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IBM

Reference Manual

IBM 9000 Series Airlines Reservation Systems

Remote Equipment

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IBM 9000 Series Airlines Reservation Systems Remote Equipment

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IBM 9000 Series Remote Equipment

A total IBM 9000 Series Airlines Reservation System includes physical equipment at a data processing center and remote installations; control programs and operational programs to integrate the operations of the system; and a complex and extensive transmission network to give the system instantaneous response.

This manual describes only the IBM equipment at the remote installations. Configurations of this equipment may vary, according to the size and needs of the individual installation and the role it plays in the over-all system.

Each piece of equipment generates signals, receives signals, transmits signals, or performs some combination of these functions. The form of these signals is inherent in the design of the equipment, but the uses to which they are put are determined by the planning and programming for each particular airline's reservation system. To give all of these signals meaning, they are interpreted in this manual. Sometimes these interpretations are described as "possible" or "typical" uses; the uses labeled as typical may be considerably changed if the signals are programmed for different responses. Functions not described as typical may be assumed to be the same in any 9000 series system.

In this manual, "input" refers to signals moving toward the data processing center; "output" refers to signals moving out of the data processing center to the remote equipment. The term "data set" is used to mean any piece of equipment connecting data processing systems with common carrier transmission networks. The term "data sets" includes subsets and modems, as well as demarcation strips and special connecting devices in telegraph systems.

Figure 32 at the end of this manual is a fold-out sheet, showing the possible configurations of remote equipment. This illustration enables the reader to keep before him a picture of the total remote-equipment pattern, while he is studying the detailed description of any component.

Because the largest amount of customer contact with the remote equipment is with the reservation agents' sets, this portion of the equipment is described first. The terminal interchanges, however, are the key processors in the remote equipment system. Understanding their operation gives insight into the logic of all other remote equipment. Therefore, the terminal interchange is the second component described. The third class of components to be discussed is equipment used to link a 9000 series system with telegraph systems.

For an over-all description of any particular 9000 series system, consult the IBM General Information Manual for that system; for a detailed description of the data processing center components of any particular 9000 series system, consult the IBM Data Processing Center Reference Manual for that system.

Agents' Sets

Most transactions in airlines reservation systems are initiated either by agents' entries into the agents' sets (Figure 1) or by external telegraph inquiries. All entries pass through a transmission network into the data processing center, where the computer acts upon them, prepares a response, transmits it to the appropriate remote equipment, and causes it to be displayed – either at the agent's set (in printed form or by lighted indicators) or as punched paper tape at other remote low-speed equipment.

By far the largest amount of input and output data for an airline's reservation system passes through the agents' sets. See Figure 2. Designed for manual input, the set contains: (1) a card reader with pushbutton controls – the IBM 1003 Air Information Device – in which the proper air information sheet is inserted manually by the agent; (2) an IBM 1003 Routine Action Pushbutton Module on which the agent enters and requests flight reservation information; (3) an IBM 1003

Figure 1. Airline Reservation Agent's Set

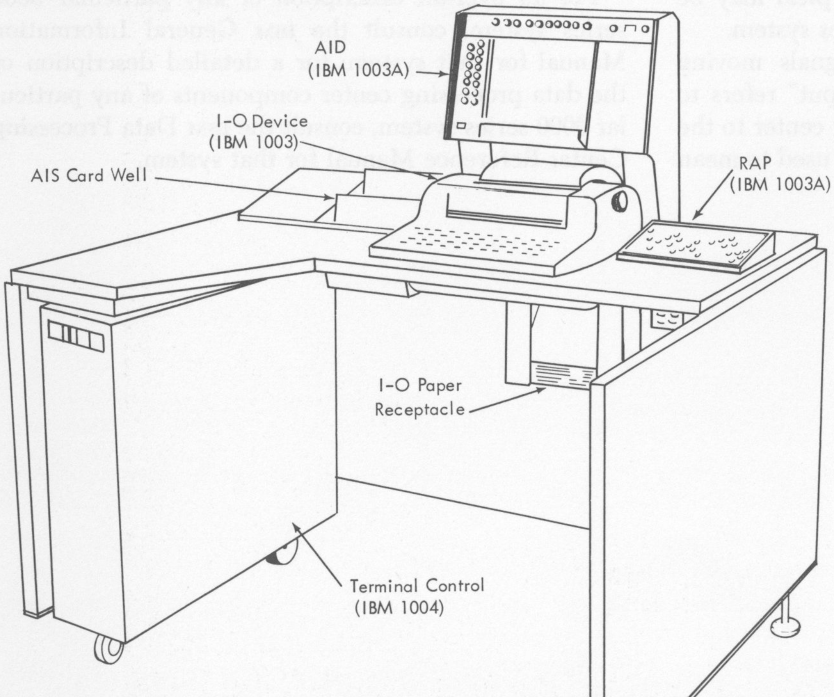


Figure 2. IBM 1003A Terminal and 1004 Terminal Control

Input-Output Device used by the agent for manual entries of passenger data and also by the computer for automatic printing of output messages; and (4) an IBM 1004 Terminal Control containing the circuitry required for agent's set operation. IBM installs these pieces of equipment in the customer's desk or counter.

Component Description

IBM 1003A Air Information Device

As the first step in inquiring for information about any flight, the agent picks from a file of air information sheets one containing the desired cities of departure and arrival. The operator places this air information sheet (AIS) in the AIS holder of the air information device (AID). The AID (Figure 3) establishes the identity of the particular air information sheet by sensing holes punched at the bottom of the sheet. Twenty-three possible punched-hole positions are provided, consisting of three data fields of seven positions each and two additional positions to ascertain that the card is properly positioned (Figure 4). The 21 positions of the three data fields constitute three characters and allow 68,921 possible combinations. When the AIS is correctly positioned, the card check light comes on.

The air information sheets are printed and punched by a printing service according to: (1) the quantity specifications (provided by the airline) for cards of each desired punched-hole combination, and (2) the reader-punch equipment and master cards designed by IBM.

LINE SELECTOR (FLIGHT) BUTTONS

At the left margin of the card holder are two vertical columns of eight buttons each, staggered so that successive horizontal rows on the air information sheet are indicated by alternate columns. If one of these buttons is pressed, all others are released. These are called

Figure 3. Air Information Device with Air Information Sheet

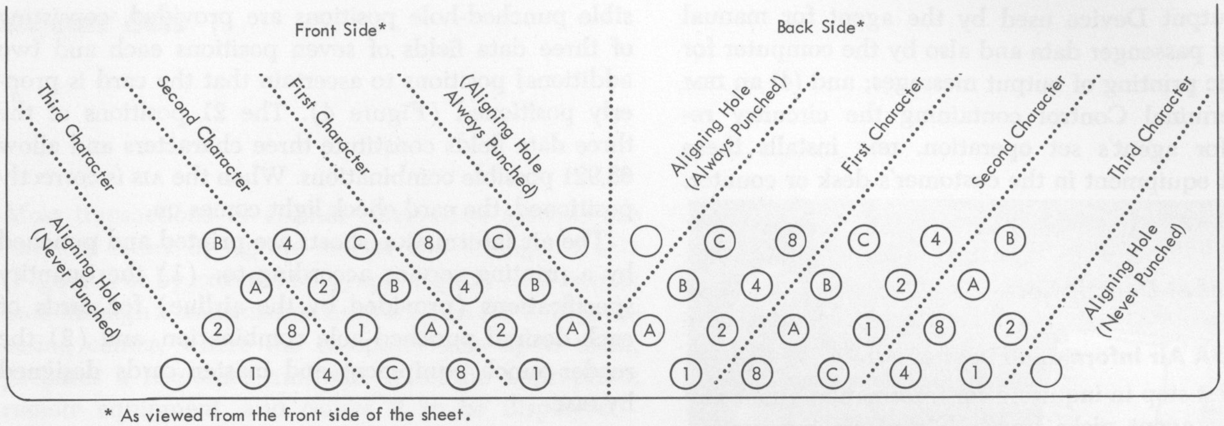


Figure 4. Air Information Sheet Identification Code

flight buttons because each designates a particular flight (or a particular type of service on a flight, such as first class, tourist, or coach). Depressing the flight button causes the character assigned to that button to be entered in the proper message position. (If no button is pressed, an all-zeros character goes to the terminal interchange where it is changed to a "no-operation" character.)

COLUMN (ORIGIN) BUTTONS

A horizontal row of eleven origin buttons, so named because they designate the points of departure of flight legs (or through flights), appears at the top of the card. Like the flight buttons, if one of these is pressed the others are automatically released. Some of these origin buttons may be temporarily blocked from use – which ones depend upon the formats of the air information sheets used. In the system shown in Figure 3, only three – the 1 button, the 6 button, and the 11 button – can be depressed. Each identifies the proper one of the three input fields on the air information sheet. As with the flight buttons, if the agent fails to depress any of the origin buttons, a no-operation character is entered into the computer.

AVAILABILITY REPLY LIGHTS

Between the air information sheet and flight buttons is a vertical column of sixteen lights; each indicates a flight line on the air information sheet and is aligned with the corresponding flight button. The purpose of these lights is to display certain types of messages from the data processing center, primarily to indicate what flight, with what particular class of service, has the requested amount of space available. If some or all of these lights are on when availability information comes to the terminal set from the computer, they are all reset off and then immediately relighted to display the new availability information. They remain lighted until another "lights" message comes through from the computer, or until the agent removes the air information sheet or presses the reset button.

INDICATOR LIGHTS

These lights convey to the agent the status of the terminal set. Four are to the left and two are to the right of the column origin buttons at the top of the air information device. The seventh indicator is in the lower left portion of the AID. From left to right across the top of the AID, the indicators are:

System Available: This light is normally on. It would be off only if an unusual circumstance disconnects the terminal from the rest of the system or prevents the terminal interchange from accepting information from the agent's set.

Keyboard Active: This light is on when the input-output device keyboard is unlocked. It indicates that the keyboard or routine action pushbuttons may be used to enter data.

Card Check: This light is on when the air information sheet is properly positioned.

Power On: This light is on when power is on in the terminal control.

Push Repeat: This light comes on when the terminal senses an invalid character in an output message from the computer. It remains on until the agent pushes the reset button. The operator then pushes the repeat button on the routine action pushbutton set, causing the computer to repeat the entire current message.

Re-enter: This light comes on with any of the following conditions:

1. When a character error is detected in an input message.
2. When an output control signal is received by the terminal while the agent is entering a message.
3. If a typing conflict occurs.

Availability Check: This light is on while an availability message from the computer is being displayed by the availability reply lights. If no space is available (no availability lights are on) and the availability check light goes on, the agent knows that the answer is back and that the answer is "No space."

RESET BUTTON

Pressing this button causes the agent's set to send a reset character to the terminal interchange. Sending this character permits the agent to re-enter a message. Depressing this button also unlocks the keyboard and returns the type-head carrier on the printer.

IBM 1003A Routine Action Pushbutton Module

This module is divided into the five fields of buttons. The action field has momentary-contact pushbuttons. All other fields have an interlock feature so that pressing any button in the field releases the other buttons in the field.

The top row of 12 buttons is the month field.

The four buttons of the second row are the tens digit of the day field.

The third row of buttons enters the units digit of the day field. In the module shown in Figure 5, the agent pushes the leftmost button (TDA) to inquire for space availability for today; the button just to the right (TMW) for tomorrow. These are examples of programmed functions for these buttons. The four buttons on the left half of the fourth row are the seats field. They can designate 1, 2, 3, or 4 seats.

The right half of the fourth row and the lowest two rows constitute the action field.

The number of keys to be used in the action field varies, depending on the needs of a particular application. When an action button is pushed, the status of the terminal is:

1. The system available light remains on.
2. The routine action pushbuttons, although operable, are ineffective until the terminal set receives a response from the computer.
3. The input-output keyboard is locked.

Depressing any action button causes sensing and transmitting of the codes for all depressed routine action pushbuttons, all depressed air information device buttons, and holes punched in the AIS. If no button is depressed in any one field, a no-operation character is inserted for that field. On the routine action push-

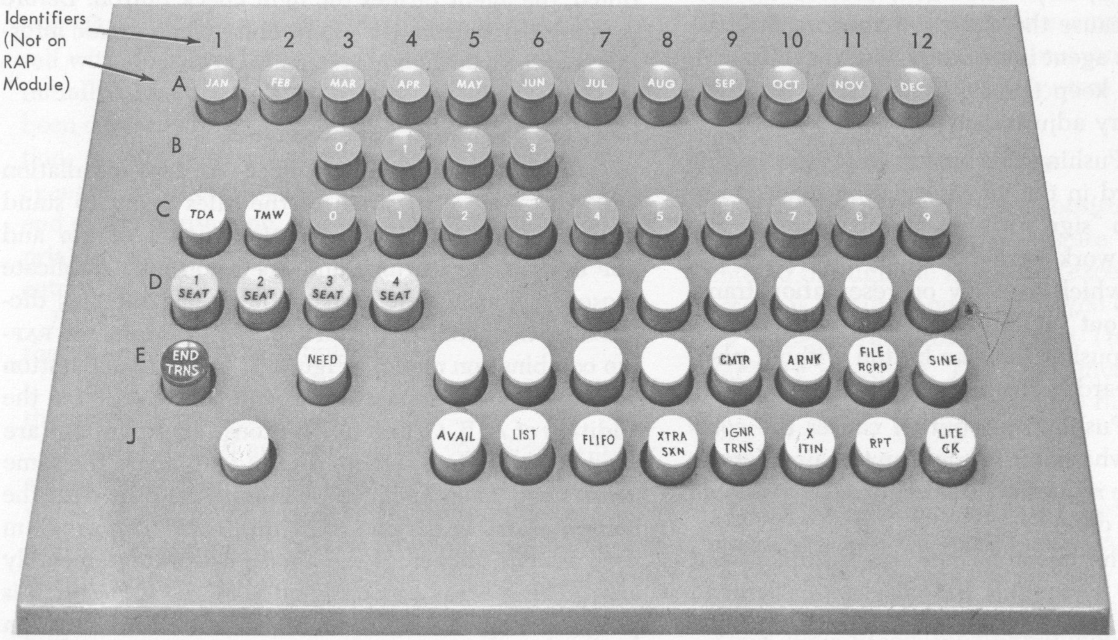


Figure 5. Routine Action Pushbutton Module

button (RAP) module shown in Figure 5, typical programmed functions for action buttons are:

END TRNS (E, 1): The agent presses the end transaction button to signal the computer that the transaction with the customer is completed and that his record may now be placed in storage.

NEED (E, 3): The agent presses this button when the customer decides to reserve space on the flight indicated by the air information sheet and flight button, origin button, date, and number of seats. Depressing this key causes the computer to update seats inventory (and reservation records if this is a correction to an existing record) and to send a confirmation message to the agent. (The format of this confirmation message is determined by the airline's programming.)

