resolution, some means must be provided for tying the sheets together as one booklet and for verifying that all sheets are present.

A preprinted identification number called a "litho-code" may be printed by NCS on the first and last pages of a booklet. The application program may utilize the litho-code to identify the beginning and end of the booklet.

Skunk marks will be unique on each form of the booklet. The application program may utilize skunk marks to identify each page of the booklet. The program should verify that the sheets of the booklet have been scanned in the proper order so that:

- Each form is resolved by the appropriate part of the program
- A missing form may be detected.

Some means should be provided for notifying the scanner operator when sheets arrive out of sequence. This allows the operator to correct the error, if possible. If the error cannot be corrected, then some means should be provided for scanning to continue and for booklet processing to resume. A special sheet can be scanned which will cue the host computer to do one of two things:

- accept the next sheet and resume page sequencing with that sheet
- look for page #1 of a booklet and ignore the record of the current booklet.

## OVERVIEW: THE ".S" PROGRAM RECORD

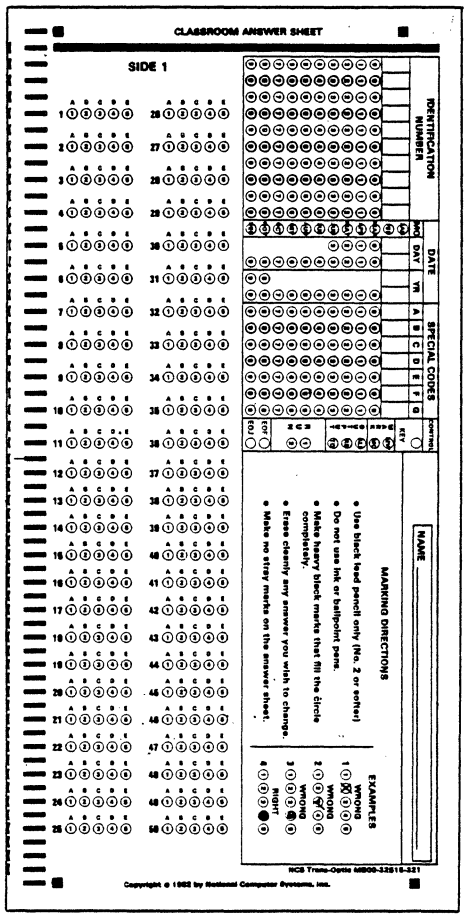
The ".S" (scoring) program is designed to scan and score one form: the NCS® Classroom Answer Sheet. While the records from the .C program are raw sheet image data, the records from .S are organized data records. All grid resolution, editing, and scoring is done at the scanner and transmission of records to the host is optional.

When using the ".S" program, the first form scanned is a Classroom Answer Sheet marked with answers to a test. This is called the key sheet. Then the students' forms are scanned. The scanner compares the student's answers to the key sheet's answers and counts the number of correct answers.

The size of the records and whether or not records are sent to the host is determined by the coding of the OUTPUT grid on the key sheet. The functions of printing on forms and sending information to the host computer are also controlled by the key sheet. The key sheet may be marked so that:

- Only the total score is printed on forms
- The total score is printed and a ">" symbol is printed to indicate where the student's answer is wrong
- The total score is printed and the correct answer (1-5) is printed to indicate where the student's answer is wrong
- An organized record from each form is sent to the host
- Two organized records from each form are sent to the host
- No record is sent to the host

CLASSROOM ANSWER SHEET



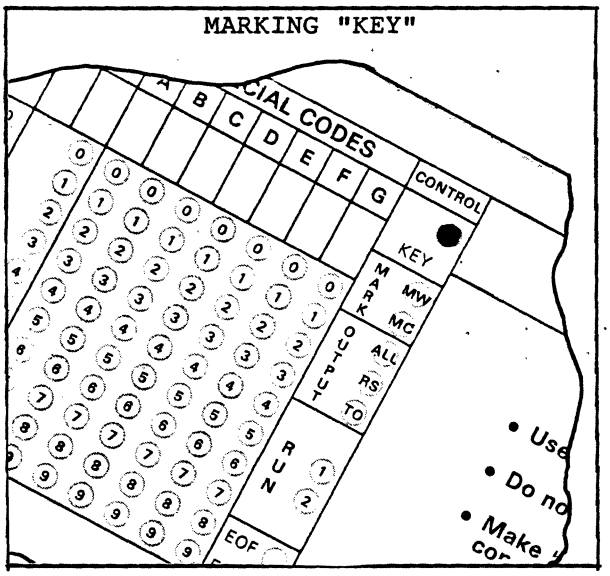
OVERVIEW: THE ".S" PROGRAM RECORD (cont.)

The key sheet also determines which side(s) of the form is scored and which side of the form must be face up when it is scanned. The key sheet may be marked so that the scanner scores:

- Side 1 only
- Side 2 only
- Either Side 1 or Side 2
- Both Side 1 and Side 2 at one pass

The following pages describe how to mark the key sheet and how to scan Classroom Answer Sheets.

EXPLANATION: MARKING THE KEY SHEET




The key sheet is a Classroom Answer Sheet that has KEY marked and the correct answers to the test marked. The KEY grid and the remaining CONTROL grids (MARK, OUTPUT, and RUN) tell the scanner:

- Which side(s) is to be scored (KEY)
- What (if anything) to print on the forms (MARK)
- Where to print on the document (RUN)
- What (if anything) to send to the host computer (OUTPUT)

The EOF/EOJ grid must be blank on a key sheet.

