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AUG 76 J G CARR, A R ETHEREDGE F30602-75-C-0216
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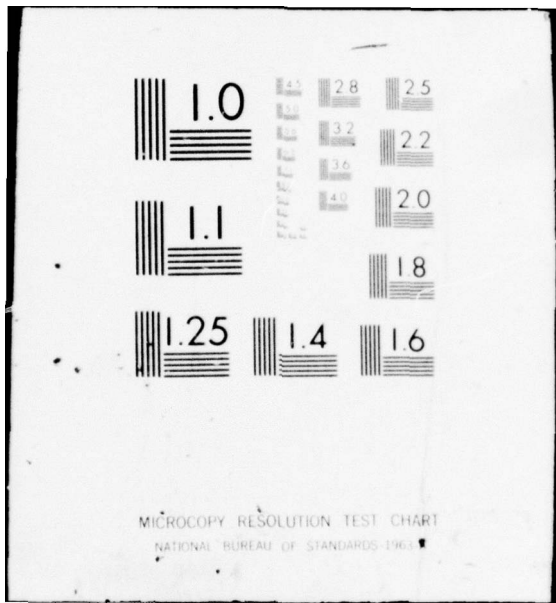


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Final Technical Report
August 1976

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STORED FORMAT AUTOMATED COMMUNICATION TERMINAL (STORFACT)

E-Systems Inc



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→ including one for free text. This is accomplished by means of removable, re-programmable Read Only Memories (ROM's). A tenth format is provided by a Random Access Memory (RAM). Formats are protected such that keyboard entry of data into a non-variable position is impossible. Formats, including variable data, are limited to 512 characters. Comments may be added to the end of a format message to make a total of 1024 characters. All 1024 characters are not necessarily transmitted. Editing may be accomplished by write-over of any character of variable data.

Received messages are stored in a separate 1024 character memory so that receipt of a message will not interfere with message composition. ↑

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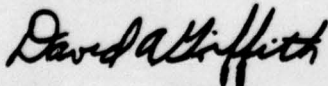
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EVALUATION

The objective of this effort was to design and produce a Stored Format Automated Communication Terminal (STORFACT) addition to the AN/UVA-7 Digital Communications Group. The AN/UVA-7 is used extensively by the Military Airlift Command (MAC) in the current operations phase of airlift management. The majority of messages utilized in airlift management are short and precisely formatted for direct computer processing and data base updating. To simplify the composition of these messages and to insure that the proper format is used was the reason for STORFACT.

Up to 10 formats are stored in ROM memory and may be selectively called up and displayed in the STORFACT display. The operator "fills in the blanks" with the variable information pertinent to this message transmission. By activating the transmit switch, only the variable information is transmitted thereby reducing channel congestion. At the receiving location, the variable information is automatically displayed with the proper format for operator action.

Four STORFACTs were produced under this effort. Cable sets were delivered to allow installation in jeeps, aircraft, shelter and fixed stations. The STORFACTs were delivered to Pope AFB and installed and tested by the contractor. Follow-on testing was conducted by Air Force personnel.



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Project Engineer

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1.0 INTRODUCTION

Defense command and control systems are in a period of technological transition from discrete manual operation to integrated automated operation. Accurate and complete source data capture at the lowest practical operating echelon and rapid communications of these data to higher echelon computers is essential. The STORFACT (Stored Format Automated Communications Terminal) development is a continuation of DoD efforts to facilitate information flow to and from low echelon operational elements. STORFACT uses portions of the AN/UYA-7 (V) Digital Data Group to maximize the effectiveness of the HF SSB radio communications.

Since the introduction of computers to handle volumes of tactical data, messages generated in support of many operations have lost their conversational character. The system computer requires that the data be in a fixed, predetermined format for direct entry into the machine. In many cases, connected terminals, printers, and keyboards are not suitable for the composition and editing tasks that fixed formats impose upon the operators at low operating echelons. The STORFACT system was designed to be used in conjunction with the basic AN/UYA-7(V) Digital Data Terminal for low echelon data capture. It provides a system employing fixed formats on a panel display with appropriate composition and editing features.

STORFACT was initially conceived as an expedient and evolutionary hardware implementation whereby the ASDAD (Airborne Source Data Automation Device) concept could be functionally demonstrated in a tactical airlift operational environment. Maximum use of available government owned equipment was key to the development plan. The ASDAD concept specifically addresses the requirements of military airlift command and control. ASDAD development is part of the TRI-TAC (478 T) Composition and Editing Device (COED) development. STORFACT will be used by the Military Airlift Command (MAC) to demonstrate the ability and feasibility of using a panel display and predetermined message formats for airlift operations. Since MAC currently uses AN/UYA-7(V) systems in support of airlift operations, the STORFACT experimental test models provide the Air Force with an economical method to demonstrate the feasibility of advance communications techniques.