CMTR (E, 9): The agent uses this commuter button to signal the computer that the customer habitually makes the requested flight. The computer then maintains this passenger's data record until signaled to destroy it. This makes it unnecessary for the agent to repeatedly re-enter passenger data such as address and telephone number on future transactions.

ARNK (E, 10): This button means arrival unknown. The agent uses it in two situations:

1. When the passenger is accomplishing a segment of this itinerary independently. To assure the computer that this segment is not being forgotten, the agent presses ARNK and then enters the following segment.

2. When the passenger's initial boarding point is elsewhere than in the city where the reservation is made. In this case, the agent enters ARNK and then the first segment of the itinerary.

FILE RCRD (E, 11): The agent presses the file-record button to cause the computer to store the passenger file that the agent is currently working with and, at the same time, keep the file immediately available for further itinerary adjustment.

SINE (E, 12): Pushing this button (after placing his own signature card in the air information device) enables the agent to "sign in" with the computer at the beginning of his work period and thereby reserve a working area in which to carry on reservation transactions. To "sign out" at the end of the work period, the agent merely pushes the sine button without placing his signature card in the air information device.

AVAIL (J, 5): Pushing this button causes the computer to indicate what flights shown on the air information sheet have the requested number of seats available on the designated date.

LIST (J, 6): The agent pushes this button to put the customer on a waiting list for the designated flight. As soon as the computer receives this signal, it sells space if any has just been released. If it cannot sell, it records the passenger information on the waiting list file.

FLIFO (J, 7): Pushing this flight information button enables the agent to receive a flight forecast or flight progress information on a designated flight.

XTRA SXN (J, 8): When the sixteenth flight line availability reply light comes on, the computer is indicating that an extra section has been made up for the flight on the date indicated. The agent now pushes the extra section button to ask for extra section space availability. The computer response may be the lighting of flight indicators or the printing of a message, depending upon programming.

IGNR TRNS (J, 9): The agent pushes this button to cause the computer to undo everything it has done since the last depression of the end transaction button.

X ITIN (J, 10): The agent pushes this button to cause the computer to cancel the complete itinerary of the passenger whose record has just been retrieved. As soon as the button is pushed, the computer erases the itinerary in the passenger's record. The inventory record is not updated correspondingly, however, until the end transaction button is pushed.

RPT (J, 11): The agent pushes the reset and then the repeat buttons under two conditions: (1) after a halt in the print-out of a message from the computer, accompanied by lighting of the push repeat light on the air information device; and (2) when no response is received from the data processing center. When the repeat button is pressed, the computer repeats the last entire output message.

LITE CK (J, 12): To test that all sixteen availability reply lights on the air information device are operational, the agent pushes the light check button. Before pushing the button, the agent must place an air information sheet in the air information device.

IBM 1003B RAP-AID Combination

In a city or airport ticket office—or any installation where it is more feasible for the sales agent to stand rather than to sit—a combination model of AID and RAP is used. Its features and operation may duplicate those previously described or they may differ as dictated by the needs of the airline. For example, the RAP-AID combination model (Figure 6) has the same button functions as the separate RAP and AID except for the addition of A, B, C, and OUT buttons. These buttons are used in installations where three agents share the same agent's set. Each agent must initially sign in with the computer, using his own signature card. The program then assigns to each of the agents a working assembly area. These areas are designated A, B, C. With this programming, the A, B, C, and OUT buttons function as follows.

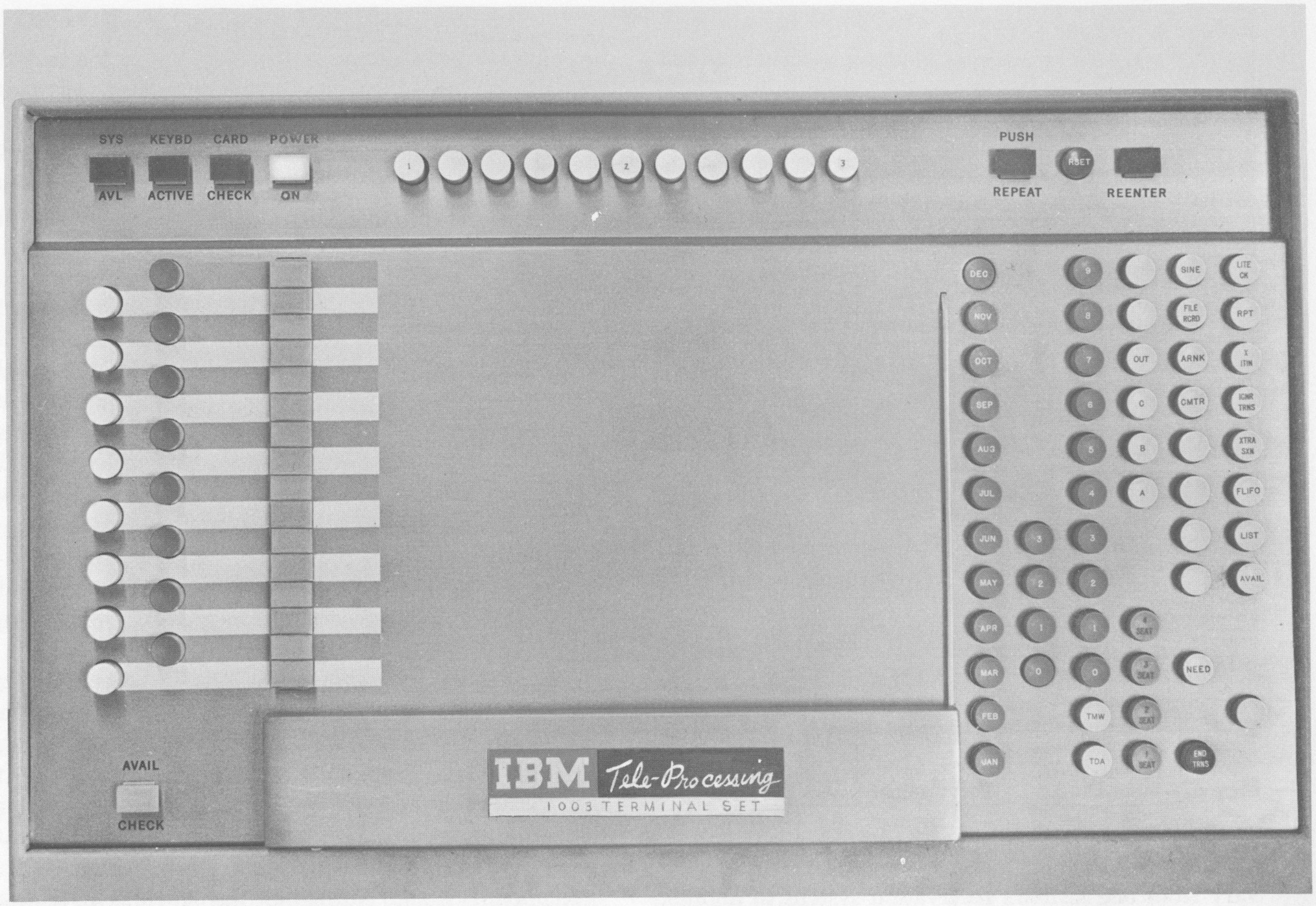


Figure 6. IBM 1003B RAP-AID Combination

A (D, 7): Agent A pushes this button to identify himself with the A working area. If agents A, B, and C have initially signed in correctly and no information has been entered since the end-transaction, ignore transaction, or OUT button was pushed, the computer sends agent A a proceed-with-transaction response. At the end of the transaction, the agent must push the appropriate release key so that the next transaction can be entered.

B (D, 8): Agent B uses this button in the same way that agent A uses the A button.

C (D, 9): Agent C uses this button in the same way that agent A uses the A button.

OUT (D, 10): If an agent has not completed a transaction but wishes to relinquish the agent's set to one of the other agents, he pushes this button. In doing so, he causes the computer to save the information in his working area so that it will be ready for renewed activity when he again pushes his own identification button.

This procedure is another example of programming possibilities and may vary not only between airline systems but also within one system.

IBM 1003 Input-Output Device

This part of the agent's set consists of a page printer and alphameric keyboard (Figure 7). All information entered through the keyboard (except the control characters) is simultaneously displayed on the printed page for visual verification. No keys (including the space bar) are repetitive. The agent must restrike a key or the space bar for each repetitive function desired.

PHYSICAL CHARACTERISTICS

The keyboard (Figures 7 and 12) codes the alphameric characters into the IBM binary coded decimal (BCD) code. The special reservation-code keys shown in Figure 7 are typical airlines reservation action codes, once again determined by programming. These functions

Figure 7. Input-Output Device (Printer) Keyboard

vary from one airline's reservation system to another. The following list shows typical functions that the special character keys can perform. Under standard procedure, the tabulate function is mechanically blocked.

FUNCTION	SYMBOL
Display	*
Change	θ
Erase	⌑
End item	╪
New number in party	$
Change status of segment (CSS)	.
Insert after segment (IAS)	/

Special operational program code labels are on all numeric keys.

On-Off Switch: This switch is in the lower right corner of the input-output device. Turning this switch to ON brings AC power into the input-output device and the air information device.

End-of-Line Signal: A bell normally signals the operator at about ten characters before the right margin stop. On input, all keys except control keys lock when the right margin stop is reached. On output, printing can continue until the type-head carrier mechanically locks, at which point overprinting occurs (if carrier return is not programmed). *The margin stops are set only by the IBM Customer Engineers.*

Keyboard Lock: Normally, the keyboard is unlocked. But the following conditions cause it to lock.

1. Depressing the enter key or any action button on the RAP causes the keyboard to lock and remain locked until either: (1) the complete answer to the agent's message has been received from the computer, or (2) the agent presses the reset button on the air information device.
2. Lack of availability of the system (as in the case of line trouble) causes the keyboard to lock until the system is again available.
3. Generation of faulty BCD characters within the input-output device itself causes a keyboard lock. Pushing the reset button unlocks the keyboard.
4. Detection of an error by the terminal interchange causes a lock. Pushing the reset button unlocks the keyboard.
5. While any message, either an answer to an entry by an agent or an unsolicited message, is coming from the computer into the agent's set, the keyboard is locked to prevent the agent's entering an input message until the output message is completed.
6. If the agent strikes more than seven keys per second (on a 74-bits-per-second terminal connection), a lock occurs, accompanied by the lighting of the reenter indicator. See "Operating Instructions."

Before entering a message through the keyboard, check that the system available light on the air information device is on. The keyboard will be unlocked. Depressing any key on the input-output device causes the character representing that key to be transmitted. The message may be of any length.

Normally, no keyboard lock should be encountered during the entry of a message if the terminal set is transmitting at about 148 or 207 bits per second; if it is transmitting at 74 bits per second, the keyboard locks briefly during each character but, unless the agent types at a rate exceeding seven keys per second, this keyboard lock will not cause an error condition. However, the lock will begin to be felt as the operator approaches a speed of seven keys per second and is a guide to the proper typing speed.

Press the enter key to end the message; this causes the keyboard to lock and remain locked until the complete return message is received by the terminal set.

If, during the entry of a message into the input-output device keyboard, the keyboard locks and the reenter light comes on (on the air information device), push the reset button on the air information device and then re-enter the message. If a message from the computer is being printed by the input-output device and the push-repeat light (on the air information device) comes on and the printer stops, push the reset button on the air information device and then the repeat button on the routine action pushbutton module. The computer will then repeat the message. If it does not, again push the reset button and the repeat button. Another unsatisfactory computer response may indicate that something about the input message is in error; therefore, push the reset button (if the reset light is on) and re-enter the input message.

IBM 1004 Terminal Control

All previously described components of the agent's set are connected to the terminal control. This unit contains the appropriate controls for the entire terminal set and supplies all DC power. It is located in the lower left portion of the terminal set—the only component located below the counter-top working area (Figure 2). Its operation is completely automatic and, because it is so closely associated with data flow, it is described more completely in the following section. The only manual operation related to the terminal control is that of turning on the master power switch for the agent's set (and then depressing the reset button on the AID). Note that the input-output device has an independent power switch that must be turned on to bring power to the input-output and air information devices.

Agent's Set Data Flow, Messages, and Codes

The various components of the agent's set are interrelated as shown in Figure 8. All information to and from all other units in the agent's set passes through the terminal control.

The terminal control operates in two modes: send (input data) mode, and receive (output data) mode. It contains a seven-bit data register. In send mode, this register receives the CBA8421 bits in parallel from any of the peripheral devices and sends them in serial form to the terminal interchange, adding two extra bits—the start bit (1) and stop bit (0). In receive mode, the data register receives the seven BCD bits serially from the terminal interchange and, after accumulating all seven bits, sends them in parallel to whichever unit of peripheral equipment they are addressed.

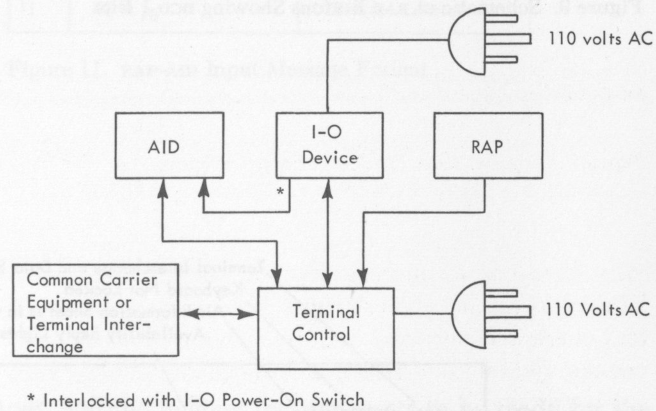
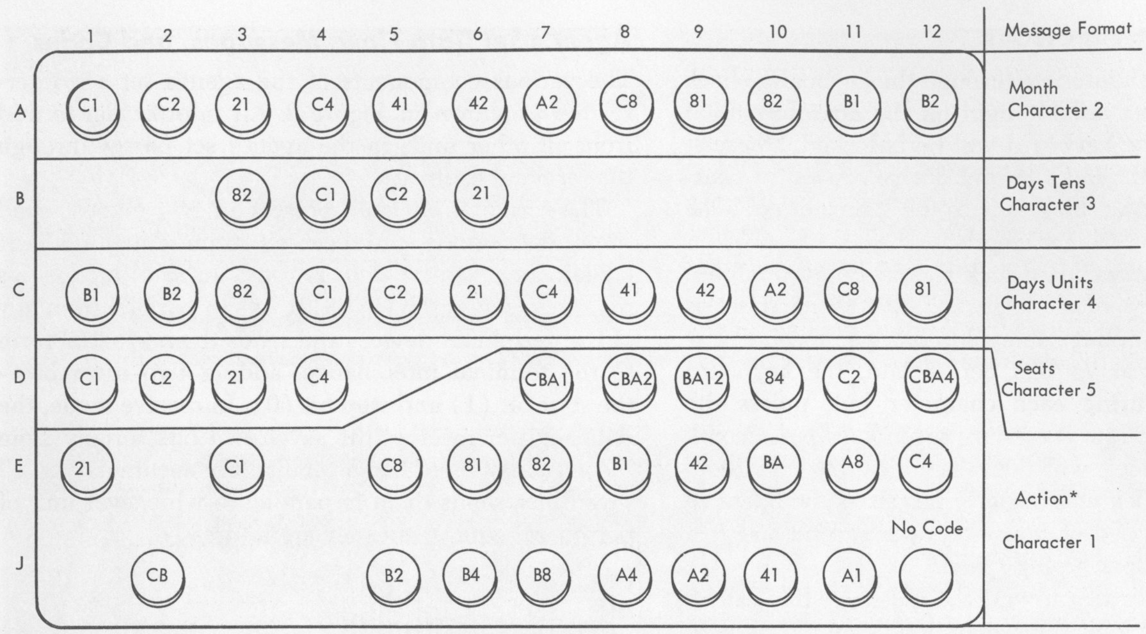


Figure 8. Connection of Agent's Set Subunits

Send Mode

The terminal control accepts information from the routine action pushbuttons (RAP) or air information device (AID) as follows. As soon as the agent presses an action key on the RAP, the scanner begins to scan all buttons on both the RAP and AID for possible input. The buttons on the RAP with their BCD code (1) bits are shown in Figure 9.