Side(s) of the Sheet

The side of the sheet on which KEY is filled in determines:

- which side is to be scored
- which side is to be face up when the form is fed into the scanner.

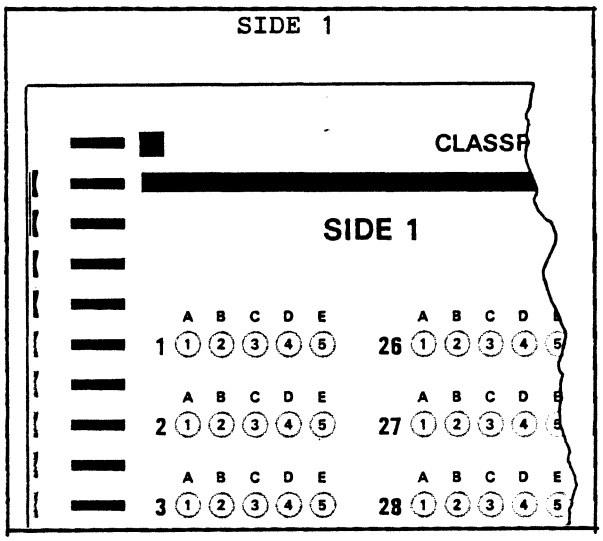
The side(s) to be scored depends on the needs of the instructor. There are four possibilities:

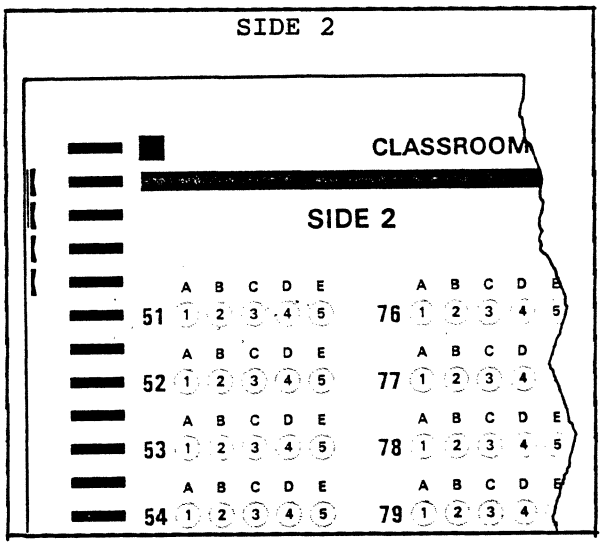
Side(s) of the Sheet (cont.)

- Score a single test of up to 50 questions on Side 1 only. In this case KEY is marked on Side 1 only, answers are marked on Side 1 only, and the key sheet and student sheets are fed into the scanner with Side 1 facing up. The scanner will score Side 1 only.

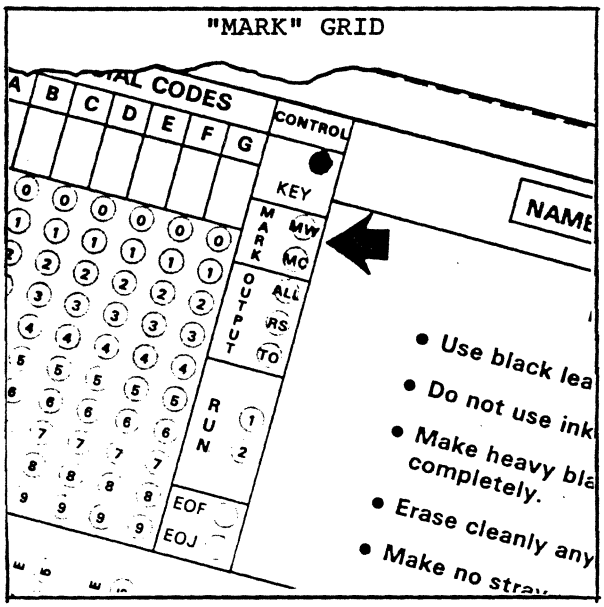
- Score another test of up to 50 questions on Side 2 only. In this case, KEY is marked on Side 2 only and the test answers marked on Side 2. Side 2 of the key sheet is fed into the scanner facing up and the scanner will score Side 2 of the student sheets and not Side 1.

- Score a single test of up to 100 questions. In this case, KEY is marked on Side 1 only but the answers are marked on both Sides 1 and 2. The key sheet and student sheets are scanned with Side 1 facing up. The scanner will score both sides of the student form in one pass through the scanner.

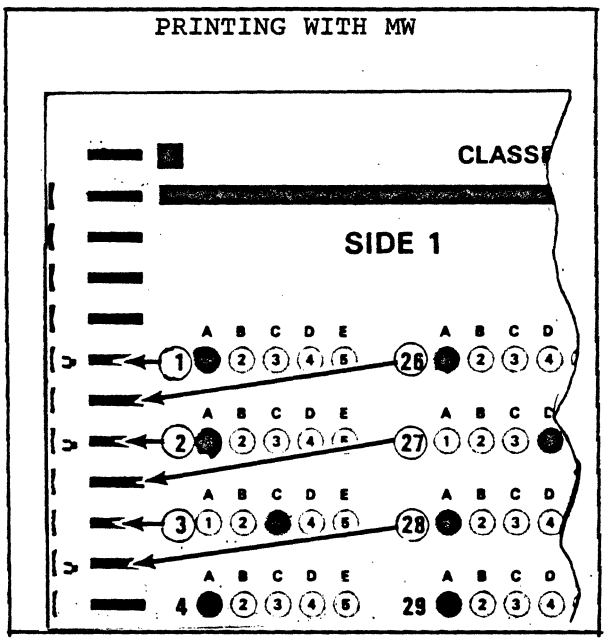


"MARK" GRID




PRINTING WITH MW




EXPLANATION: KEY SHEET (cont.)