2.0 TECHNICAL PROBLEM

The technical problem faced was to design an alternate input/output device for the AN/UYA-7(V) system which would employ a display and fixed message formats. The system had to provide a choice of formats to be displayed such that the operator could see the data as it was entered and thus easily edit, be compatible with the AN/UYA-7(V) system, both electrically and physically, and retain the basic operating features of the AN/UYA-7(V). The STORFACT also should provide the capability to change fixed formats and to handle one format which may be transmitted to a particular station to satisfy short-term, volatile reporting requirements. Additionally, the STORFACT should be able to recognize that a received message is in format and automatically display that message in the proper format.

3.0 TECHNICAL SOLUTION

3.1 METHODOLOGY

The approach selected to solve the technical problem was that of a special purpose, hardwired processor. This offers a number of advantages: it may not be changed by an operator in the field; it handles repetition tasks easily; it provides a powerful processing capability with a relatively small number of IC's; and it provided a means for logically controlling the great number of modes and functions that are inherent in the AN/UYA-7(V). The custom logic approach was rejected since it would have resulted in more IC's and a much more complicated machine in terms of understanding the functions of the system. There is quite a bit of custom logic involved with STORFACT but this is largely required by the specialized nature of the interfaces. A general-purpose microprocessor approach was also rejected for the previously mentioned reason; since the interfaces would require a significant amount of custom logic, the part savings effected by the microprocessor would be more than offset by the software effort necessary to produce operating programs.

The counterpart to the electronic portion of the technical problem was the packaging problem. Each of the units of the system had to be packaged in such a way that if it replaced something in the basic UYA-7 system, it would be the same form factor.

Additionally, for both those units which replace existing units and those which are completely new, there existed the problem of mounting the units such that a STORFACT could fit any of the standard UYA-7 configurations; a suitcase system, a jeep system, or a TALCE (Transportable Airlift Control Element).

3.2 SYSTEM CONCEPT

STORFACT consists of the following equipment:

- Figure 1) Keyboard/Display Unit (KDU), Part No. 401-22242-01
 - Figure 2) Auxiliary Control Unit (ACU), Part No. 401-22243-01
 - Figure 3) Format Logic Unit (FLU), Part No. 401-22244-01
 - Figure 4) Power Supply Unit (PSU), Part No. 401-22246-01
- STORFACT Cable Set, Part No. 401-22245-01/02/03

A system block diagram is shown in Figure 5.

These units replace the present AN/UYA-7 C-7599 Keyboard/Control, C-7600 Digital Data Group/Control and External Message Adapter. The STORFACT elements as a group are electrically interchangeable and no modification is required on existing AN/UYA-7 terminals. All existing functions present in the AN/UYA-7 terminal are incorporated into STORFACT.