The scanner scans first the action buttons; second, the month buttons; third, the days (tens) buttons;



* Action buttons do not lock down. They are momentary contact switches

Figure 9. Schematic of RAP Buttons Showing BCD 1 Bits

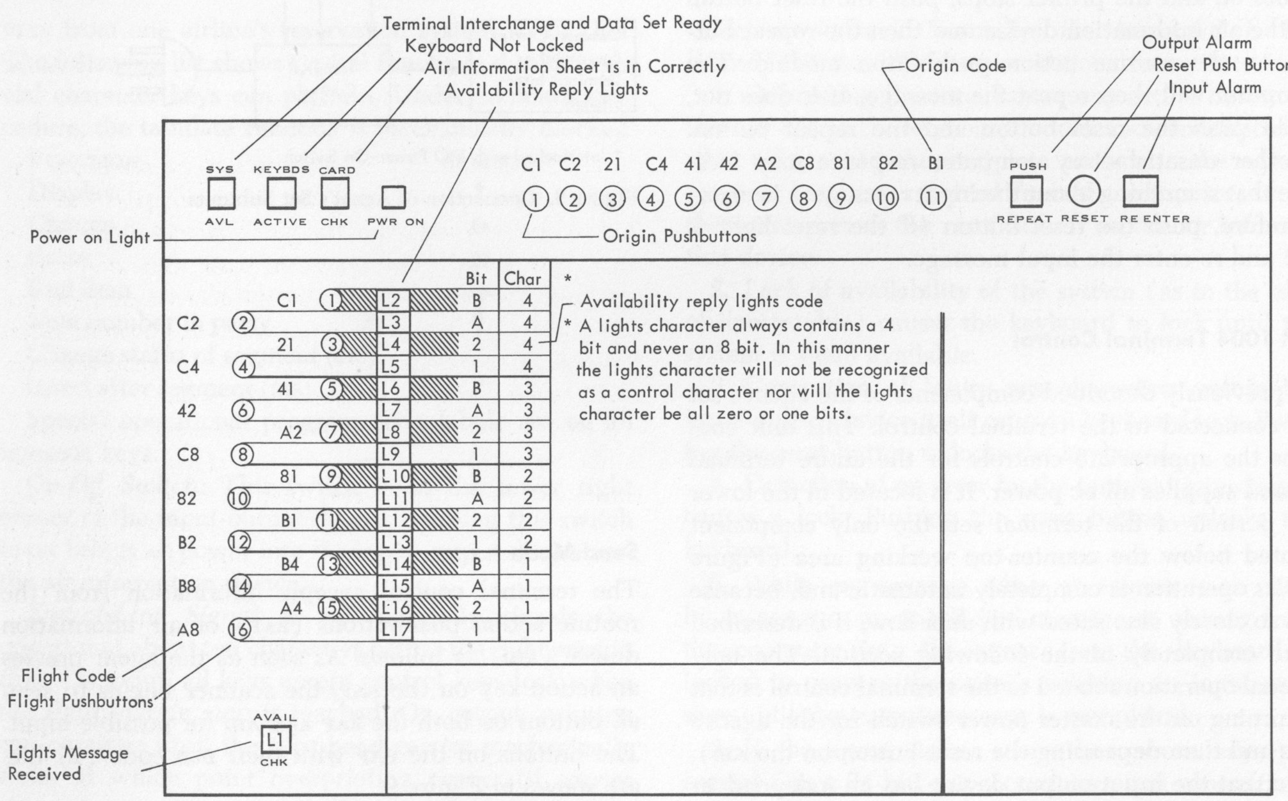


Figure 10. Schematic of AID Showing BCD 1 Bits

fourth, the days (units) buttons; fifth, the seats buttons. If it finds a field in which no button is depressed, a 0000000 code is automatically entered into the data register. This is changed to a 1010000 (no-operation code) by the terminal interchange.

The buttons on the AID with their BCD (1) bits are shown in Figure 10. The scanner, after it has finished scanning the buttons on the RAP, then scans the flight buttons on the AID; next the origin buttons; and finally each of the three fields of identification punches at the bottom of the air information sheet. The scanner has now brought ten BCD characters, one at a time, into the data register; they have been sent out serially to the terminal interchange. A character counter, coming to the count of 11, causes the automatic injection of the end-of-message-for-RAP-AID (EOM_{PB}) character. Thus, the input message for the RAP-AID consists of the 11-character format shown in Figure 11. The sending of a RAP-AID message causes the keyboard to lock during the wait for an answer from the computer.

Input messages from the input-output device may be of any length. The code for each key (Figure 12) is loaded in parallel into the data register. It is also routed through an even-parity checking circuit in the input-output device. If no error is found, the character is sent out serially from the data register to the interchange, with the addition of a 1 start bit and a 0 stop bit.

If the character does not pass the even-parity check, it causes an immediate keyboard lock and the lighting of the re-enter indicator on the AID. In an error condition with the keyboard locked and the re-enter light on, the operator depresses the reset button on the AID and then re-enters the complete message.

As soon as the agent strikes the enter key, the end-of-message-complete code is transmitted through the terminal control data register into the system. This end-of-message character also causes the keyboard to lock while the agent's set waits for an answer from the computer.

Char #	Text	Machine
1	Action	RAP
2	Month	RAP
3	Days Tens	RAP
4	Days Units	RAP
5	Seats	RAP
6	Flight Line	AID Pushbuttons
7	Origin	AID Pushbuttons
8	1st Char AIS	AID Photocells
9	2nd Char AIS	AID Photocells
10	3rd Char AIS	AID Photocells
11	EOM_{PB}	Terminal Control

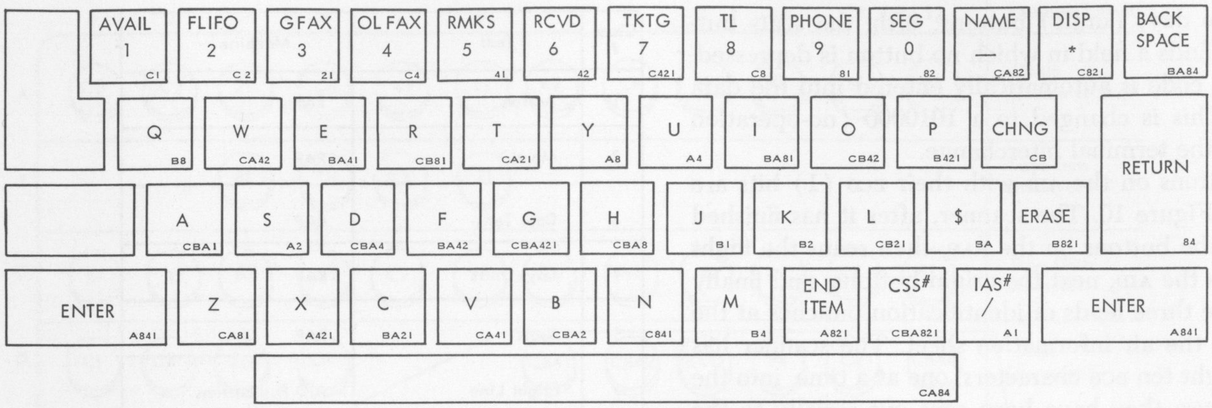
Figure 11. RAP-AID Input Message Format

Receive Mode

An output-data message could be either a "lights" message for the AID or a printed message for the input-output device. The identifying difference between the two is the presence or absence of a lights-start control code as the first character of the message. If no such code is sensed, the input-output device connection is made. The input-output magnet register receives the first character and passes it through a checking circuit where it is checked for even parity (as in send mode). As the character passes the parity check, it is typed out, and the magnet register resets to be ready for the next character. If the character does not pass the test, it is typed anyway, but the push repeat light comes on (on the AID). The operator must then push reset and push the repeat button on the RAP whereupon the computer will resend the message. On an unattended terminal, unsolicited messages may be received correctly, even if the push repeat light is on.

If the lights-start character is sensed, the line-to-lights connection turns on a character scanner (counter). The total lights display comes from four BCD data characters (of which only the BA21 positions are used) as shown in Figures 10 and 13. Each character turns on as many of four lights as it has 1's in the BA21 positions. (In addition, all light characters must have a 1 bit in the 4 position to prevent no-bit characters.) Thus, the sixteen availability reply indicators are turned on in four sections of four at a time. The format of the availability reply message is shown in Figure 13.

The output printer message may be of any length; however, it is made up of segments of not more than



Note: The notation in the lower right corner of each key represents the BCD 1 bits corresponding to the key. This notation does not appear on the actual keyboard.

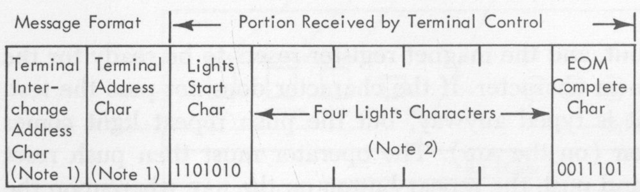
NUMERIC KEY CODES

- AVAIL. Availability. (Similar to RAP except can request more than 4 seats.)
- FLIFO. Flight information
- GFAX. General facts
- OLFAX. "Own Line" facts
- RMKS. Remarks
- RCVD. Identity of reservation requester
- TKTG. Ticketing information
- TL. Time limit for ticket pickup
- PHONE. Phone number of passenger
- SEG. Flight segment
- NAME. Name of passenger
- DISP. Display record of passenger

SPECIAL CHARACTER NOTES

- Change key prints θ
- Erase key prints ⌑
- End item key prints ǂ
- The tab key is mechanically blocked on the standard keyboard
- All keys are single cycle; none are repetitive

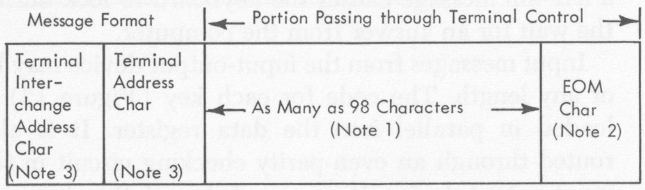
Figure 12. Schematic of I-O Keyboard Showing BCD 1 Bits



Note 1. See Figure 14.
Note 2. Table of Programmer's Output BCD Code for Lights Messages:

BCD Code C B A 8 4 2 1	Character 1	Character 2 (Flight Lines)	Character 3	Character 4
0 1 0 0 1 0 0	13	9	5	1
1 1 1 0 1 0 0	13,14	9,10	5,6	1,2
1 1 0 0 1 1 0	13,15	9,11	5,7	1,3
1 1 0 0 1 0 1	13,16	9,12	5,8	1,4
0 1 1 0 1 1 0	13,14,15	9,10,11	5,6,7	1,2,3
0 1 1 0 1 0 1	13,14,16	9,10,12	5,6,8	1,2,4
1 1 1 0 1 1 1	13,14,15,16	9,10,11,12	5,6,7,8	1,2,3,4
0 0 1 0 1 0 0	14	10	6	2
1 0 1 0 1 1 0	14,15	10,11	6,7	2,3
1 0 1 0 1 0 1	14,16	10,12	6,8	2,4
0 0 1 0 1 1 1	14,15,16	10,11,12	6,7,8	2,3,4
0 0 0 0 1 1 0	15	11	7	3
1 0 0 0 1 1 1	15,16	11,12	7,8	3,4
0 0 0 0 1 0 1	16	12	8	4
1 0 0 0 1 0 0	None	None	None	None

Figure 13. Format and BCD Code for an Availability Reply Message



Note 1. See Figure 12.
Note 2. See Figure 15.
Note 3. Table of Programmer's Output BCD Code for Terminal Interchange Addresses and Terminal Addresses:

Terminal Interchange Address	BCD Code C B A 8 4 2 1	Terminal Address	BCD Code C B A 8 4 2 1
1	1 0 0 0 0 0 1	1	1 0 0 0 0 1 0
2	1 0 0 0 0 1 0	2	1 0 0 0 1 0 0
3	0 0 0 0 0 1 1	3	0 0 0 0 1 1 0
4	1 0 0 0 1 0 0	4	1 0 0 1 0 0 0
5	0 0 0 0 1 0 1	5	0 0 0 1 0 1 0
6	0 0 0 0 1 1 0	6	0 0 0 1 1 0 0
7	1 0 0 0 1 1 1	7	1 0 0 1 1 1 0
8	1 0 1 0 0 0 0	8	1 0 1 0 0 0 0
9	0 0 1 0 0 0 1	9	0 0 1 0 0 1 0
10	0 0 1 0 0 1 0	10	0 0 1 0 1 0 0
11	1 0 1 0 0 1 1	11	1 0 1 0 1 1 0
12	0 0 1 0 1 0 0	12	0 0 1 1 0 0 0
13	1 0 1 0 1 0 1	13	1 0 1 1 0 1 0
14	1 0 1 0 1 1 0	14	1 0 1 1 1 0 0
15	0 0 1 0 1 1 1	15	0 0 1 1 1 1 0
16	1 1 0 0 0 0 0	16	1 1 0 0 0 0 0
17	0 1 0 0 0 0 1	17	0 1 0 0 0 1 0
18	0 1 0 0 0 1 0	18	0 1 0 0 1 0 0
19	1 1 0 0 0 1 1	19	1 1 0 0 1 1 0
20	0 1 0 0 1 0 0	20	0 1 0 1 0 0 0
21	1 1 0 0 1 0 1	21	1 1 0 1 0 1 0
22	1 1 0 0 1 1 0	22	1 1 0 1 1 0 0
23	0 1 0 0 1 1 1	23	0 1 0 1 1 1 0
24	0 1 1 0 0 0 0	24	0 1 1 0 0 0 0
25	1 1 1 0 0 0 1	25	1 1 1 0 0 1 0
26	1 1 1 0 0 1 0	26	1 1 1 0 1 0 0
27	0 1 1 0 0 1 1	27	0 1 1 0 1 1 0
28	1 1 1 0 1 0 0	28	1 1 1 1 0 0 0
29	0 1 1 0 1 0 1	29	0 1 1 1 0 1 0
30	0 1 1 0 1 1 0	30	0 1 1 1 1 0 0
Data Proc Center	1 1 1 0 1 1 1		

Figure 14. Format of Printer Message including BCD Code for Terminal-Interchange and Terminal-Control Addresses

100 characters. The format is shown in Figure 14. On output messages, the end-of-message (EOM) character is the same for either a printer or lights message. The differences in end-of-message characters for output messages are EOM complete, EOM incomplete (which never reaches the agent's set), and EOM unsolicited. All input and output control codes used at the agent's set are shown in Figure 15.