Printing on Forms

If the optional printer is present, a total score(s) is automatically printed on each form (including the key sheet). In addition to the total score, a symbol may be printed to indicate when the student's answer is incorrect (">") or the correct answer (1-5) may be printed when the answer is incorrect. This is done by marking either MW or MC in the MARK grid.

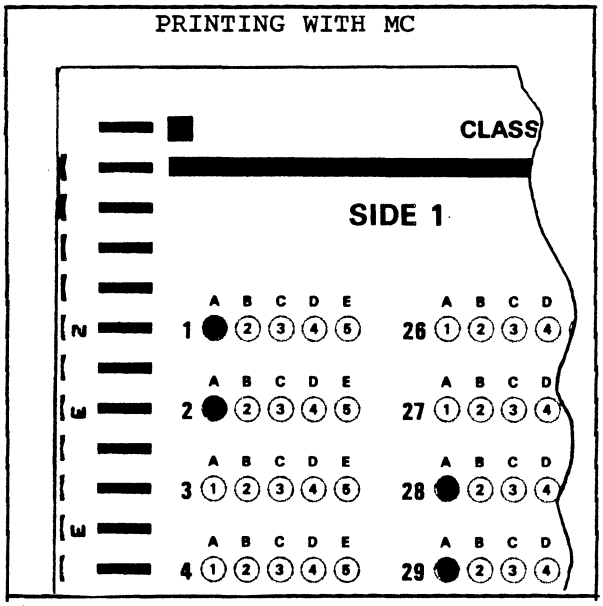
Only one of the two positions (MW or MC) may be marked or they may both be blank. Leaving MARK blank on the key sheet (or scoring both sides at one pass through the scanner) causes only the total score to be printed on the forms.

Marking MW (mark wrong answers) in MARK on the key sheet will cause a ">" to be printed to indicate an incorrect student answer. For instance, if the answer to #1 is wrong, ">" is printed next to the sixth timing mark; if #2 is wrong, ">" is printed next to the eighth timing mark; if #28 is wrong, ">" is printed next to the eleventh timing mark; etcetera.

EXPLANATION: KEY SHEET (cont.)

Printing on Forms (cont.)

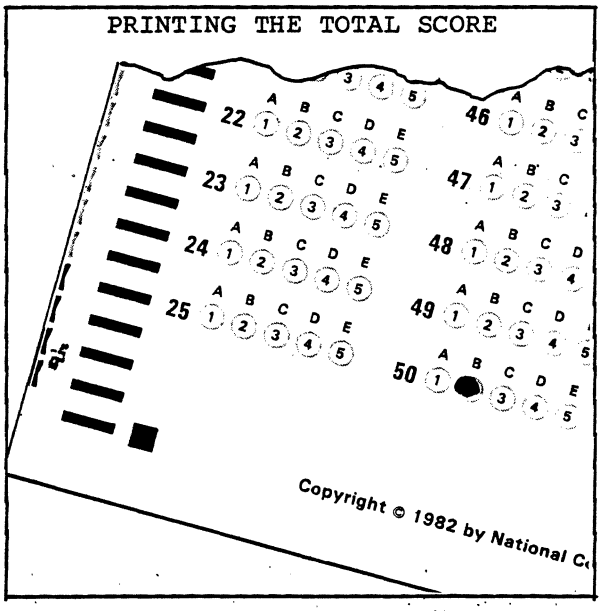
When MC (mark correct answers) is marked in MARK on the key sheet, the correct answer (1-5) will be printed for all incorrect answers. This number is the correct answer to the question as marked on the key sheet. For example, the correct answer to the first question is #2 but the student has marked #1. The correct answer to the second question is #3; to the 28th question, #3.




Even when MARK is left completely blank, a total score will be printed (after question #25) if the printer is present.

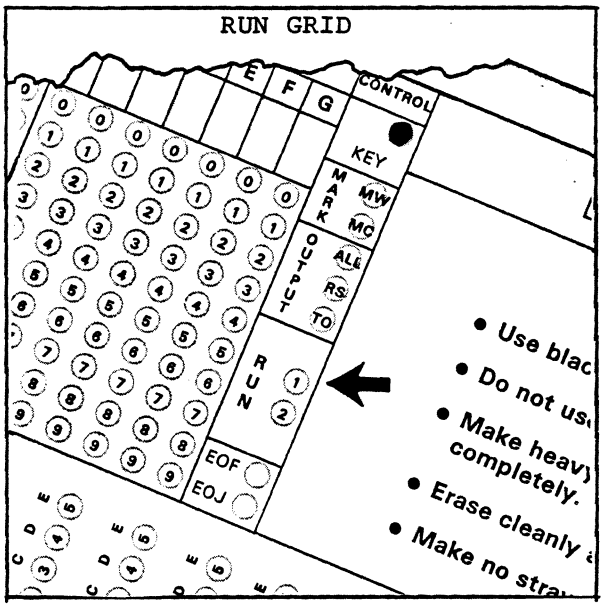
If both sides of the form are scored in one pass through the scanner, the score for Side 1 is printed after question #25 on Side 1 and the total score from Side 1 and 2 combined is printed before question #1 on Side 1. A separate score for Side 2 is not printed when both sides are scored at one pass through the scanner.