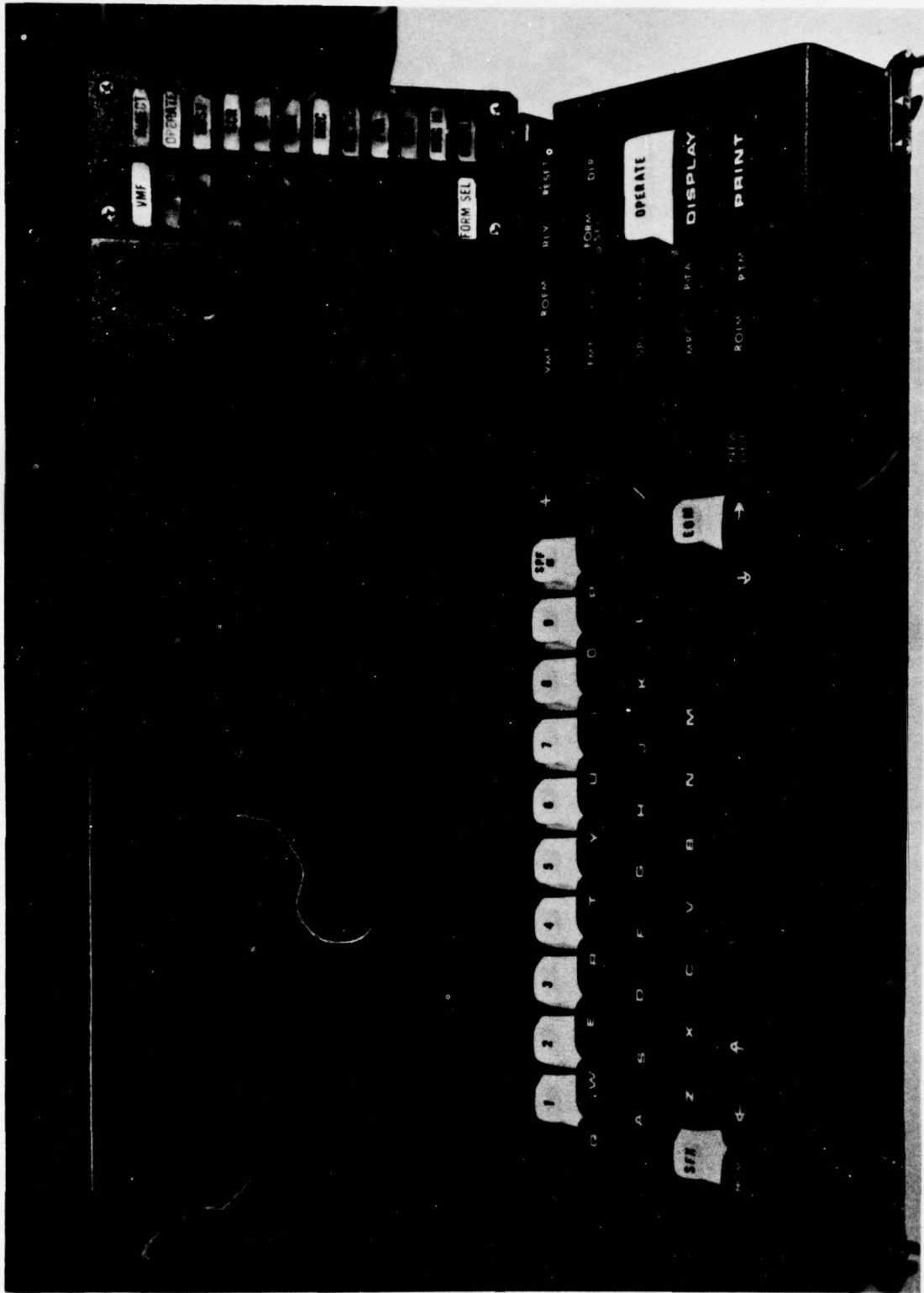


FIGURE 1. STORFACT KEYBOARD/DISPLAY UNIT

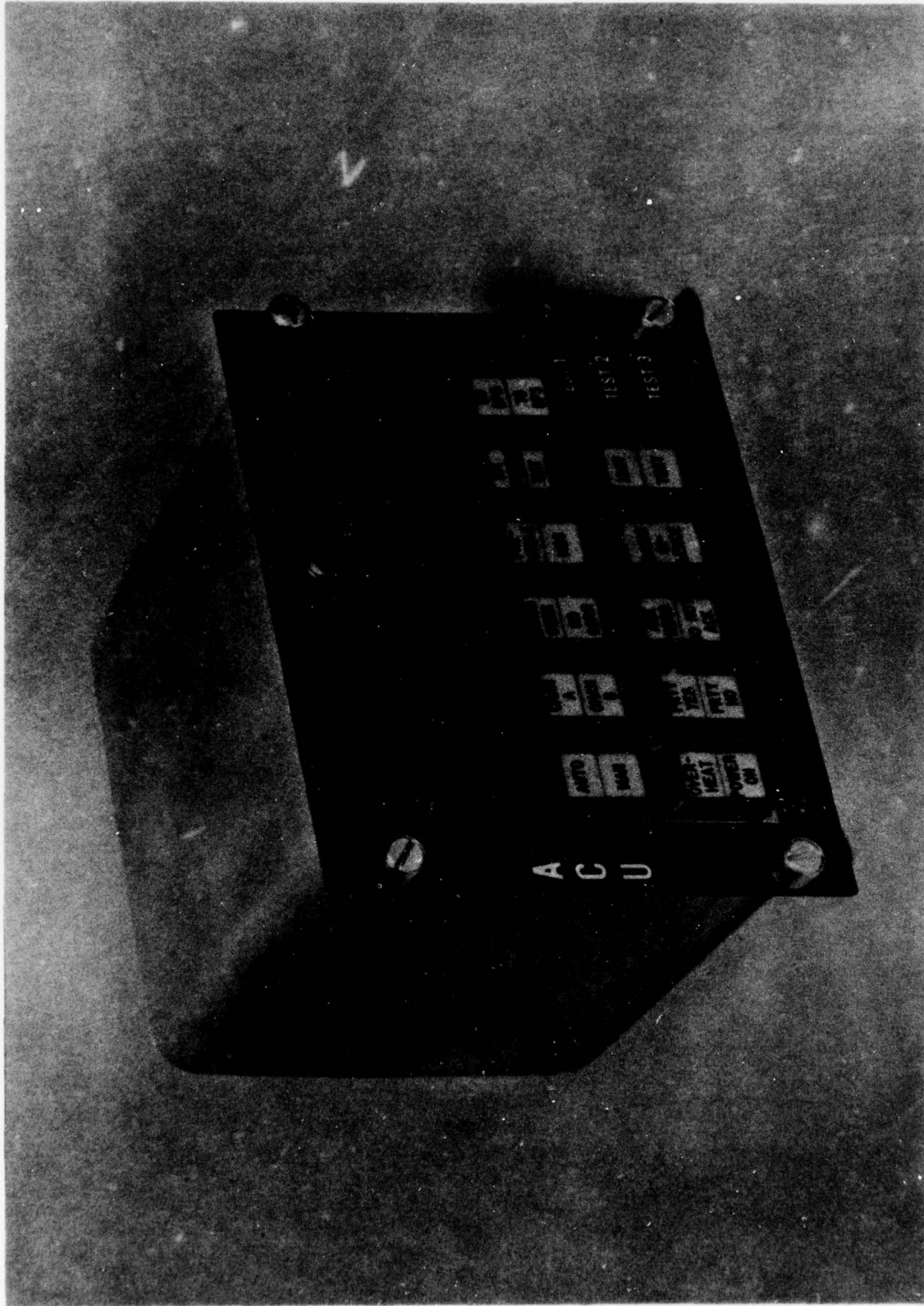


FIGURE 2 STORFACT AUXILIARY CONTROL UNIT

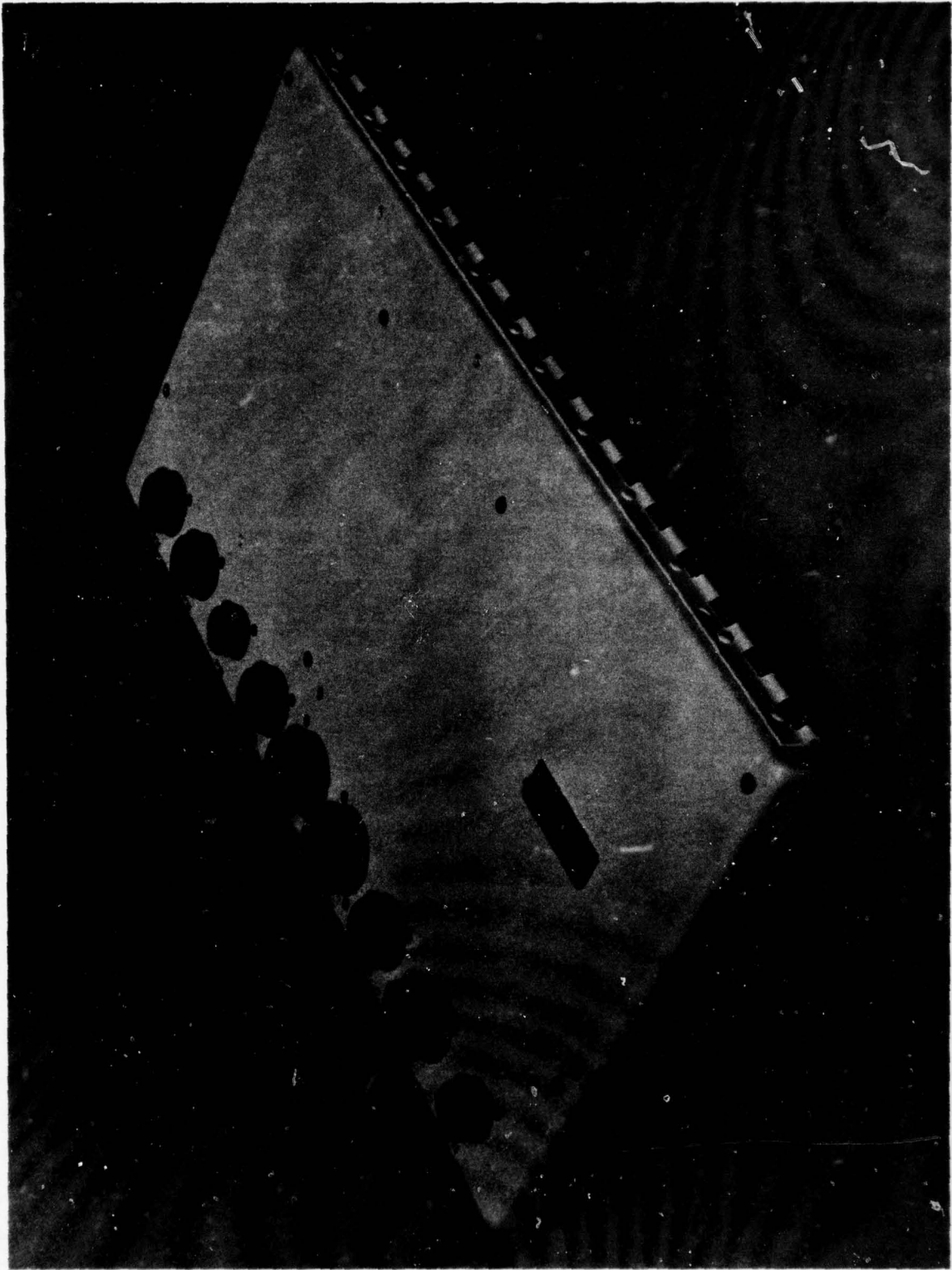


FIGURE 3. FORMAT LOGIC UNIT

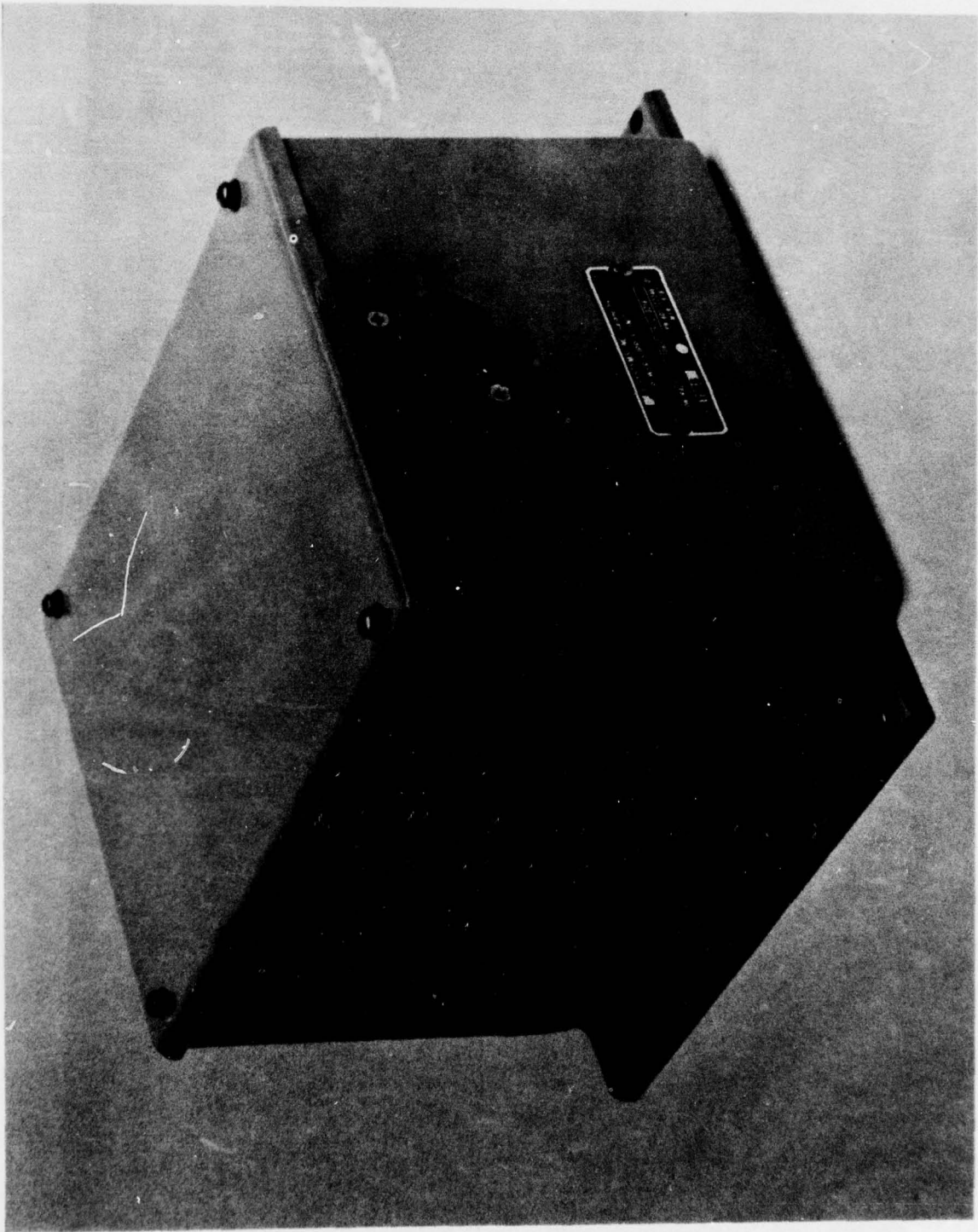


FIGURE 4. POWER SUPPLY UNIT

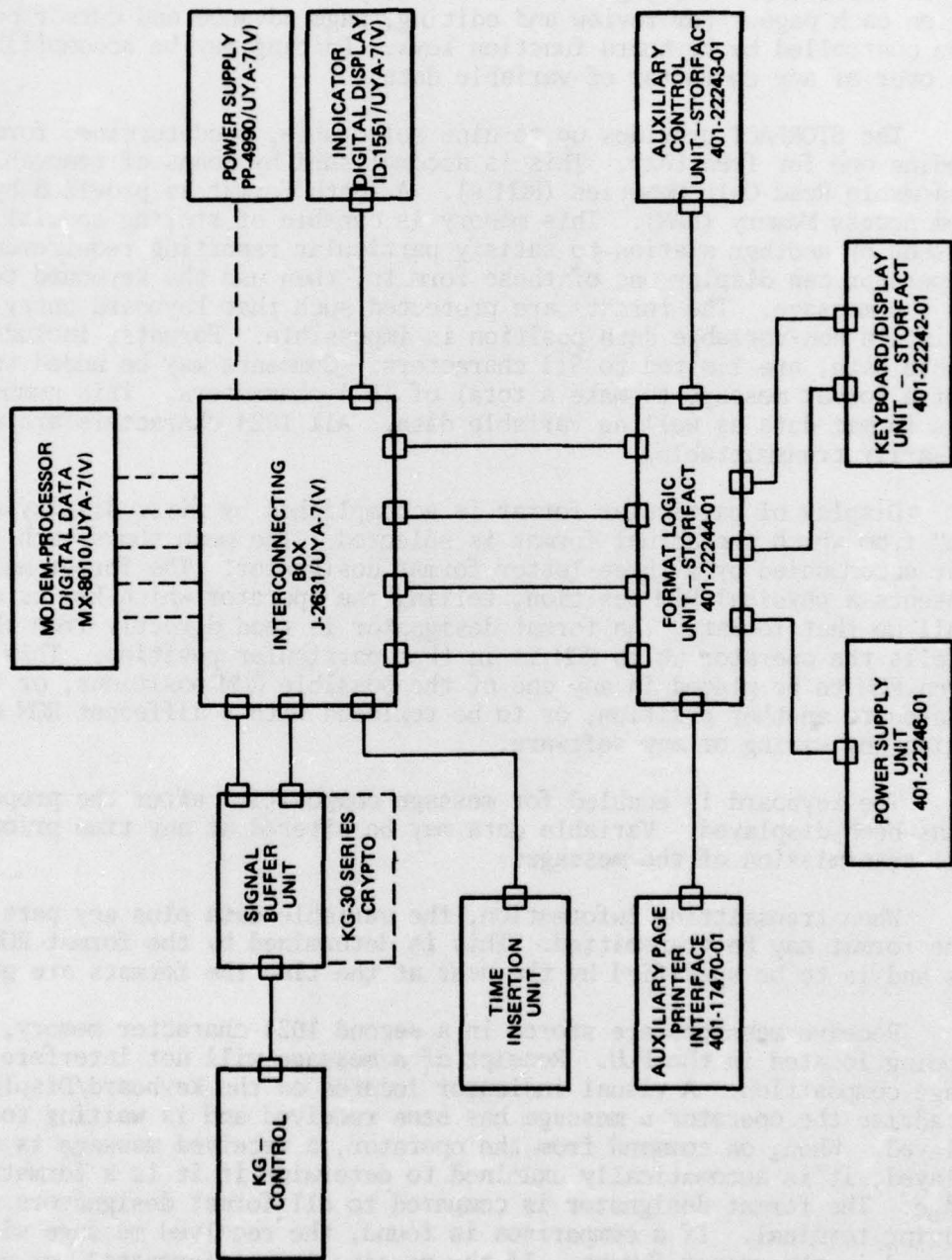


FIGURE 5. STORFACT SYSTEM BLOCK DIAGRAM

STORFACT utilizes a solid-state, plasma discharge display module capable of displaying up to 256 characters in eight lines of 32 characters each. Associated with the display, and located in the KDU, is a memory capable of holding four 256 character pages (1024 characters). Contents of the memory are displayed one page at a time. The display has a cursor which advances to the next character position in the variable data field each time a key is depressed. The page is automatically advanced after the 256th character on each