Special Terminal Sets

Terminal sets with the same appearance and line connections as the agents' sets may be used for many other purposes such as supervisors' sets, dispatchers' sets, operation sets for maintenance scheduling, and other purposes. The functions of each of these types of terminals are determined by programming.

For every terminal interchange, one of its terminals (either agent's set or supervisor's set) must be located within viewing distance of the interchange customer-engineering panel as a reliability aid for the system. This terminal (with the permanent address of 1) will also be the test terminal. Terminal 2 is also used for customer-engineer testing and should be convenient to the terminal interchange and terminal 1.

The operator who turns on power for the terminal interchange at the beginning of the work period can check for correct operation of the interchange by turning the interchange test switch to TEST and typing a message at terminal 1. If the terminal interchange is operating correctly, the message will be returned immediately from the interchange and will be typed automatically at terminal 1. (Because of the nearness of terminal 1 to the terminal interchange, terminal 1 will normally be used. However, this test can be performed by any terminal.) For this and other testing reasons, terminal set 1 is a "physical testing" set and must be located next to the terminal interchange.

Other variations in agents' terminal sets will be the result of individual customer systems needs.

BCD Code C B A 8 4 2 1	Programmed Control Function Description	Direction: Input (to Computer)	Direction: Output (from Computer)
0 0 0 1 1 0 0	Type-Head Carrier Return (I-O Device)	X	X
	Out (RAP)	X	
1 0 0 1 1 1 0	Type-Head Carrier Return (I-O Device)	Note 1	X
1 0 1 1 1 0 0	Space (I-O Device)	X	X
1 1 0 1 1 0 0	Tab (I-O Device)	Note 2	X
0 1 1 1 1 0 0	Backspace (I-O Device)	X	X
0 0 1 1 1 0 1	EOM (Complete) (I-O)	X	X (I-O) & Lights)
0 1 0 1 0 1 1	EOM (Unsolicited) (I-O)		X
1 1 1 1 1 0 1	EOM (Pushbutton) (RAP AID)	X	
1 1 0 1 0 1 0	Lights Start (AID)		X

Note 1. Normally not used.
Note 2. Available upon request.

Figure 15. Agent's Set Nonprinting Control Characters

IBM 1006 Terminal Interchange

The Terminal Interchange (Figure 16) is a hold-and-forward communications information processor. It controls messages traveling back and forth between the data processing center and the peripheral equipment (agents' sets, input communication adapters, output communication adapters, or telegraph equipment). Since data flow is similar with all types of peripheral equipment, all types will be called terminals in this section of the manual. For direct telegraph-interchange communication, see "Special Considerations for Telegraph" at the end of this section. Each high-speed pair of lines (trunk) from the data processing center may have as many as thirty terminal interchanges. Each terminal interchange may service up to thirty terminals.

The interchange collects data sent serially (one bit at a time) from the terminals at low speeds of approximately 74, 148, or 207 bits per second; it then transmits at 2,000 bits per second to the data processing center.

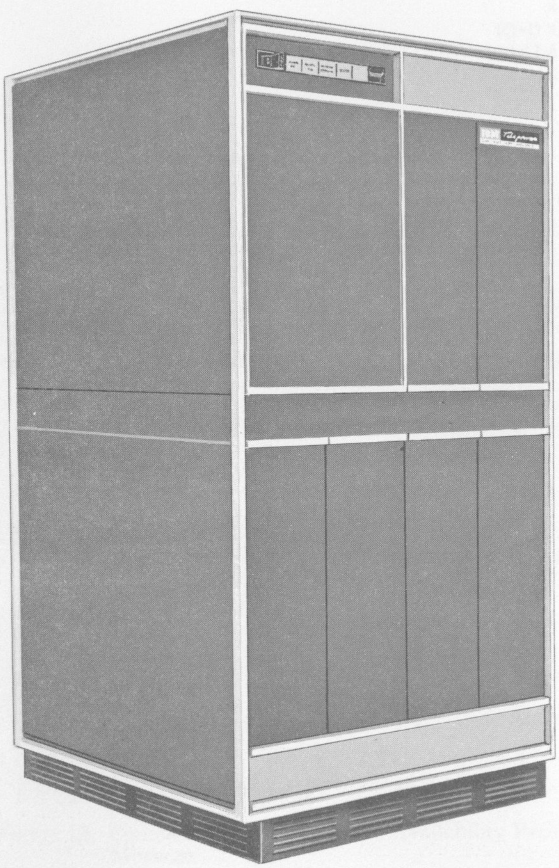


Figure 16. IBM 1006 Terminal Interchange

On outgoing messages to the terminals, it performs a reverse sequence of operations. Figure 17 shows the possible types of connections, and their speed ranges, to the terminal interchange. No over-all predetermined control, timing, clocking, or synchronization exists between the terminal interchange and the terminal. Each terminal feeds immediately into the terminal interchange and receives immediately from it.

A typical procedure for handling terminal interchange transmissions to the data processing center is: The computer sends a go-ahead message (described under "Messages—Codes and Format") to the most remote terminal interchange on each of its high-speed lines. Each most remote interchange transmits all messages accumulated since the last transmitting period. At the end of its total transmission, the interchange sends a go-ahead signal to the next-less-remote interchange on the line. This process repeats until the closest interchange has completed transmission. This interchange sends a go-ahead signal to the data processing center which again starts the cycle of scanning with the most remote interchange. Meanwhile, the data processing center may be sending output messages to any of the terminals.

In the terminal interchange is a 4,000-character storage (with eight bits per character to accommodate the seven bits of BCD code plus an extra control bit). The storage is divided into 39 sections for storing data and one section for controls. Thus, there are forty 100-character sections (buffers).

These buffers provide an ample assembly area for messages to and from the terminal sets. If thirty terminals were feeding into the interchange simultaneously, each would be sending, into a (currently assigned) buffer, serial bits to be accumulated up to a buffer capacity of 98 characters of data for a complete message or for the first segment of a long message. For additional segments of a long message, the buffer capacity is 97 data characters.

The interchange automatically adds two characters to a complete message or the first section of a long message. These characters are the terminal address and end-of-message. To the follow-on segments of a long message, it adds a third character—the segment identifier. When the buffer contains 100 characters, or when an end-of-message is sensed from the terminal supplying input to a buffer, the contents of the buffer are ready to be transmitted to the data processing center.

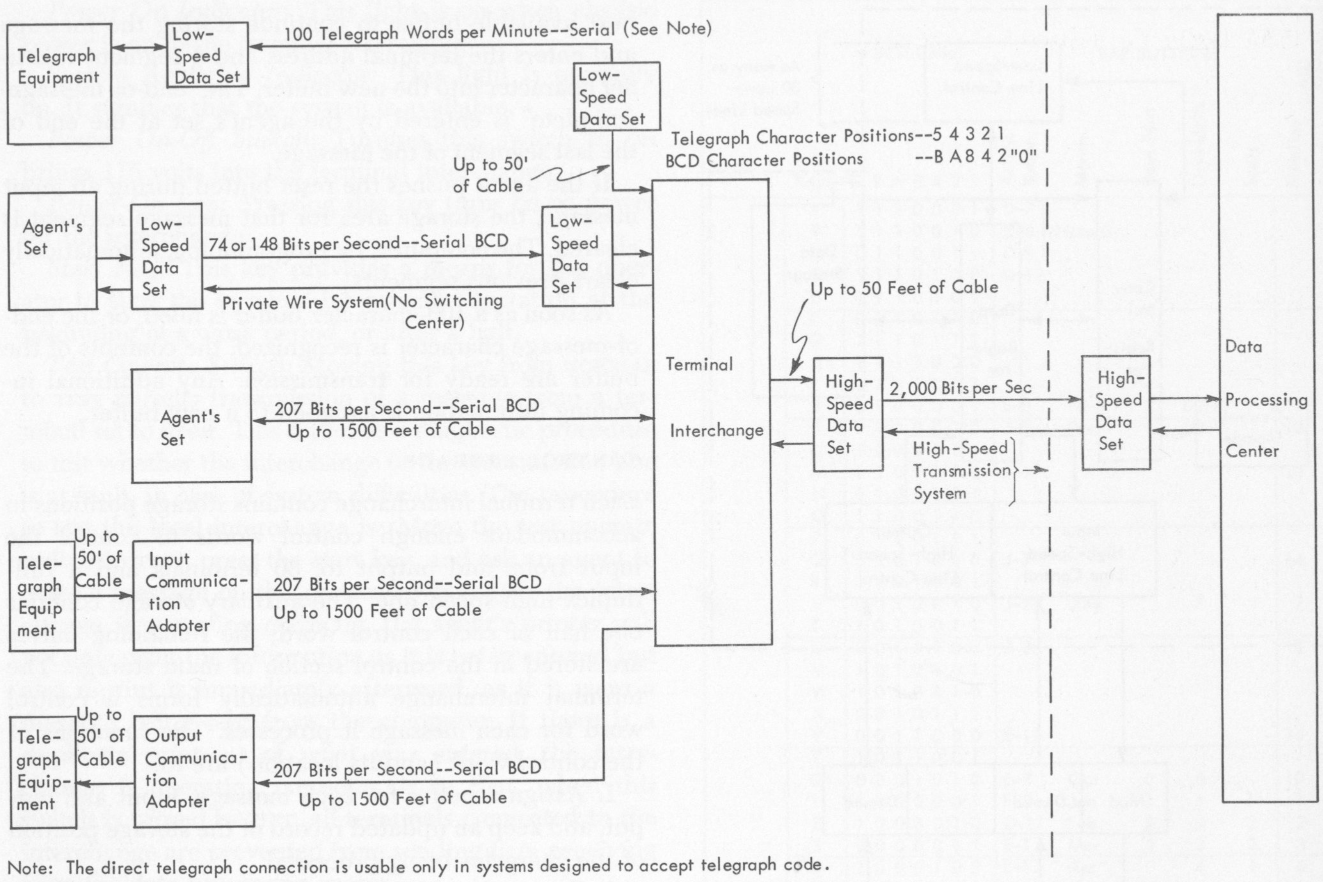


Figure 17. Connections to the Terminal Interchange

There is no permanent assignment of any buffer to any terminal. The buffers are assigned upon demand so that the interchange can make maximum effective use of its storage capacity.

The agent is not limited as to the length of message entered into the terminal; however, each 98 (or 97) data characters of the message are transmitted as soon as they are accumulated in their interchange buffer. Output messages from the computer to the terminal are restricted in length to 100 characters, including terminal address and end-of-message characters. This means that, for output data of more than 100 characters, the program must place a new terminal address and end-of-message character in each 100-character segment of the message, thus making it appear to the interchange as a separate message. (The program must also prefix each message segment with the interchange address, but this character is not included in the 100-character capacity of the message.)

Because the interchange may be simultaneously servicing all connected terminals and high-speed lines, it may be operating in from one to four modes simultaneously. These four modes are: receive low-speed (from the terminal), send high-speed (to the computer), receive high-speed (from the computer), and send low-speed (to the terminal). Any one buffer in the interchange, however, is operated upon in only one mode at any one time.

Components

Figure 18 shows the general composition of the terminal interchange and relationship of the components. The primary components are: data storage; control storage for input-output line controls, and other controls; and registers for data and the control word. The arrows represent the direction or directions in which

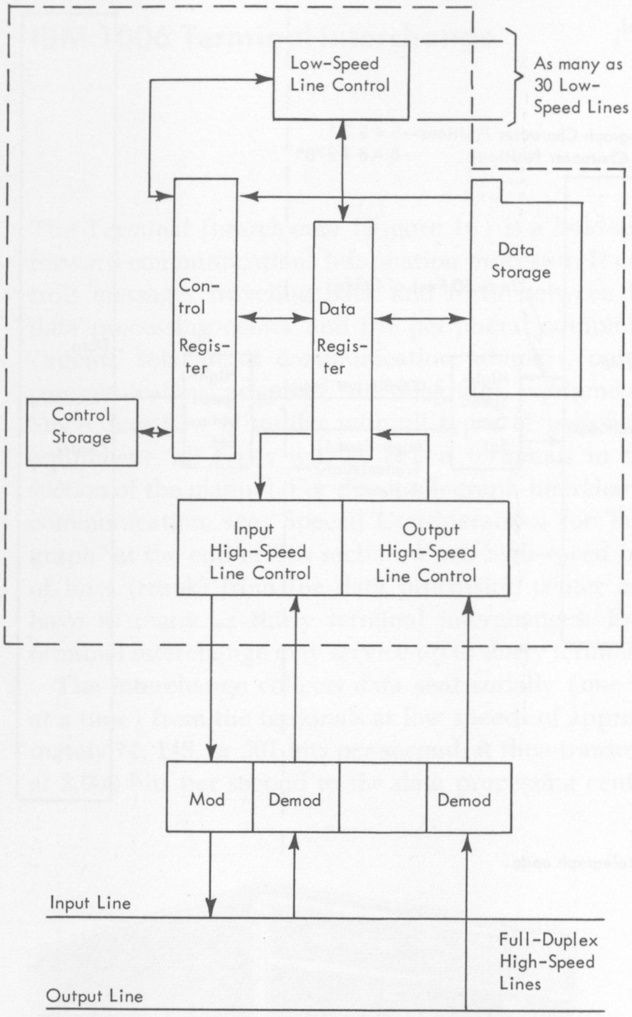


Figure 18. Principal Components of the Terminal Interchange

data may, in some mode, pass from one section to another within the interchange. The section on "Modes and Data Flow" discusses which direction the data follow in each mode.