Incorrect answer indicators are not printed on either side when scoring both sides at a single pass through the scanner.

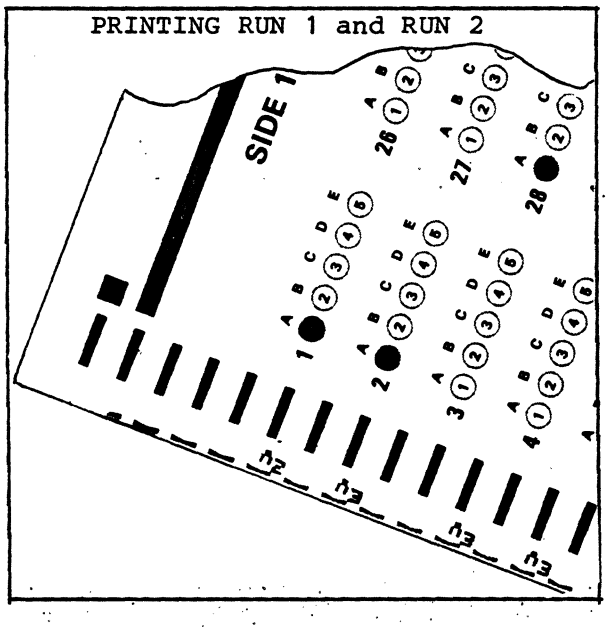


EXPLANATION: KEY SHEET (cont.)

Printing on Forms (cont.)




It may be desirable to scan the same side of the form twice. So that printing of the second run does not overprint the printing of the first run, RUN "2" is marked on the key sheet during the second scanning. This will cause the scanner to print slightly below and offset from the original characters.



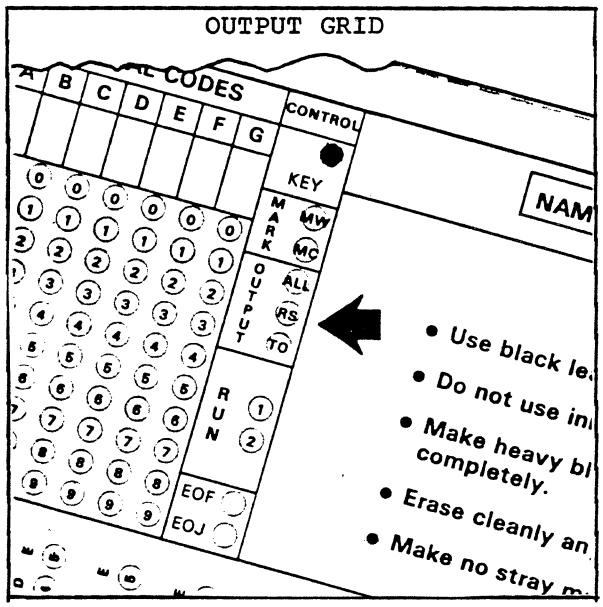

In the example shown, the instructor wants to score the tests first to indicate which answers are incorrect (using MW) and then to give the tests back to the students to correct. RUN "1" is specified on the key sheet for the first scanning. The tests are then scored a second time, this time printing the correct answers (using MC) to questions still answered incorrectly. RUN "2" is marked for the second scanning. Note that, in the example shown, the student still answered incorrectly the second time but will now know what the correct answer is.

Leaving RUN blank gets the same results as marking "1".

EXPLANATION: KEY SHEET (cont.)

## Sending Information to the Host

The OUTPUT grid on the key sheet determines what, if anything, is sent to the host computer. Only one of the three choices (ALL, RS, or TO) may be marked or the grid may be left blank.




When ALL is marked on the key sheet, the scanner will send an 80-character record to the host for every form scanned (including the key sheet). The record contains the total score, test answers, and other information from the form.

When RS (raw score) is marked, a 30-character record is sent that does not include test answers.

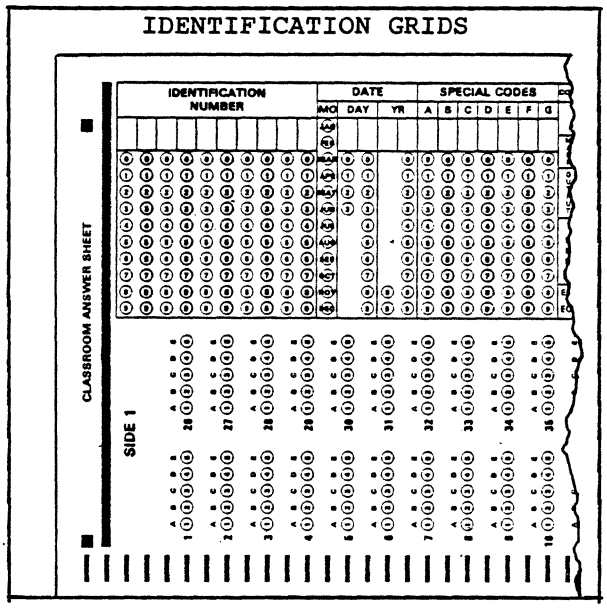
When TO (test only) is marked on the key sheet or none of the three choices is marked, nothing is sent to the host.