page. For review and editing, page advance and cursor position may be controlled by keyboard function keys. Editing may be accomplished by write over of any character of variable data.

The STORFACT provides up to nine selectable, predetermined formats, including one for free text. This is accomplished by means of removable, programmable Read Only Memories (ROM's). A tenth format is provided by a Random Access Memory (RAM). This memory is capable of storing special formats sent by another station to satisfy particular reporting requirements. The operator can display one of these formats, then use the keyboard to complete the message. The formats are protected such that keyboard entry of data into a non-variable data position is impossible. Formats, including variable data, are limited to 512 characters. Comments may be added to the end of a format message to make a total of 1024 characters. This number includes format data as well as variable data. All 1024 characters are not necessarily transmittable.

Display of particular format is accomplished by first displaying the "menu" from which the actual format is selected. The menu shows each format number accompanied by a three-letter format designator. The format number represents a physical ROM position, telling the operator which key is used to call up that format. The format designator is read directly from the ROM and tells the operator which ROM is in that particular position. This permits a given ROM to be placed in any one of the possible ROM positions, or to be relocated to another position, or to be replaced with a different ROM without changing any wiring or any software.

The keyboard is enabled for message composition after the proper format has been displayed. Variable data may be altered at any time prior to actual transmission of the message.

When transmitting information, the variable data plus any part or all of the format may be transmitted. This is determined by the format ROM programs and is to be specified by the user at the time the formats are generated.

Receive messages are stored in a second 1024 character memory, this one being located in the FLU. Receipt of a message will not interfere with message composition. A visual indicator located on the Keyboard/Display Unit will advise the operator a message has been received and is waiting to be displayed. When, on command from the operator, a received message is to be displayed, it is automatically examined to determine if it is a formatted message. The format designator is compared to all format designators at the receiving terminal. If a comparison is found, the received message will be displayed in the proper format. If the message is not formatted, or no comparison is made, the received message is displayed as received.