Storage

The storage unit comprises 39 buffers (data storage) and one control storage. An auxiliary storage houses the remaining control information.

DATA STORAGE

As many as 39 messages or message segments of up to 98 data characters may be stored in the buffers. If a message coming in from the terminal set exceeds 98 characters, the interchange automatically assigns the next available buffer to continue storing the message and enters the terminal address and a segment identifier character into the new buffer. The "end-of-message-complete" is entered by the agent's set at the end of the last segment of the message.

If the agent pushes the reset button during an input message, the storage area for that message segment is cleared. The computer, by programming, automatically clears previous segments.

As soon as a 100-character buffer is filled, or the end-of-message character is recognized, the contents of the buffer are ready for transmission. Any additional incoming information is assigned to a new buffer.

CONTROL STORAGE

Each terminal interchange contains storage positions to accommodate enough control words to control the input from, and output to, 30 terminals and a full-duplex high-speed line. The auxiliary storage contains one half of each control word; the remaining halves are stored in the control section of main storage. The terminal interchange automatically forms a control word for each message it processes. The functions of the control word (and its location) are to:

1. Assign a buffer for each message, input and output, and keep an updated record of the storage position of the character being processed.
2. Determine the timing to read in and read out bits at various speeds. Included in this function are delays after the type-head carrier returns (and tabulates in special request systems) sent to terminal sets.
3. Queue as many as 31 messages to be transmitted over the high-speed line.
4. Identify whether a message is incoming or outgoing.
5. Control an output message until the terminal set is ready to accept it.
6. Translate the multiple-character telegraph end-of-message into the BCD end-of-message-complete character, on direct input telegraph messages.
7. Perform parity check on characters received from terminals.

The control word for each terminal and high-speed line is placed in storage. The control word is placed temporarily in the control register during bit processing and is then replaced in storage. The function of the control register is to control the input and output to and from high-speed and low-speed lines.

Operator's Panel

The terminal interchange is an automatic, normally unattended component of 9000 series systems. However, it has an operator's panel containing two indicators, two switches, and two keys:

Power On Indicator: This light is on when electric power is on in the terminal interchange.

System Available Indicator: This light is normally on. It signifies that the system is available.

Power On-Off Switch: Turning this switch to ON brings 115 volts into the terminal interchange.

Power-On Key: Pressing this key turns on DC power for the interchange.

Start Key: This key provides a means for the operator to start the terminal interchange operation at the beginning of a work period, or after a halt.

Test Operate Switch: Moving this key from NORMAL to TEST permits transmission of a message from a terminal set to itself. This serves as a diagnostic procedure to test whether the interchange or the transmission line is at fault, in case of system difficulties. The procedure to test the local interchange is: Move the test operate switch to TEST, press the start key, and ask an agent to enter a message on the printer keyboard. If the interchange is operating correctly, the agent's printer will not only print the information as it is being entered but also reprint it immediately afterward, as if it were a message being sent from the computer. If there is a duplicate print-out of what was entered, the interchange is operating correctly. Note that, when this switch is turned to TEST, all terminals connected to the interchange are prevented from sending to or receiving from the data processing center.

Messages—Codes and Format

Messages in a 9000 series system may be categorized as input data messages, output data messages, go-ahead messages to the interchange, go-ahead messages to the next interchange, and change-interchange-address messages (from the computer).

Codes

Figure 19 shows the seven-bit BCD code for the characters sent through the terminal interchange to and from the pushbuttons, the air information device, and the printer keyboard. Figure 20 shows the BCD code for control signals. All characters enter the terminal interchange from any type of terminal as BCD in serial form. (The direct telegraph input and output characters are discussed under "Special Considerations for Telegraph.") Note that each character is made up of six basic data bits designated as B, A, 8, 4, 2, 1. Additional control bits and a check bit are added and dropped at various points in the system. The character manipulations that take place in the terminal interchange are described in "Modes and Data Flow."

		BCD Code[1]							RAP BUTTONS					AID BUTTONS	
	I-O Keys	C[2]	B	A	8	4	2	1	Action Button	Month	Days Tens	Days Units	Seats	Fliteline	Origin
	A	1	1	1	0	0	0	1	D-7						
	B	1	1	1	0	0	1	0	D-8	Note 3					
	C	0	1	1	0	0	1	1	D-9						
	D	1	1	1	0	1	0	0	D-12						
	E	0	1	1	0	1	0	1							
	F	0	1	1	0	1	1	0							
	G	1	1	1	0	1	1	1							
	H	1	1	1	1	0	0	0							
	I	0	1	1	1	0	0	1							
	J	0	1	0	0	0	0	1	E-8	Nov		Date		11	11
	K	0	1	0	0	0	1	0	J-5	Dec		TMW		12	
	L	1	1	0	0	0	1	1							
	M	0	1	0	0	1	0	0	J-6					13	
	N	1	1	0	0	1	0	1							
	O	1	1	0	0	1	1	0							
	P	0	1	0	0	1	1	1							
	Q	0	1	0	1	0	0	0	J-7					14	
	R	1	1	0	1	0	0	1							
	S	0	0	1	0	0	1	0	J-9	July		7		7	7
	T	1	0	1	0	0	1	1							
	U	0	0	1	0	1	0	0	J-8					15	
	V	1	0	1	0	1	0	1							
	W	1	0	1	0	1	1	0							
	X	0	0	1	0	1	1	1							
	Y	0	0	1	1	0	0	0	E-11					16	
	Z	1	0	1	1	0	0	1							
	0	0	0	0	1	0	1	0	E-7	Oct	0	0		10	10
	1	1	0	0	0	0	0	1	E-3	Jan	1	1	1	1	1
	2	1	0	0	0	0	1	0	D-11	Feb	2	2	2	2	2
	3	0	0	0	0	0	1	1	E-1	Mar	3	3	3	3	3
	4	1	0	0	0	1	0	0	E-12	Apr		4	4	4	4
	5	0	0	0	0	1	0	1	J-10	May		5		5	5
	6	0	0	0	0	1	1	0	E-9	June		6			
	7	1	0	0	0	1	1	1							
	8	1	0	0	1	0	0	0	E-5	Aug		8			
	9	0	0	0	1	0	0	1	E-6	Sept		9			
	/	0	0	1	0	0	0	1	J-11						
	*	1	0	0	1	0	1	1							
End Item	(‡)	0	0	1	1	0	1	1							
Erase	(⌑)	0	1	0	1	0	1	1							
	.	1	1	1	1	0	1	1							
	-	1	0	1	1	0	1	0							
Chng	θ	1	1	0	0	0	0	0	J-2						
	$	0	1	1	0	0	0	0	E-10						
	Blank	1	0	1	0	0	0	0	J-12 (NO OP)						

1. Even parity within terminal interchange.
2. Check bit dropped before high-speed transmission and added for low-speed output.
3. Shown only in Figure 6 as ticketing buttons A, B, C, OUT. Other action buttons are displayed in both Figure 5 and Figure 6.

Note: Code for D10 is shown in Figure 20 as Type-Head Carrier Return (0001100)

Figure 19. BCD **Data Code Summary for Agent's Set Messages**

C[1]	BA	8421	Type of Control
0	00	1111	Go Ahead
1	10	1111	Change Interchange Address; also TIC_2 (ICA and OCA)
0	11	1111	First Character of Character Synchronization
1	11	1110	Second Character of Character Synchronization
0	11	1010	-----
1	10	1010	Lights Start
0	10	1110	TIC_1 (ICA and OCA)
0	00	1100	Type-Head Carrier Return (I-O Device); also D10 (A Ticketing Pushbutton)
1	01	1100	Space (I-O Device)
1	10	1100	Tab (I-O Device)(Available only upon request)
1	11	1100	Backspace (I-O Device)
1	00	1110	Type-Head Carrier Return (I-O Device)(Output Only)
0	01	1110	Segment Identifier
1	01	1111	-----
1	00	1101	End-of-Message Incomplete
0	01	1101	End-of-Message Complete
0	10	1101	End-of-Message Unsolicited (Answer-Back, OCA)
1	11	1101	End-of-Message, for Pushbuttons and Air Information Device (Signal for OCA Start or Request Repeat)

[1]Even parity is used for low-speed lines. This check bit is dropped before high-speed transmission and added for low-speed BCD output.

Figure 20. BCD Control Code Summary

Message Format

Messages exchanged between the interchange and the computer center are in this format: bit synchronization group, character synchronization group, interchange address, terminal address, message, end of message, and check character. If more than one message is to be sent, only the first requires the synchronization group; the others may then be chained and transmitted without interruption.

On output messages, each new 100-character (or smaller) group is preceded by the interchange address, includes the terminal address and end-of-message characters, and is, therefore, received as a new message.

Figure 21 shows the data message format for both input and output messages on the high-speed line to the data processing center. The first message transmitted after the interchange receives the go-ahead message from the preceding terminal interchange is prefaced by two synchronization characters. The first of these consists of six 1 bits; the second, of five 1's and a 0 bit. These are followed by a one-character interchange address, followed by a one-character terminal address. These two characters are added by the terminal interchange to input messages; they are entered by the program on output. The interchange address is stripped off (on output) as soon as the interchange receives the message. The body of the message may contain up to 98 characters followed by an end-of-message character that may be an end-of-message-complete, end-of-message-incomplete, end-of-message-unsolicited (output), or end-of-message from the pushbuttons (and air information device). If the body of the message contains 98 characters, the terminal interchange address may be thought of as a prefix to the message, because it is not stored in a terminal interchange buffer. The segment identifier is a character that is added by the terminal interchange to all follow-on segments of long input messages. The segment identifier is not used in output messages.

The last character of the message is a check character, a polynomial character of extremely high checking ability. This character is added by the interchange to input just before sending the message to the high-speed line. It is compared with a check character independently generated by the computer. In the output message, the check character is used to compare against a check character independently generated in the terminal interchange. On output messages, the interchange drops this check character after making the comparison. It also drops the two synchronization characters received at the beginning of the first message.

Every output data message that is either incomplete or unsolicited elicits a return message from the interchange confirming its receipt. The format of this return

Note 1		Note 2		Note 3			Note 2
Sync I Char	Sync II Char	Interchange Address	Terminal Address (Stored in Buffer)	Segment Identification	BODY OF MESSAGE (Stored in Buffer)	End of Message (Stored in Buffer)	Check Char
111111	111110	1 Char	1 Char	1 Char	As Many as 98 Characters	1 Char	1 Char

Note 1. Interchange adds these characters to first input message after receiving the go-ahead and drops them from output messages, upon receipt.
Note 2. Interchange adds these characters just before an input message goes to the high-speed data set; on output messages, it uses these characters but does not transmit them to the terminals.
Note 3. Interchange adds this character to all follow-on segments of a long input message.

Figure 21. High-Speed Data Message Format (Input and Output)

message is: interchange address, terminal address, end-of-message-incomplete character, and check character.

The go-ahead message (Figure 22) differs somewhat from the data message format. It begins with the two synchronization characters and continues with the one go-ahead character followed by the one-character interchange address and ends with the end-of-message character followed by the check character. The go-ahead message format does not contain the end-of-message or check character when it originates in a terminal interchange.

Only if First Message (Sync I Char, Sync II Char) — Note 1 (End of Message, Check Char)

Sync I Char	Sync II Char	Go Ahead	Inter-change Address	End of Message	Check Char
111111	111110	1 Char	1 Char	1 Char	1 Char

Note 1. These characters are used only in the message from the Data Processing Center

Figure 22. Go-Ahead Message Format

The third unique type of format is the change-interchange-address message. This message is used to modify the go-ahead message sent by the interchange and keeps the line scan going whenever an interchange is removed from service. Figure 23 shows that this type of message consists of:

1. The one-character terminal interchange address.
2. A character meaning "change interchange address."
3. The next interchange address (one-character).
4. End-of-message character.
5. Check character.

Only if First Message (Sync I Char, Sync II Char)

Sync I Char	Sync II Char	Inter-change Address	Change Inter-change Address	Next Inter-change Address	End of Message	Check Char
111111	111110	1 Char	1 Char	1 Char	1 Char	1 Char

Figure 23. Change-Interchange-Address Message Format

Modes and Data Flow

The four modes of operation for the terminal interchange—receive low speed, send high speed, receive high speed, and send low speed—have been defined. To clarify what is going on inside of the terminal interchange, remember that each 100-character buffer of the interchange storage is being operated upon in only one mode at a time. Also note that the expression "simultaneous" when applied to handling of messages within the terminal interchange means the following (some aspects of simultaneity have already been touched upon but are repeated here to show the interleaving of activities that permit simultaneous operation in up to four modes):

1. On input from the low-speed line: The scanning of terminal input lines is so rapid that all bits on all lines are scanned many times during the period that they are present on the line. Interchange design includes provisions for maximum possible rejection of noise and distortion. Random inputs from all terminals are accepted simultaneously.

2. On output to the low-speed lines: Characters are clocked out in such a way that any number of messages can proceed at any time. Output messages to the terminals are released immediately on receipt from the high-speed line and processing in the interchange (if the terminal is not occupied in handling another message), but without any type of synchronization link to any other messages. Consequently, all messages can be progressing simultaneously.

3. On output from high-speed lines: Messages are received and processed one at a time. On input to high-speed lines: Messages are sent one at a time. However, the two processes can go on simultaneously without interfering with each other or with the operation of the terminals.

4. Within the interchange: All characters are actually processed one bit at a time, under the direction of the appropriate control word. What gives the practical result of simultaneous processing of all inputs and outputs is the speed of the internal operations of the interchange. These operations are so rapid that all possible character activity can be handled during the real-time life of any character that is coming from, or going to, any line. The interchange processes a character bit of one message, then a character bit of another message, and so forth—dealing with each character or demand for a character as it presents itself, regardless of what message it is associated with. The automatic controls call out the proper control word for each high-speed or low-speed line and thereby process the character correctly.

Although the path of a data character through the interchange is not continuous (but is interrupted by step-by-step similar processing of all other characters needing service), the following simplified description ignores interruptions and considers only the successive operations on characters of one message. On input, these characters come in from a terminal, proceed through the interchange, and are sent to the high-speed input line data set; on output, they follow the reverse process and are sent out to a terminal.

Receive Low-Speed Mode

When the interchange receives the message from the terminal, each character is made up of nine serial bits: a start bit, a BCD parity check bit, six BCD character data bits, and a stop bit (Figure 24). As each new bit of a character is shifted into the data register, the preceding bits are shifted one position farther into the register. When the stop bit is received, the most remote position of the register senses the start bit and the register controls send the other eight bits of the character into storage. The start bit is dropped at this point.