If both sides of the form are scored in one pass through the scanner and either ALL or RS is marked in the OUTPUT grid, then the scanner sends to the host computer two records for every form scanned (including the key sheet). The first record is for Side 1, the second for Side 2. A total score for both Sides 1 and 2 combined is not sent to the host computer.

## Summary of the CONTROL Grids

General rules to keep in mind when marking the CONTROL grids on the key sheet are:

- MARK, RUN, and/or OUTPUT may be blank
- EOF/EOJ must be blank




EXPLANATION: KEY SHEET (cont.)

Summary of the CONTROL Grids (cont.)

If MARK is blank, only the total score will be printed (if the printer is present). If RUN is blank, the scanner will assume this is RUN "1". If OUTPUT is blank, no information will be sent to the host computer.

Marking the Identification Grids

With one exception, the IDENTIFICATION NUMBER, DATE, and SPECIAL CODES grids may be used for any special purposes desired such as identifying a class or school when sending information to a host computer.

The SPECIAL CODES grid on the key sheet has one restriction. If anything at all is entered into columns F and G, it must be a two-digit number (00-99) which is equal to the number of questions which have answers on the key sheet. Using columns F and G helps ensure that the key sheet contains the expected number of answers for the test. This restriction does not apply to student sheets.

For example, if the test contains 25 questions on Side 1, "25" is marked on Side 1 in columns F and G. Or, F and G may be left entirely blank. If both sides will be scored in one pass through the scanner and the number of test questions is 100, "00" is marked in columns F and G. Columns A-E are available for other data.

The total number of correct answers on the key sheet includes questions with one or more answers marked. Questions with no answers marked are not included in the total.

## Marking the Test Answers

The test may contain 1-100 questions. The instructor marks the correct answers to the test on the key sheet. The student's score is the number of correct answers. A student's answer is counted as correct when:

- The key sheet has the same answer
- The key sheet has more than one answer to the question

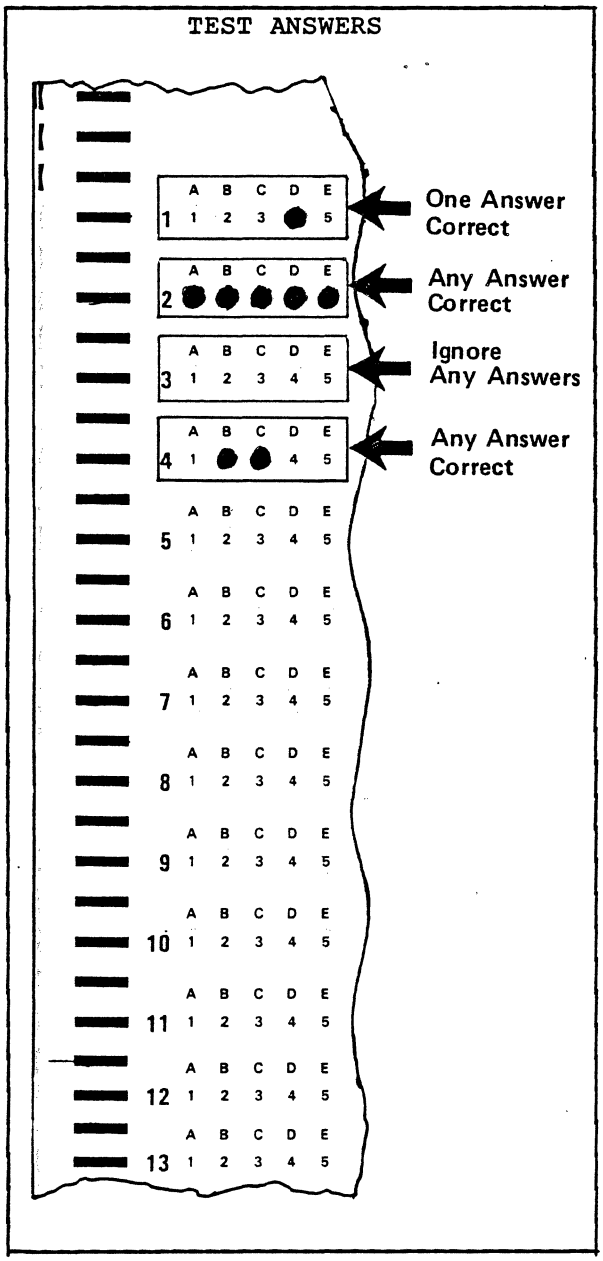
Note that any student's answer (including no answer) is counted as correct if the key sheet contains more than one answer to the question. If the instructor intends this, it is recommended that all five answers are marked to distinguish the item from the others.

A student's answer is ignored when the key sheet contains no answer to that question.

A student's answer is marked as incorrect when:

- The student's answer does not match the key sheet answer
- The student has marked more than one answer and the key sheet contains only one answer
- The student has no answer marked and the key sheet contains only one answer

Note that the student is not penalized for guessing.