3.3 KEYBOARD/DISPLAY UNIT (KDU)

The KDU is the operator control for STORFACT. In addition to the 256 character display, associated 1024 character memory, and associated driving electronics, the KDU contains an alpha-numeric keyboard and a set of system function keys (see page 10). Associated with the function keys are 24 back lighted system status indicators. Display cursor controls and manual memory page advance controls are grouped with the alpha-numeric keys. The KDU contains its own power supply.

3.3.1 KDU FUNCTION KEYS DESCRIPTION

A description of the AN/UYA-7(V) modes of operation is given in E-Systems' Document No. 416-04007, Description of the AN/UYA-7(V) Digital Communications Group, dated 1 September 1972. A brief description of the KDU function keys follows:

- (1) VMF Configures system for transmission of a variable-length message. This is the basic mode of operation. The maximum length is 1024 characters.
- (2) FMF Configures system for transmission of a fixed length message (147 characters).
- (3) SPL Configures system for transmission of a special message such that the receive terminal will display the received message on the AN/UYA-7(V) Digital Data Indicator.
- (4) MRC Configures system for manual transmission of "Message Received Correctly" acknowledgement.
- (5) ROIM Configures system for transmission of command to receiving terminal for automatic readout of that terminal's AN/UYA-7 memory.
- (6) ROEM Configures system for transmission of command to receiving terminal for automatic readout of an External Memory (storage) device.
- (7) ROPTA Configures system for transmission of command of position/time data as may be available from an external source; e.g., Aircraft Navigation System.
- (8) ROPTM Configures system for transmission of command to receiving terminal for automatic readout of position/time data as may be available from an external source such as a manual updated storage device.
- (9) PTA Configures system for automatic transmission of position and time data from an automatically updated device such as an Aircraft Navigation System which is interfaced with the AN/UYA-7.

VMF	DIRECT
FMF	OPER
SPL	BUSY
MRC	SCR
ROIM	PE
ROEM	MR
ROPTA	MRC
ROPTM	RLY RCD
PTA	FTA
PTM	RLM
TX RLY	MSG IN
FORM SEL	OVRFLW

STATUS DISPLAY
DISPLAY PANEL
RIGHT SIDE

VMF	ROEM	RELAY	RESET
FMF	ROPTA	FORM SEL	DIR
SPL	ROPTM	OPERATE	
MRC	PTA	DISPLAY	
ROIM	PTM	PRINT	

FUNCTION KEYS
KEYBOARD
RIGHT SIDE

- (10) PTM Configures system for transmission of position and time data from a manually updated device such as a THUMBWHEEL updated device which is interfaced with the AN/UYA-7.
- (11) RELAY Causes the receiving terminal to store the received message in its internal memory and indicates to the receiving terminal operator that this message is to be relayed to another net terminal.
- (12) FORM SEL FORMAT SELECT causes the menu to be displayed, allowing the operator to select the proper format. This control is active only in the VMF or FMF modes.
- (13) RESET This control allows the operator to interrupt certain functions and reset the system to the stand-by condition.
- (14) DIR DIRECT configures the system to transmit a message to the receiving terminal without first sampling the radio link. (The normal mode of operation, RTT causes a Ready-To-Transmit/Ready-To-Receive "handshake" between transmitting and receiving terminals before the text portion of the message is transmitted).
- (15) OPERATE This control allows the operator to indicate transmit or one of the self-test functions.
- (16) DISPLAY This control allows the operator to display contents of receive memory.
- (17) PRINT This function allows printing of all displayed information (both variable and format) upon operator command. This is in addition to normal automatic printing of all transmit and receive messages.

3.3.2 KDU STATUS DISPLAY INDICATORS

The 24 Status Display Indicators illuminate to advise the operator of the current mode of operation of the terminal and various states in the transmit and receive sequence. Illumination of the following indicators will be a direct result of depression of the corresponding keyboard function key. These indicators are associated with various transmit functions.

- (1) VMF (Variable Message Format)
- (2) FMF (Fixed Message Format)
- (3) SPL (Special)
- (4) MRC (Message Received Correct)
- (5) ROIM (Read Out Internal Memory)

- (6) ROEM (Read Out External Memory)
- (7) ROPTA (Read Out Position Time Automatic)
- (8) ROPTM (Read Out Position Time Manual)
- (9) PTA (Position Time Automatic)
- (10) PTM (Position Time Manual)
- (11) TX RELAY (Transmit Relay Message)
- (12) FORM SEL (Format Select)
- (13) DIRECT
- (14) OPER (Operate)

Illumination of the following status displays indicate to the operator that certain commands have been received by his STORFACT terminal.