As these characters are assembled, they are placed in a buffer. This buffer is assigned and its address is placed in the control word at the start of the message (or message segment). Other portions of the control word are similarly determined automatically.

Send High-Speed Mode

As soon as the 98 data characters have been received, the proper end-of-message is inserted (if not received already) and the message is assigned to the input high-speed line control. Immediately, a queue counter steps one position. As other messages are completed, they are similarly transferred and the queue counter steps accordingly. Therefore, at the time that the go-ahead message is received, the interchange has an accurate count of the number of messages waiting to be transmitted. As each message is transmitted, a message-transmission counter is stepped 1 and the buffer containing that message is made available for other messages. As soon as the message transmission count equals the queue count, the terminal interchange knows that it has transmitted all of its messages; it then initiates a go-ahead message.

Receive High-Speed Mode

At the start of receiving a message from the data processing center, a buffer is assigned to the control word for the output high-speed line. The interchange receives each character from the high-speed line and adds a parity check bit. The character then goes into storage in the position designated by the control word storage address. This process continues until, at the end of the high-speed message, the check character accumulated (within the interchange) for this particular message is compared against the check character that is received as the last character of the message. If the comparison does not agree, the buffer used to accumulate the message is made available for service, thus discarding the incorrect message. (If this was an incomplete or unsolicited message, the data processing center, failing to receive an answer-back, will retransmit the message. If the erroneous message was a reply to an inquiry, the agent, failing to receive the reply, presses the repeat button.)

If the message is correct and accepted by the interchange, the control for that buffer is transferred to the control word for the low-speed line. When the receive-high-speed message is completed, accepted, and transferred, the interchange is ready to service the next message. This transfer process is so rapid that messages may arrive with no delay between them.

Send Low-Speed Mode

Under control of the interchange, characters are sent out to a terminal at the terminal's correct operating speed. Since low-speed output takes place immediately if the terminal addressed is not busy, no queuing controls are necessary. If the terminal is occupied, however, the output message is put in a waiting status. As soon as the terminal is free, the message is sent out. Receipt of an incomplete or unsolicited message causes the interchange to respond with a confirmation-of-receipt message after the output message itself is sent out to the terminal.

Special Considerations for Telegraph

The terminal interchange can process telegraph messages as direct input and output.

During receive-low-speed mode, the five-bit telegraph characters are assembled in the five high-order data bits of each BCD interchange-input character. Zeros fill out the character (Figure 25). The interchange can recognize either a three- or four-character telegraph end-of-message. (Any one particular interchange can recognize only one type of telegraph end-of-message.) After recognizing the end-of-message sequence, the interchange inserts a 9000 series BCD end-of-message-complete character to terminate the message.

On output, the characters (including the telegraph end-of-message sequence) are received from the data processing center in the character format described above. The 9000 series BCD end-of-message character follows the telegraph end-of-message sequence but is not transmitted beyond the interchange.

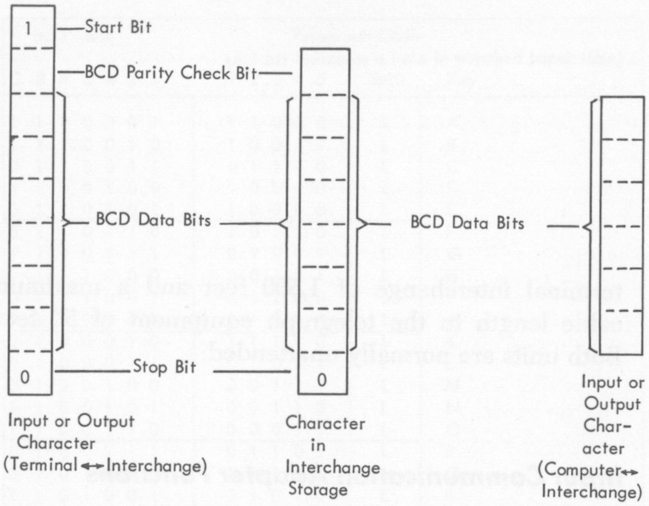


Figure 24. Changes in Character Composition between the Data Processing Center and Terminals

BCD Character Format C B A 8 4 2 1	Telegraph Code (A 1 bit indicates a hole in punched paper tape) 1 2 3 4 5	Shift	Key
1 1 0 0 0 0	1 1 0 0 0	L	A
1 0 0 1 1 0	1 0 0 1 1	L	B
0 1 1 1 0 0	0 1 1 1 0	L	C
1 0 0 1 0 0	1 0 0 1 0	L	D
1 0 0 0 0 0	1 0 0 0 0	L	E
1 0 1 1 0 0	1 0 1 1 0	L	F
0 1 0 1 1 0	0 1 0 1 1	L	G
0 0 1 0 1 0	0 0 1 0 1	L	H
0 1 1 0 0 0	0 1 1 0 0	L	I
1 1 0 1 0 0	1 1 0 1 0	L	J
1 1 1 1 0 0	1 1 1 1 0	L	K
0 1 0 0 1 0	0 1 0 0 1	L	L
0 0 1 1 1 0	0 0 1 1 1	L	M
0 0 1 1 0 0	0 0 1 1 0	L	N
0 0 0 1 1 0	0 0 0 1 1	L	O
0 1 1 0 1 0	0 1 1 0 1	L	P
1 1 1 0 1 0	1 1 1 0 1	L	Q
0 1 0 1 0 0	0 1 0 1 0	L	R
1 0 1 0 0 0	1 0 1 0 0	L	S
0 0 0 0 1 0	0 0 0 0 1	L	T
1 1 1 0 0 0	1 1 1 0 0	L	U
0 1 1 1 1 0	0 1 1 1 1	L	V
1 1 0 0 1 0	1 1 0 0 1	L	W
1 0 1 1 1 0	1 0 1 1 1	L	X
1 0 1 0 1 0	1 0 1 0 1	L	Y
1 0 0 0 1 0	1 0 0 0 1	L	Z
0 1 1 0 1 0	0 1 1 0 1	F	0
1 1 1 0 1 0	1 1 1 0 1	F	1
1 1 0 0 1 0	1 1 0 0 1	F	2
1 0 0 0 0 0	1 0 0 0 0	F	3
0 1 0 1 0 0	0 1 0 1 0	F	4
0 0 0 0 1 0	0 0 0 0 1	F	5
1 0 1 0 1 0	1 0 1 0 1	F	6
1 1 1 0 0 0	1 1 1 0 0	F	7
0 1 1 0 0 0	0 1 1 0 0	F	8
0 0 0 1 1 0	0 0 0 1 1	F	9
1 0 1 1 1 0	1 0 1 1 1	F	/
1 1 0 1 0 0	1 1 0 1 0	F	,
0 0 1 1 0 0	0 0 1 1 0	F	
1 0 0 1 0 0	1 0 0 1 0	F	$
0 0 1 1 1 0	0 0 1 1 1	F	.
0 1 1 1 1 0	0 1 1 1 1	F	;
1 1 0 0 0 0	1 1 0 0 0	F	—
0 1 0 1 1 0	0 1 0 1 1	F	&
0 0 1 0 1 0	0 0 1 0 1	F	#
0 1 0 0 1 0	0 1 0 0 1	F	)
1 1 1 1 0 0	1 1 1 1 0	F	(
1 0 0 1 1 0	1 0 0 1 1	F	?
1 1 0 1 1 0	1 1 0 1 1	L/F	Figures Shift (↑)
1 0 0 0 1 0	1 0 0 0 1	F	"
0 0 0 1 0 0	0 0 0 1 0	L/F	Carriage Return (<)
0 0 1 0 0 0	0 0 1 0 0	L/F	Space (▬)
1 1 1 1 1 0	1 1 1 1 1	L/F	Letters Shift (↓)
1 0 1 0 0 0	1 0 1 0 0	F	bell
0 1 0 0 0 0	0 1 0 0 0	L/F	Line Feed (≡)
0 1 1 1 0 0	0 1 1 1 0	F	:
1 0 1 1 0 0	1 0 1 1 0	F	!

Note: The content of the C position is disregarded on output; on input no bit is entered into the C position.

Figure 25. Direct Input-Output Telegraph Code in BCD Character Format

IBM 1005A Input Communication Adapter

IBM 1005B Output Communication Adapter

The IBM 1005A Input Communication Adapter (ICA) and 1005B Output Communication Adapter (OCA) transfer data between two data-handling systems having different codes, speeds, and control systems. These two systems are: (1) a telegraph system, and (2) an IBM 9000 series Airlines Reservation System. The ICA and the OCA are completely independent units. The ICA transfers information from a telegraph network to an IBM 1006 Terminal Interchange; the OCA does the reverse. The principal advantages of using the ICA and the OCA to transfer data between the two systems are:

Their translation of telegraph code into true BCD code that needs no further programmed translation in the data processing center, and vice versa.

The ICA's automatic editing of the incoming telegraph message and the OCA's automatic insertion of special telegraph control characters in outgoing messages.

The compatibility of their BCD control signals with *all* types of data processing center equipment.

The automatic retransmission by the ICA of any input message that is in error when received at the data processing center.

The ICA and the OCA (Figure 26) are identical in external appearance except for differing operator's panels. Each can have a maximum cable length to the terminal interchange of 1,500 feet and a maximum cable length to the telegraph equipment of 50 feet. Both units are normally unattended.

Figure 26. IBM 1005 Input Communication Adapter or Output Communication Adapter

Input Communication Adapter Functions

To transfer telegraphic data into the Airlines Reservation System, the ICA translates codes, edits the incoming telegraph code, recognizes a telegraph end-of-message sequence, and retransmits a message if necessary. Associated functions are: controlling input from telegraph equipment, using messages of preset formats, and alerting an operator to any alarm condition that may arise.

Translating

The ICA accepts from the telegraph equipment a five-level code and translates this code into binary-coded-decimal (BCD) characters (Figure 27). The five-level code has two "shift" characters, letters shift and figures shift, enabling the ICA to distinguish between alphabetic and numeric (including punctuation) characters. As soon as they have served this purpose, the shift characters are edited out of the message that is relayed into the 9000 series system. Blank characters are also edited.

The telegraph-code input to the ICA is parallel by bit and serial by character (Figure 27A); the BCD characters are transmitted to the terminal interchange serially by bit and serially by character. The ICA can receive input speeds up to 200 words per minute (20 characters per second); it transmits each character as it is received from the telegraph equipment. During retransmission, it transmits 23 characters per second. The *bit rate* of transmission and retransmission is approximately 207 bits per second.

Characters sent from the ICA to the terminal interchange consist of:

Start bit, check bit, six data bits, stop bit

Several different sequences of as many as four characters are used in telegraph code to signify the end of a message. The ICA can be programmed to recognize any one of these; the programming can be easily modified whenever necessary.

BCD Code C B A 8 4 2 1	Telegraph Code (A 1 bit indicates a hole in punched paper tape) 1 2 3 4 5	Shift	Key
1 1 1 0 0 0 1	1 1 0 0 0	L	A
1 1 1 0 0 1 0	1 0 0 1 1	L	B
0 1 1 0 0 1 1	0 1 1 1 0	L	C
1 1 1 0 1 0 0	1 0 0 1 0	L	D
0 1 1 0 1 0 1	1 0 0 0 0	L	E
0 1 1 0 1 1 0	1 0 1 1 0	L	F
1 1 1 0 1 1 1	0 1 0 1 1	L	G
1 1 1 1 0 0 0	0 0 1 0 1	L	H
0 1 1 1 0 0 1	0 1 1 0 0	L	I
0 1 0 0 0 0 1	1 1 0 1 0	L	J
0 1 0 0 0 1 0	1 1 1 1 0	L	K
1 1 0 0 0 1 1	0 1 0 0 1	L	L
0 1 0 0 1 0 0	0 0 1 1 1	L	M
1 1 0 0 1 0 1	0 0 1 1 0	L	N
1 1 0 0 1 1 0	0 0 0 1 1	L	O
0 1 0 0 1 1 1	0 1 1 0 1	L	P
0 1 0 1 0 0 0	1 1 1 0 1	L	Q
1 1 0 1 0 0 1	0 1 0 1 0	L	R
0 0 1 0 0 1 0	1 0 1 0 0	L	S
1 0 1 0 0 1 1	0 0 0 0 1	L	T
0 0 1 0 1 0 0	1 1 1 0 0	L	U
1 0 1 0 1 0 1	0 1 1 1 1	L	V
1 0 1 0 1 1 0	1 1 0 0 1	L	W
0 0 1 0 1 1 1	1 0 1 1 1	L	X
0 0 1 1 0 0 0	1 0 1 0 1	L	Y
1 0 1 1 0 0 1	1 0 0 0 1	L	Z
0 0 0 1 0 1 0	0 1 1 0 1	F	0
1 0 0 0 0 0 1	1 1 1 0 1	F	1
1 0 0 0 0 1 0	1 1 0 0 1	F	2
0 0 0 0 0 1 1	1 0 0 0 0	F	3
1 0 0 0 1 0 0	0 1 0 1 0	F	4
0 0 0 0 1 0 1	0 0 0 0 1	F	5
0 0 0 0 1 1 0	1 0 1 0 1	F	6
1 0 0 0 1 1 1	1 1 1 0 0	F	7
1 0 0 1 0 0 0	0 1 1 0 0	F	8
0 0 0 1 0 0 1	0 0 0 1 1	F	9
0 0 1 0 0 0 1	1 0 1 1 1	F	/
1 0 0 1 0 1 1	1 1 0 1 0	F	,
0 0 1 1 0 1 1	0 0 1 1 0	F	
0 1 0 1 0 1 1	1 0 0 1 0	F	$
1 1 1 1 0 1 1	0 0 1 1 1	F	.
1 0 1 1 0 1 0	0 1 1 1 1	F	;
1 1 0 0 0 0 0	1 1 0 0 0	F	–
0 1 1 0 0 0 0	0 1 0 1 1	F	&
1 0 1 0 0 0 0	0 0 1 0 1	F	#
0 0 0 1 1 1 1			
1 1 0 1 1 1 1	0 1 0 0 1	F	)
0 1 1 1 1 1 1			
1 1 1 1 1 1 0	1 1 1 1 0	F	(
0 1 1 1 0 1 0	1 0 0 1 1	F	?
1 1 0 1 0 1 0	1 1 0 1 1	L/F	Figures Shift (↑)
0 1 0 1 1 1 0	1 0 0 0 1	F	"
0 0 0 1 1 0 0	0 0 0 1 0	L/F	Carriage Return (<)
1 0 1 1 1 0 0	0 0 1 0 0	L/F	Space (▬)
1 1 0 1 1 0 0	1 1 1 1 1	L/F	Letters Shift (↓)
0 1 1 1 1 0 0	1 0 1 0 0	F	bell
1 0 0 1 1 1 0	0 1 0 0 0	L/F	Line Feed (≡)
0 0 1 1 1 1 0	0 1 1 1 0	F	:
1 0 1 1 1 1 1	1 0 1 1 0	F	!