## CONSIDERATIONS: MARKING THE KEY SHEET

Both sides are read at one pass through the scanner. Therefore, stray marks can result in key sheet errors. Do not make any marks except those intended to be scanned.

| OUTPUT = "ALL" (80 Characters) | |
|---|---|
| 1 | Side Number (1 or 2) |
| 2 | KEY Indicator (0 or 1) |
| 3 | RUN (blank, 1, or 2) |
| 4 | Blank (* if 2-sided key) |
| 5 | Blank |
| 6-15 | ID NUMBER |
| 16-21 | DATE |
| 22-28 | SPECIAL CODES |
| 29-78 | Test Answers (1-5) |
| 79-80 | Total Score (00-99) |

| OUTPUT = "RS" (30 Characters) | |
|---|---|
| 1 | Side Number (1 or 2) |
| 2 | KEY Indicator (0 or 1) |
| 3 | RUN (blank, 1, or 2) |
| 4 | Blank |
| 5 | Blank |
| 6-15 | ID NUMBER |
| 16-21 | DATE |
| 22-28 | SPECIAL CODES |
| 29-30 | Total Score (00-99) |

EXPLANATION: ".S" RECORD FORMAT

The first 28 characters of the 80- and 30-character records are the same. Each record contains:

- Side number: 1 character
  1 for Side 1
  2 for Side 2
- KEY Indicator: 1 character
  0 for two sided key (see below)
  1 for all other keys
  Blank for student sheets
- RUN number: Position 3
  Blank for no run number marked
  1 for "1" marked
  2 for "2" marked
- Blanks: Positions 4 and 5
- ID NUMBER: Positions 6-15
  Ten character ID number
  Blank for item not marked
  * for item with more than one mark
- Data (first two characters: 01-12 for month; second two characters: 01-31 for date; last two characters: 83-99 for the year)

In addition, both types of records will include the total score for the test(s). For the 80 character record, the two character total score is located in positions 79-80. The total score is located in positions 29-30 for the 30 character record.

The 80-character record also contains the same data as the 30-character records except that the 80-character record contains the answers marked in the 50 test items. Character positions 29-78 of the record will contain one character for each test item. The characters will be:

- 1,2,3,4 or 5 if a single mark was found in an item

EXPLANATION: ".S" RECORD FORMAT (cont.)

- "-" if no mark was found in the item
- "*" if more than one dark mark was found in the item.

The key sheet may be marked so that two records for each sheet scanned will be sent to the host computer. (This is done by marking the key sheet with KEY on Side 1 and answers on both Side 1 and 2.) The record for Side 1 will be sent first and the record for Side 2 follows immediately. Two records will be sent for the key sheet also. The first of the two key sheet records will contain an asterisk (*) in character position #4 to distinguish it as the first record of a two-record key. The second record of the key sheet will contain:

- 2 in position #1
- 0 in position #2
- blank, 1, or 2 in position #3
- blank in positions #4 and #5

A combined total score for Side 1 and 2 is not transmitted to the host.

A

# APPENDIX: HARDWARE INTERFACE

## INTRODUCTION

This appendix describes information about the cable(s) which connect the scanner to the host computer and auxiliary device (if used).

## OVERVIEW: HARDWARE INTERFACE

The hardware interfaces between the scanner and the host computer or modem and the scanner and an auxiliary device, if used, are cables which conform to the EIA RS-232-C standard. The EIA standard describes the pin assignments for the electrical signals of 25 control functions. The EIA standard does not discuss such things as data formats and control codes which are functions of the communications protocol.

The signal lines to be used in the cables are determined in part by the requirements of the scanner and also by what the scanner must connect to:

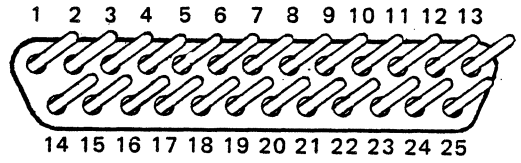
- Host computer
- Modem
- Modem eliminator
- Auxiliary device.

Refer to your manufacturer's hardware manuals to determine the pin assignments and requirements for the cable(s) neded in your system. The requirements of the 3000 scanner and cables offered by NCS are described below. Cable installation is also presented.

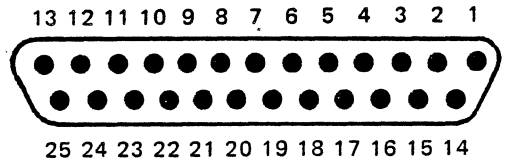
EXPLANATION: SENTRY 3000 REQUIREMENTS

The scanner requires the male version of the standard D-type subminiature rectangular connector.

D-TYPE CONNECTORS

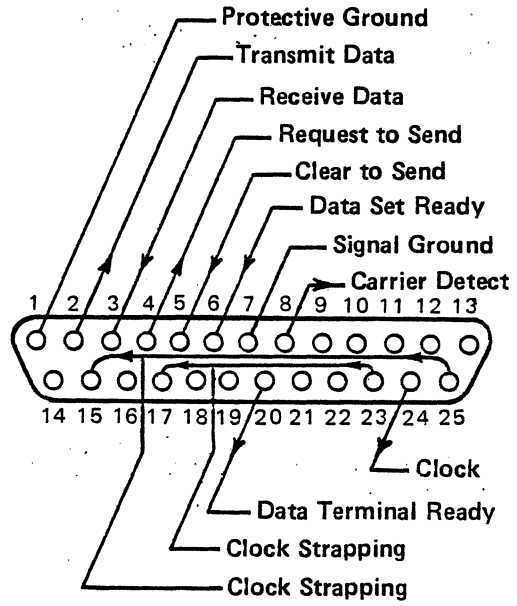



Male Connector




Female Connector

SENTRY 3000 PIN ASSIGNMENTS




The HOST PORT of the scanner uses pins 1,2,3,4,5,6,7,15,17,23,24, and 25. The AUX PORT is the same except it does not have the clocking pins (15,17,23, 24, and 25). The signal functions and directions are illustrated on the left.