Figure 27. Telegraph-BCD Equivalents

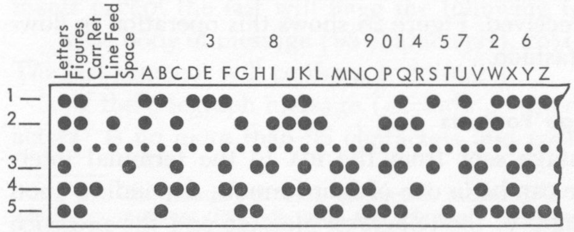


Figure 27A. Paper Tape Characters

Transmitting

After accepting, translating, and transmitting as many as 95 data characters (excluding edited characters), the ICA stops further data transmission to the terminal interchange until it receives an "answer-back" from the data processing center. The answer-back is a one-character message (address characters are dropped in the interchange) signifying that the data processing center has received the input message, checked it for character errors, and found it correct. If the ICA fails to receive the answer-back within a predetermined interval of time, it retransmits the input message. If it again fails to receive an answer-back within the time limit, it sounds an alarm to summon an operator.

Alarm Conditions

Four alarm conditions cause the ICA to summon the services of an operator. They are: input check, output check, time-out, and reader check. The first three conditions cause the re-enter light to come on; the fourth causes the reader check light to come on. Any of these conditions causes the audible alarm to be sounded.

The *input check alarm* results when the terminal interchange senses an invalid character in an input message from the ICA.

The *output check alarm* is produced when the ICA receives an output message (answer-back) that is an invalid character instead of an end-of-message character.

The *time-out alarm* occurs when the following sequence of events has taken place: the ICA has transmitted a message to the terminal interchange; it has not received an answer-back within the preassigned time; it has retransmitted the message once; it has not received an answer-back from the retransmitted message.

The *reader check alarm* signifies to the operator that some error condition exists in the telegraph equipment to which it is connected.

Input Communication Adapter Operations

Operations performed by the input communication adapter in carrying out its various functions can be divided into four phases or modes:

Input Mode: In this mode, data are received from the telegraphic equipment, translated, and edited. As each character is stored in ICA storage, it is transmitted over the data input line to the terminal interchange.

Wait Mode: Upon filling its storage or recognizing a telegraph end-of-message sequence, the ICA goes into wait mode to await the answer-back message from the data processing center.

Output Mode: When the answer-back message is received on the ouput data line, the ICA is in this mode. Upon recognition of the answer-back, the ICA returns to input mode.

Retransmission Mode: After a predetermined time interval, if no answer-back arrives from the data processing center, the ICA retransmits the message previously stored while it was in input mode. Immediately upon finishing the retransmission of the message, it once more enters wait mode to again await an answer-back. This process is described further under "Wait for Response from the Data Processing Center."

Use of the Data Register and Core Storage

The *data register* has many functions in the ICA. All input data pass through this register en route from the telegraph equipment to the terminal interchange. Output data (answer-backs) are temporarily stored here. The register also acts as an input-output device to the core storage.

The *core storage* contains positions for 96 characters. Translated characters minus edited characters (from telegraph equipment) are stored here. They are held until, during retransmission mode, the ICA again transmits the contents of its storage to the terminal interchange, or until, during input mode, the next message replaces them.

Translating, Editing, and Recognizing Telegraph End-of-Message Sequence

The translating portion of the ICA is composed of two sections, the decoder and the encoder.

The *decoder* allows all 64 combinations of the five-level code (with shifts) to be recognized. Decoded alphabetic and numeric characters are wired directly to the encoder. Punctuation and special characters are wired to a control panel by the IBM customer engineer.

The *encoder* is partially wired directly to the decoder and partially wired to the control panel. Its function is to generate the 9000 series BCD character for the corresponding five-level code character. By use of the control panel, the punctuation and special characters can be encoded to any BCD character desired. Also, any of these characters can be used for telegraph end-of-message recognitions or be edited out of the input message.

An *editing control* allows the ICA to edit any special character or punctuation character from the input telegraph message. To do this, outputs from the decoder are directed to the edit-control portion of the control panel. Editing is done merely by preventing both storage and transmission of the unwanted character.

The *telegraph end-of-message recognition control* is able to recognize any character sequence up to four telegraph characters, if they are directed to the telegraph-EOM portion of the control panel.

Character Generation

Certain control characters are generated in the ICA during input mode.

Terminal Identifying Character 1 (TIC_1): This character is generated when the input message is a normal message. It is the first character; its bit configuration is:

START	C B A 8 4 2 1	STOP
1	0 1 0 1 1 1 0	0

Terminal Identifying Character 2 (TIC_2): This character is generated when no answer-back arrives within the predetermined time limit or when manual intervention has been necessary for re-entering a message from the telegraph equipment. The bit configuration for this character is:

START	C B A 8 4 2 1	STOP
1	1 1 0 1 1 1 1	0

End of Message Incomplete (EOM_I): This character is generated when the ICA has transmitted 95 characters (unless the character following the 94th telegraph character is to be edited, in which case only 94 characters are transmitted) and the telegraph end-of-message sequence has not been recognized. The bit configuration for this character is:

START	C B A 8 4 2 1	STOP
1	1 0 0 1 1 0 1	0

End of Message Complete (EOM_C): This character is generated when the telegraph end-of-message sequence is recognized in the incoming message. (If the 95th character is the last character of the telegraph end of message, the EOM_C is generated.) The bit configuration for this character is:

START	C B A 8 4 2 1	STOP
1	0 0 1 1 1 0 1	0

Wait for Response from the Data Processing Center

When the ICA enters the wait mode, a predetermined time interval control is activated. This control is adjustable to compensate for different response times from the data processing centers. It is after this predetermined time interval has expired that the input message is retransmitted, if the answer-back message has not been received. Figure 28 shows this operation in flowchart fashion.

Message Formats

A message sent from the ICA to the terminal interchange can be in one of four formats, depending upon the length of the telegraph message and the presence or absence of alarm conditions.

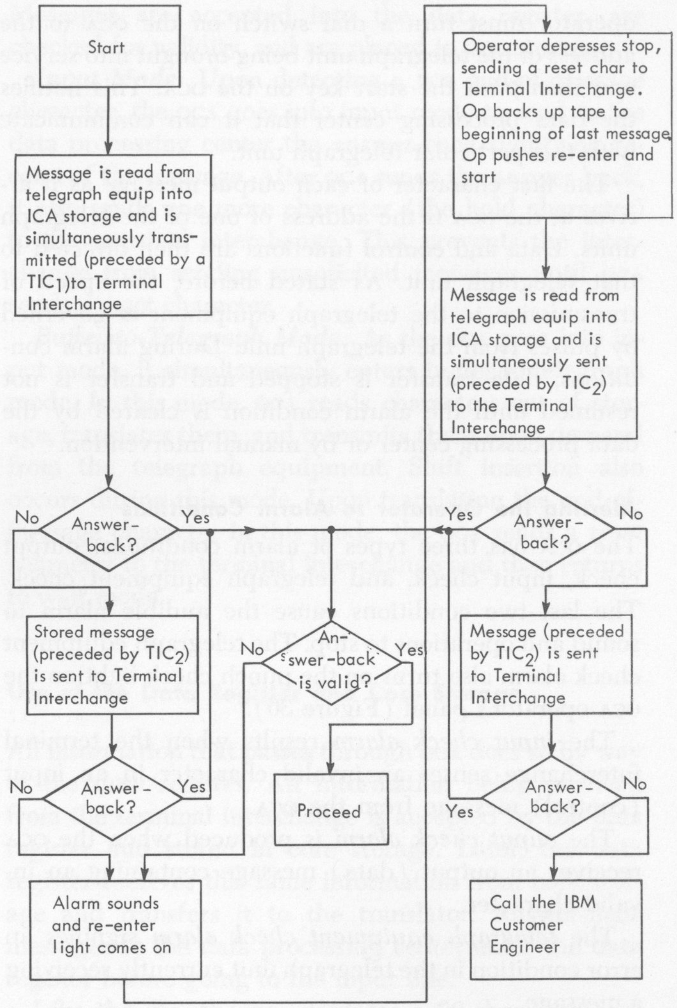


Figure 28. No-Answer-Back Routine for the ICA

1. If the telegraph message, excluding edited characters (and the end-of-message characters may be edited), is no more than 95 characters and contains the end-of-message sequence, the format is:

TIC_1, body of message (maximum 95 characters[1]), EOM_C

2. If the message from the telegraph equipment is longer than 95 characters (excluding edited characters), the ICA will divide it into segments. All segments except the last will have the following format:

TIC_1, body of message (95 characters[2]), EOM_I

The last segment will conform to format 1.

3. If the telegraph message (excluding edited characters) is no more than 95 characters and contains a telegraph end-of-message sequence and *if the message is being retransmitted*, its format is:

TIC_2, body of message (maximum of 95 characters[1]), EOM_C

4. If an incomplete-message segment is being *retransmitted*, its format is:

TIC_2, body of message (95 characters[2]), EOM_I

If the last segment of the long message is being retransmitted, however, its format will be:

TIC_2, body of message (maximum of 95 characters[1]), EOM_C

The only output message to the ICA is the answer-back from the data processing center. This is a one-character message: EOM_C.

In addition to normal message formats, a "reset" character is sent to the terminal interchange when the stop key is depressed. This character has the following bit configuration:

START	C	B	A	8	4	2	1	STOP
1	1	1	1	1	1	1	1	0

Input Communication Adapter Operator's Panel

The operator's panel is used to control the ICA and to place it in normal operating condition. The switches, keys, and lights, and their functions are (Figure 29):

Power Off/On: This switch controls the AC power. It must be in the ON position for normal operation.

Start: Depressing this key resets the ICA so that it is able to receive input messages and operate normally.

Stop: Depressing this key stops all ICA operations except a retransmission and sends a reset character to the terminal interchange.

Re-enter: Depressing this key causes a TIC_2 character to be generated as the first character of the input message. This key is pressed after a message has been re-entered manually in the telegraph equipment. The start key must be pressed after the re-enter key.

Power On: This light indicates that AC power is present in the ICA.

System Available: This light is normally on. It signifies that the 9000 series system is available.

Re-enter: This light indicates that an input message was in error when it was transmitted by the ICA, and

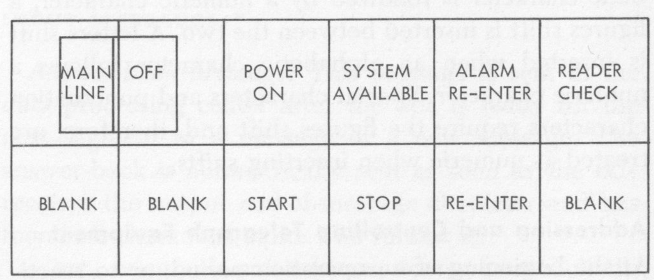


Figure 29. ICA Operator's Panel

[1]Note that the number of data characters included in the 95-character message depends upon the telegraph end-of-message sequence used.
[2]See preceding explanation of EOM_I.

that it should be re-entered manually from the telegraph equipment.

Reader Check: This light indicates that an alarm condition exists in the telegraph equipment.

Output Communication Adapter Functions

To transfer data from the Airlines Reservation System to a telegraph system, the OCA translates the code, inserts telegraph-code shift characters, and transmits the message to the particular telegraph terminal equipment addressed. Associated functions are: checking the validity of each character received from the data processing center, sending an answer-back to the data processing center if all characters are valid, and alerting an operator to any alarm condition that may arise.

Translating and Validity Checking

The OCA translates the six data bits of the BCD characters into five-level telegraph code (Figure 27). The output message from the data processing center arrives at approximately 207 bits per second, serially by bit and serially by character. The OCA checks each BCD character for validity as it is received. If it finds a character with an odd number of one bits (excluding the start bit), it does not send an answer-back to the data processing center. Instead, it returns to wait mode and awaits a retransmission from the data processing center.

Transmitting

The OCA transmits data to telegraph equipment in five-level code characters. The transmission is serial by character and parallel by bit (Figure 27A). The rate of this transmission is governed by the demand of the receiving equipment.

In addition, OCA transmits control characters to the terminal interchange. See "Output Communication Adapter Message Formats."

Inserting Shift Characters

As the output message passes through the OCA, the proper shift characters are inserted. When an alphabetic character is followed by a numeric character, a figures shift is inserted between the two. A letters shift is inserted when an alphabetic character follows a numeric character. Special characters and punctuation characters require the figures shift and, therefore, are treated as numeric when inserting shifts.

Addressing and Controlling Telegraph Equipment

At the beginning of an operation period, or to reactivate a telegraph unit that has been out of service, the operator must turn a dial switch on the OCA to the address of the telegraph unit being brought into service and then push the start key on the OCA. This notifies the data processing center that it can communicate with this particular telegraph unit.

The first character of each output message as it arrives at the OCA is the address of one of the telegraph units. Data and control functions are then directed to that telegraph unit. As stated before, the speed of transmission to the telegraph equipment is governed by pulses from the telegraph unit. During alarm conditions, data transfer is stopped and transfer is not resumed until the alarm condition is cleared by the data processing center or by manual intervention.

Alerting the Operator to Alarm Conditions

The OCA has three types of alarm conditions: output check, input check, and telegraph equipment check. The last two conditions cause the audible alarm to sound and operations to stop. The telegraph equipment check alarm also turns on the punch check light on the OCA operator's panel (Figure 30).

The *input check alarm* results when the terminal interchange senses an invalid character in an input (control) message from the OCA.

The *ouput check alarm* is produced when the OCA receives an output (data) message containing an invalid character.

The *telegraph equipment check alarm* signifies an error condition in the telegraph unit currently receiving a message.

Output Communication Adapter Operations

Operations in the OCA, like those in the Input Communication Adapter, are divided into four phases or modes.

Wait Mode: The OCA is normally in this mode prior to receiving a message from the data processing center.

Output Mode: Upon receipt of an output message, OCA transfers from the wait mode to the output mode.

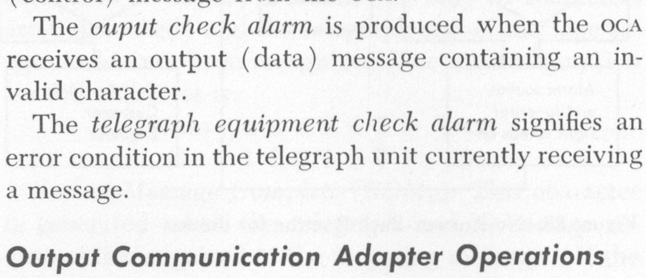


Figure 30. OCA Operator's Panel

Messages are accepted into the data register, are checked for validity, and are placed in OCA storage.

Input Mode: Upon detecting a BCD end-of-message character, the OCA goes into input mode to send to the data processing center the answer-back signifying receipt of the message. After OCA sends the answer-back, it also sends one more character (the hold character) to the terminal interchange. This prevents the interchange from sending unsolicited messages until OCA sends a reset character.

Buffer-to-Telegraph Mode: As the OCA goes into input mode, it simultaneously enters buffer-to-telegraph mode. In this mode, OCA reads characters out of storage, translates them, and transmits them upon demand from the telegraph equipment. Shift insertion also occurs during this mode. Upon translating the end-of-message character in this mode, the OCA sends a reset character to the terminal interchange and then returns to wait mode.

Use of the Data Register and Core Storage

All information that passes through OCA does so by way of the *data register*. All information being received from the terminal interchange is accepted by the data register and stored in core storage. Later, the data register receives this same information from core storage and transfers it to the translator. Answer-back messages to the data processing center enter the data register before going to the input line.

Like the ICA, the OCA contains a 96-character *core storage* where output messages are stored before their transfer to the telegraph unit.

Translation and Shift Insertion

The translator in OCA has two sections: the decoder and the encoder. The *decoder* interprets all 64 combinations of the BCD code and presents them as inputs to the *encoder*. Certain special combinations (punctuation and special characters) are programmed through an IBM customer engineer control panel to special five-level code characters. Part of the encoder is wired to the decoder and part is wired to the control panel. The encoder accepts outputs from the decoder and translates to the corresponding five-level code.

As each BCD character is read from the core storage, it is checked to determine the five-level *shift code* that should precede it. The character is compared with the shift already set up in the controls (by the previous character). If the shift is the same, the character is translated into the five-level code with no insertion of a shift character. If the shift is different, the correct shift character is inserted. Immediately following the insertion, the BCD character is translated and transmitted to the telegraph equipment.

Message and Address Controls

Upon receipt of the output message and a signal from the telegraph equipment that it is ready to receive, the input message control sends the normal answer-back message to the data processing center. When the OCA or one of the telegraph units is being restored to normal operation, the input message control is used to send the reactivation message (see "Message Formats") to the data processing center.

The first character of the output message, as it is received at the OCA, is the telegraph unit address. The OCA is able to address one of four units:

TELEGRAPH UNIT NUMBER	BCD Address C B A 8 4 2 1
1	1 0 0 0 0 0 1
2	1 0 0 0 0 1 0
3	0 0 0 0 0 1 1
4	1 0 0 0 1 0 0

The OCA address itself is dropped by the terminal interchange after it has been used to put the output message on the correct output line to the OCA indicated by the address. The OCA and ICA addresses follow the pattern of "Terminal Addresses" shown in Figure 14.

Validity Checking Control

As each output character is received from the terminal interchange, it is checked for an even number of one bits (excluding start bit). Whenever an odd number is found, the OCA ceases the transmission, sends a reset character to the terminal interchange, and returns to wait mode.

Message Formats

Although all data messages pass through the OCA as output messages, control characters make up input messages.

INPUT MESSAGES

Answer-back Message: This message is sent to the data processing center after the OCA is ready for the next segment of a message or a new message. The answer-back is automatically sent as soon as the OCA receives the output end-of-message character and has found all characters valid. The format is:

TIC_1, telegraph unit address, EOM_{UN} (unsolicited), hold character

The bit configuration of the hold character is:

START	C B A 8 4 2 1	STOP
1	0 0 0 1 1 1 1	0

Reactivation Message: This message informs the data processing center that one of the four telegraph units (the one designated by the low-speed unit selector) is ready to receive output massages. The format of this message is:

Reset character, TIC_1, telegraph unit address, EOM_{UN}, reset character

This message is initiated manually by pushing the start key.

Reset Character: The reset character is sent by the OCA immediately after the operator presses the start key; it also is sent automatically between data messages when the OCA is ready for the next message; finally, it is sent whenever a validity error occurs. The bit configuration of the reset character is:

START	C B A 8 4 2 1	STOP
1	1 1 1 1 1 1 1	0

OUTPUT MESSAGES

Output messages contain data to be sent to the telegraph units.

Incomplete Message: This is one in which no telegraph end-of-message sequence is contained in the body of the message. Its format is:

Telegraph unit address, body of message (95 characters), EOM_{PB}*

*EOM_{PB} is not sent to the telegraph unit.

Complete Message: The telegraph end-of-message sequence is contained in the body of this message. Its format is:

Telegraph unit address, body (maximum of 95 characters), EOM_C*

*EOM_C is dropped in the OCA. The telegraph end-of-message sequence, however, is included in the body of the message.

Output Communication Adapter Operator's Panel

This panel (Figure 30) is used to control the OCA and to place it in normal operating condition. The switches, keys, and lights, and their functions are:

Power Off/On: This switch controls the AC power. It must be in the ON position for normal operation.

Start: Depressing this key resets the OCA so that it is able to receive an output message and operate normally. It also causes the input message control to send the reactivation message to the data processing center, signaling the data processing center that the telegraph unit specified by the low-speed unit selector is ready to receive messages.

Stop: Depressing this key stops all operations of OCA. If a message is being transferred to the telegraph equipment, however, data transfer is not stopped until a complete message has been sent.

Tape Feed: Pushing this key causes a letters shift character to be sent to the selected telegraph unit. This key is effective only when no output message is being transferred.

Low-Speed Unit Selector: This multiple-position switch allows the operator to select one of the four telegraph units. Selecting a unit is always followed by either pushing the start key to reactivate the unit, or pushing the tape feed key to send a letters shift character to the unit.

Power On: This light indicates that AC power is present in the OCA.

System Available: This light is normally on. It signifies that the 9000 series system is available.

Punch Check: This light indicates that an alarm condition exists in one of the telegraph units.

An IBM 9000 Series Airlines Reservation System is interwoven with common carrier service in three general areas: (1) The common carrier bears messages at 2,000 bits per second on full-duplex lines between the data processing center and the terminal interchanges. (2) If the agents' sets are located farther than 1,500 feet from their terminal interchanges, a common carrier service carries the messages over these distances, at approximately 74 or 148 bits per second on full-duplex lines. (3) A common carrier telegraph network system may feed into and receive from the IBM 9000 series system either through the input and output communication adapters or by direct connection with the terminal interchanges at speeds up to 100 telegraph words per minute.

At every point where the Airlines Reservation System data and control signals enter or leave a common carrier service, they must pass through a common carrier data set. Depending upon the speed, distance, and complexity of the transmission, the data set may need to modulate, demodulate (or both), act as a special connector, or consist of a demarcation strip.

The specifications for the low-speed data sets required for the most remote areas of a 9000 series system must be decided by the individual airline to conform to particular system plans and common carrier service. The predetermined specifications for data sets located between agent sets and the terminal interchanges are that they be full-duplex sets, able to carry approximately 74 or 148 bits per second. Variable factors in determining these data sets include the distance of transmission, need or lack of need for modulation, preference as to type of modulation and demodulation, and availability of differing types of service at the geographic locations involved.

The specifications for the higher-speed data sets located at the data processing center and at every terminal interchange connection with the main trunk lines are given in the Electronic Industries Association's *Recommended Standards 232.* These sets must handle at least 2,000 bits per second on a full-duplex basis. They must both modulate and demodulate. At the data processing center, each data set consists of a modulation unit attached to the output line and a demodulation unit for the input line. The possible arrangements for data sets at the terminal-interchange connections to the trunk lines are shown in Figure 31.

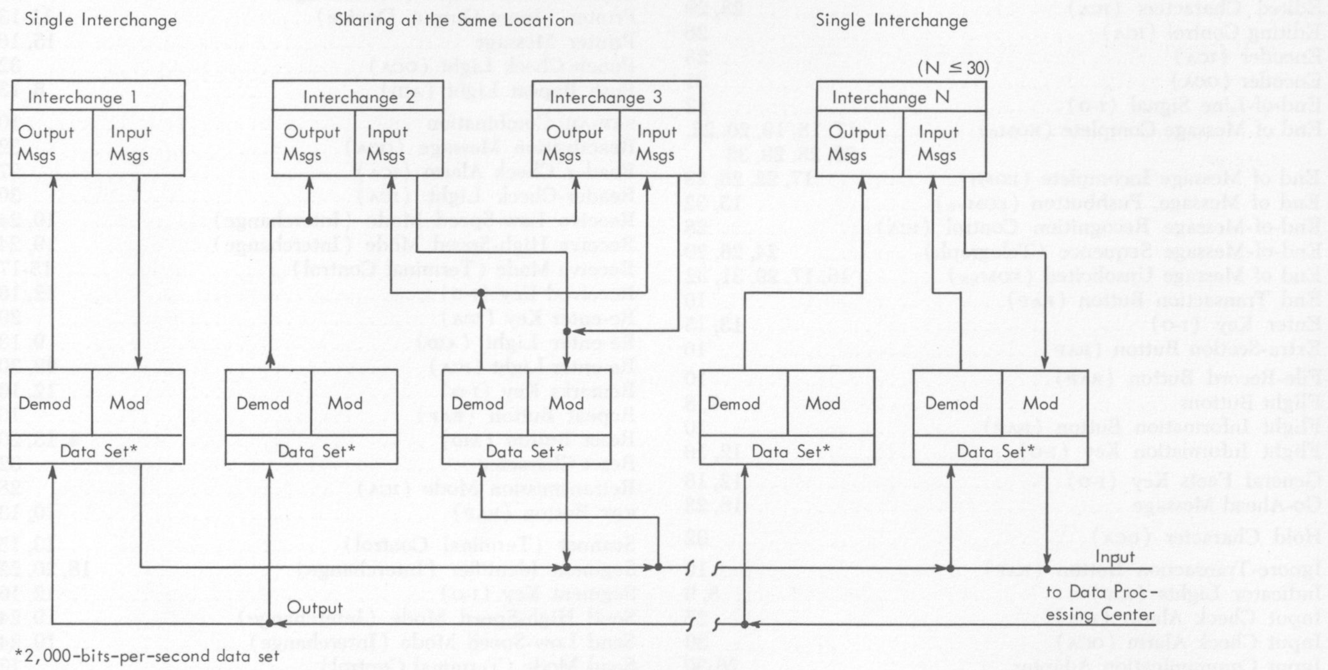
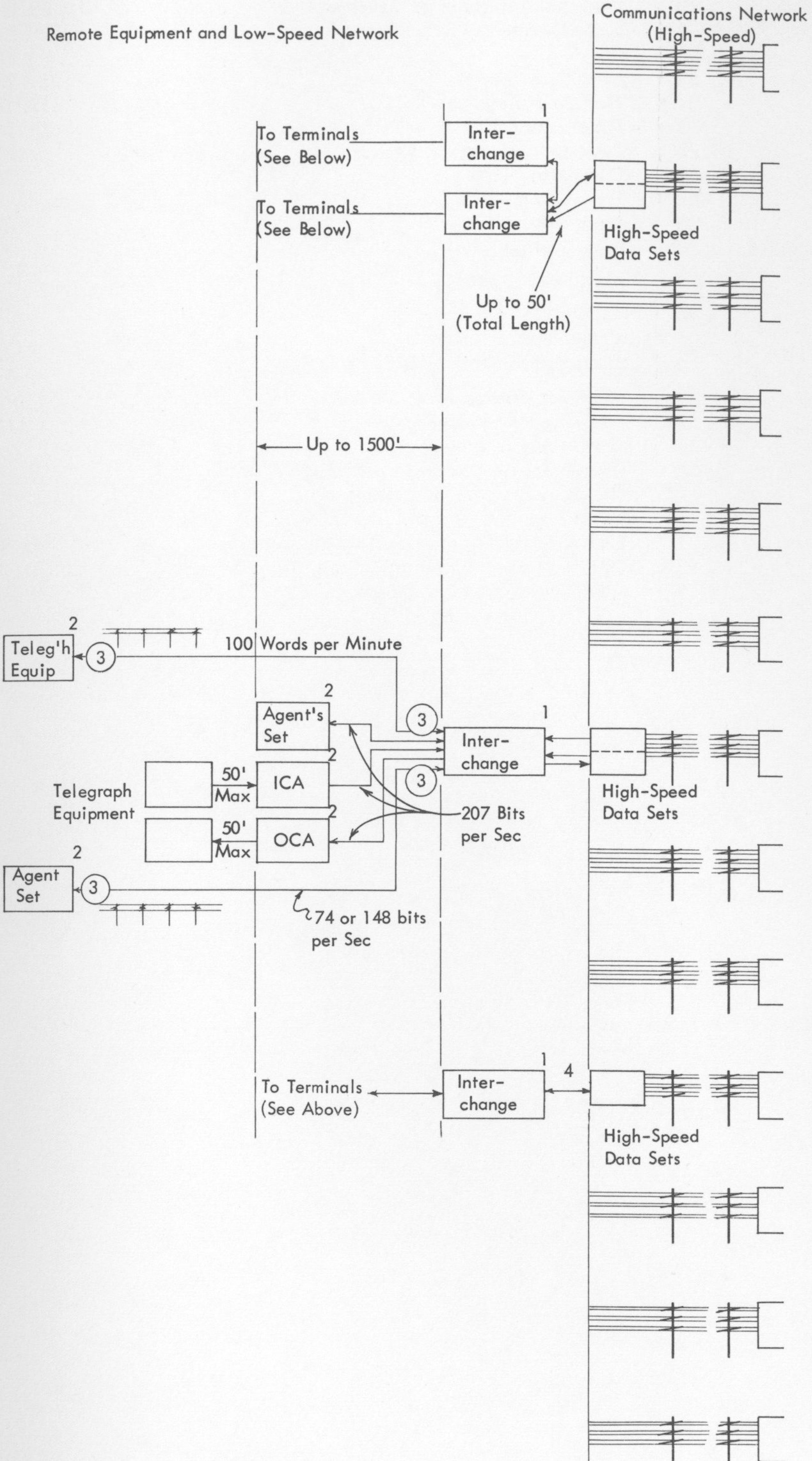


Figure 31. Arrangements of High-Speed Data Sets and Terminal Interchanges

Index



Remote Equipment and Low-Speed Network
Communications Network (High-Speed)
To Terminals (See Below)
To Terminals (See Below)
1
Inter-change
Inter-change
High-Speed Data Sets
Up to 50' (Total Length)
Up to 1500'
2
Teleg'h Equip
3
100 Words per Minute
2
Agent's Set
3
1
Inter-change
2
ICA
3
50' Max
Telegraph Equipment
2
OCA
50' Max
207 Bits per Sec
High-Speed Data Sets
2
Agent Set
3
74 or 148 bits per Sec
1
4
To Terminals (See Above)
Inter-change
High-Speed Data Sets

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