(Pins 6 and 8 are connected together internally as are pins 23,24, and 25. Protective Ground (pin 1) is connected internally to the scanner chassis and externally to the third wire ground of the power plug. Protective Ground should not be connected to Signal Ground.)

EXPLANATION: NCS® CABLES

National Computer Systems stocks three cables which are designed for use with the Sentry 3000 scanner. One cable interfaces the Sentry 3000 scanner to a modem, modem emulator, multiplexer, or other modem-like device. There are two local cables which are identical except that one has a female connector and the other a male connector on the host computer end.

If an NCS® cable is needed, you may specify the cable's part number when placing your scanner order. One cable is included in the cost of the system. If another cable is needed, NCS can build, at an additional charge, a special cable to meet your needs. Contact the 3000 hotline with your system requirements and purchase order. (Call 1-800-328-3518 except in Minnesota. Minnesota customers may call 1-612-830-7600 collect and ask for the 3000 hotline.)

All cables described here are 15 feet long. The Sentry 3000 scanner end of the cable is always male and is the same whether it is used on the HOST PORT or AUX PORT connector on the back of the scanner.

| PART NO. 308-913-003 (male-to-male) | | | | |
|---|---|---|---|---|
| 3000 End | | Wire | Modem End | |
| 1 | Ground | green | Ground | 1 |
| 2 | Transmit Data | red | Receive Data | 2 |
| 3 | Receive Data | brown | Transmit Data | 3 |
| 4 | Request to Send | orange | Request to Send | 4 |
| 5 | Clear to Send | yellow | Clear to Send | 5 |
| 7 | Signal Ground | black | Signal Ground | 7 |
| 8 | Carrier Detect | white | Carrier Detect | 8 |
| 20 | Data Terminal Ready | gray | Data Terminal Ready | 20 |
| 15<br>25 | Clock Strapping | * | | |
| 17<br>23 | Clock Strapping | * | | |
| 24 | Clock | violet | Clock | 24 |

## Modem (Remote) Cable

The standard cable for use of the Sentry 3000 scanner in a remote arrangement where modems or modem-like devices are needed in the system is shown to the left. The NCS part number is 308-913-003.

| PART NO. 308-919-000 (male-to-female)<br>PART NO. 308-914-001 (male-to-male) | | | | |
|---|---|---|---|---|
| 3000 End | | Wire | Host End | |
| 1 | Ground | green | Ground | 1 |
| 2 | Transmit Data | red | Receive Data | 3 |
| 3 | Receive Data | brown | Transmit Data | 2 |
| 4 | Request to Send | * | Carrier Detect | 8 |
| 5 | Clear to Send | yellow | Request to Send | 4 |
| 6 | Data Set Ready | * | Clear to Send | 5 |
| 20 | Data Terminal Ready | blue | Data Terminal Ready | 20 |
| 7 | Signal Ground | violet | Data Set Ready | 6 |
| 15<br>25 | Clock Strapping | black<br>* | Signal Ground | 7 |
| 17<br>23 | Clock Strapping | * | | |
| 24 | Clock | white | Clock | 24 |

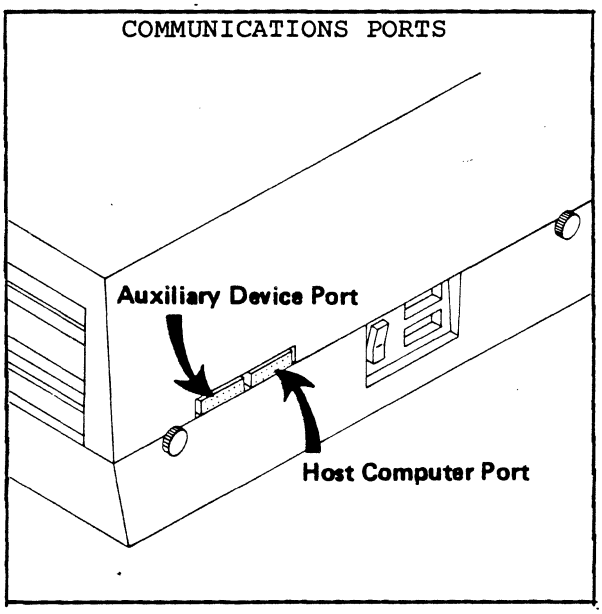
## Local Cable

There are two standard local cables which are used when connecting the Sentry 3000 locally (no modems) to a host computer or auxiliary device. Their functions are identical except that one has a female end and one a male end. (The 3000 end is always male.) The one with the female end (P.N. 308-919-000) can be used to interface a Sentry 3000 scanner with an IBM Personal Computer. The one with two male ends (308-914-001) is used to interface the Sentry 3000 scanner to an Apple II Computer.

## EXPLANATION: CABLE INSTALLATION

There are two ports for communications cables on the back of the scanner. The ports are labeled "AUX PORT" and "HOST PORT." A cable from a host computer (or modem) is attached to the scanner at the port labeled "HOST PORT." The port labeled "AUX PORT" is for a cable from an auxiliary device (an optional capability of the scanner).

If a cable(s) was provided with the parts of the scanner, the end labeled "3000" is attached to the appropriate port on the back of the scanner. Attach the other end to the device(s) with which the scanner will communicate.

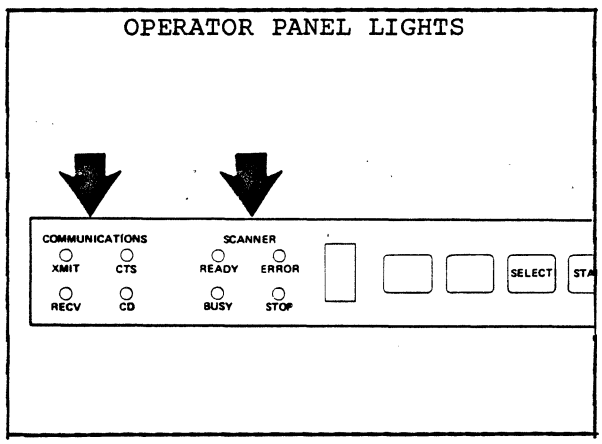



## EXPLANATION: COM STATUS LIGHTS

With any cable, the XMIT light will come on intermittently during active communications. Every time the scanner transmits a record, the XMIT light goes on. If the protocol is controlled (the scanner is receiving prompts or data from the host computer), the RECV light will be lit while the host is actively transmitting to the scanner.

The CTS light indicates an active Clear to Send signal in the cable. The scanner needs to receive this signal (either from the modem or within the cable itself through strapping) before the scanner can transmit.

In a remote installation, if the modem is half duplex, the modem will give a CTS signal when the scanner raises its RTS (Request to Send) signal asking



EXPLANATION: COM STATUS LIGHTS (cont.)

clearance to transmit. In this case, the CTS light will come on before the XMIT light and go out when the XMIT light goes out. If the modem is full duplex, typically the CTS signal is continuously raised and the CTS light will always be lit when the modem is on and active.

In a local connection, the cable is designed so that the scanner's RTS signal is strapped to the scanner's CTS signal. In this situation, the CTS light on the operator panel will go on when the scanner wishes to transmit. The XMIT and CTS lights will act identically and will be on if the scanner is actively transmitting or off if the scanner is not transmitting.

The CD (carrier detect) light on the operator panel also indicates a hardware status. When the arrangement is remote, the CD light will come on just before the RECV comes on. This shows that the modem is receiving a sufficient level of carrier. Or, if the modem is full duplex, there may be a constant CD signal which would cause the CD light to be on any time the modem is on and active and the scanner is in a communications mode.

In a local connection using a modem eliminator cable that has no Carrier Detect pin (part nos. 308-919-000 or 308-914-001), the 3000 has the CD and DSR pins wired together. The modem eliminator cable has pin 20 (DTR) on the host end connected to pin 6 (DSR) on the 3000 end of the cable. The CD/DSR input to the 3000 is used to drive the CD status light on the 3000. The CD light then indicates that the 3000 is connected to a host device and that the host device is powered up and ready.

B

# APPENDIX:
# NCS® TABLETOP
# SCANNER COMPATIBILITY

## INTRODUCTION

This appendix is intended for users who already have a Sentry 70 tabletop scanner (7000, 7001, 7001D, or 7004) in the operating system.

## OVERVIEW: COMPATIBILITY

The following discussion addresses the differences in NCS Asynchronous Communications protocol for the Sentry™ 3000 and the Sentry™ 70 tabletop scanners (7000, 7001, 7001D, and 7004). If you have Sentry 70 tabletop scanners in your system already, you will want to pay special attention to these differences. You may be able to use the same driver program but you must be aware of the differences in protocol features between the two types of scanner.

## EXPLANATION: FEATURES

Certain features that are available for the Sentry 70 scanners listed above are not available for the Sentry 3000. They are:

- oEND OF BATCH
- oTIMEOUT BEFORE NEXT TRANSMISSION
- oAUTOMATIC DISCONNECT AFTER 100 SECS
- oNUMBER OF RETRIES
- oSTART SCANNER
- oSELECT STACKER
- oREQUEST FOR STATUS
- oCPU TERMINATE CODE

Any of these features will be ignored by the Sentry 3000 (unless the same characters are used on the 3000 Configurator Sheet for another feature).

Certain features available on the Sentry 3000 scanner are not available on the Sentry 70 scanners. They are:

- oEND OF DOCUMENT
- oCOMPRESS
- oAUX PORT ECHO
- oSELECT AUX PORT
- oAUX PORT DATA
- oSELECT SCANNER FROM HOST
- oSELECT SCANNER FROM AUX

EXPLANATION: ABSENT CODES (cont.)

Any of these codes will be ignored by the Sentry 70 scanners (unless the same characters are used on the Async Configurator Sheet for those scanners for another code).

EXPLANATION: ERROR CHECKING

- The Sentry 70 scanners will edit the Configurator Sheet to ensure that, for example, END OF INFORMATION is defined when PRINT DATA is defined or POSITIVE RESPONSE is defined when CHECK CHARACTER is defined. Editing for END OF INFORMATION and for the MANDATORY GRIDS (including CHECK SUM) are the only checks performed by the Sentry 3000.

- The Sentry 3000 scanner does not send a status report.

## COMMENT SHEET

**Host Programmer's Guide**

**(Publication Number 202 151 973, Revision A)**

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