- (15) BUSY This display indicates that the link is busy.
- (16) SCR SEL CAL Received (AN/UYA-7 Function Indicator) indicates to the operator that traffic on the link is addressed to his terminal.
- (17) P E Indicates to the operator a message being received by his terminal contains Parity Error(s).
- (18) MR Indicates to the operator at the initiating terminal that the addressed station received his transmitted message with Parity Error(s).
- (19) MRC Indicates to the operator at the initiating terminal that the addressed station message was received correctly (free from Parity Error(s)).
- (20) RLY RCD Indicates to the operator the message being received is to be relayed to another net station.
- (21) FTA This display indicates to the operator that his terminal has received a message whose originator requires a manually initiated (Final Technical) acknowledgment.
- (22) RLM Indicates to the operator that his terminal has been commanded to read out the contents of the STORFACT memory. (See Section 4.6).

The remaining two indicators are associated with the STORFACT receive memory:

- (23) MSG IN MESSAGE IN MEMORY. Illumination informs the operator of a message stored in the STORFACT receive memory waiting to be displayed.
- (24) OVRFLW OVERFLOW. Indicates to the operator that the receive memory is full and a second message is being received. Second message will not be stored in memory, but will be printed on hardcopy so message will not be lost.

3.4 AUXILIARY CONTROL UNIT (ACU)

The Auxiliary Control Unit (ACU) provides selected control functions and additional monitoring for the STORFACT system. The ACU contains ten (10) infrequently used system controls, the SELCAL and ALLCALL switches, and provides three (3) system test modes. The function of these controls are as follows:

- (1) AUTO/MAN Alternate action back lighted switch. In auto position, the system alternately samples the receive audio of two transceivers. In manual position, the operator may select either transceiver for operation.
- (2) CHAN A/
CHAN B With AUTO/MAN control in MAN position, the operator selects either of the two transceivers for station operation by depressing CHAN A/CHAN B control.
- (3) ERROR CORR/
NO CORR Error detection and correction circuitry is switched in or out of the system configuration by this control.
- (4) PREAMBLE/
MSG With the ERROR CORR/NO CORR control in ERROR CORR position, the operator may choose error detection and correction on only the preamble or on the entire message.
- (5) INT MODEM/
EXT MODEM Allows selection of either the internal (AN/UYA-7) modem or an external modem for transmission of data.
- (6) 50 BPS/
75 BPS This control allows the operator to select either of the two data rates used by the AN/UYA-7 system when INT MODEM is selected.
- (7) POWER ON/
OVERHEAT Depressing this control applies 28 VDC power to the STORFACT and AN/UYA-7 system. The overheat portion is a display only and indicates an overheat condition exists in the AN/UYA-7.
- (8) PRTY YES/
PRTY NO This control allows the STORFACT system to be compatible with another communications system (AN/URC-53) and will normally remain in the PRTY (Priority) NO position.

- (9) ACK REQD/
DO NOT ACK This control allows the operator to preclude the receiving station from acknowledgement (automatically) of messages from his station, or to require automatic acknowledgement of message receipt.
- (10) RADIO
SILENCE This control inhibits the AN/UYA-7 from transmitting any traffic, including normal automatic responses to other stations.
- (11) XMIT/TEST This control allows normal operation (XMIT) or selection of any one of three system test modes. In the test mode, the selected system test is shown by three indicators located to the right of the XMIT/TEST Switch.

Address controls and code indicator lights are included on the ACU. The capability to program SELCAL and ALLCALL addresses is provided by these controls. The SELCAL address is the Call Sign (address) for the individual terminal and, causes the terminal to recognize and copy any message directed specifically to that terminal. The ALLCALL is the common Call Sign for a group of terminals in a net. When a message is sent with an ALLCALL address, all terminals with that address will receive the message simultaneously. Each column of switches represents a character in Fielddata code.

A set of code indicator lights display the information bits in Fielddata code that represents the alpha-numeric character being entered into Call Sign storage. These indicators are keyed to the output of the alpha-numeric keys on the keyboard.

3.5 FORMAT LOGIC UNIT (FLU)

The Format Logic Unit (FLU) contains format generation logic, sequence control logic, and the 1024 character receive memory. The FLU functions as the interface between the Keyboard/Display Unit (KDU) and the AN/UYA-7. There are no operator controls located on the FLU. A 19.2 KHz system clock, serving both the FLU and KDU, is located on the connector printed circuit board (A3) in the FLU.

Design of the FLU was patterned along the lines of a computer processor unit. A sequential state counter, analogous to a computer program counter, controls all logic action within the FLU. A sequential state diagram is shown in Figure 6. A block diagram of FLU functional operation is shown in Figure 7. Interconnection between the FLU, KDU, Auxiliary Control Unit (ACU), Auxiliary Page Printer Interface (APPI), Power Supply Unit (PSU), and AN/UYA-7 is completed by means of nine MS type connectors located on the FLU chassis.

4.0 THEORY OF OPERATION

4.1 POWER ON/CLEAR SEQUENCE

As shown in the Format Logic Unit (FLU) state diagram, Figure 6, eleven states (0-10) control all operations of the STORFACT system. State 0

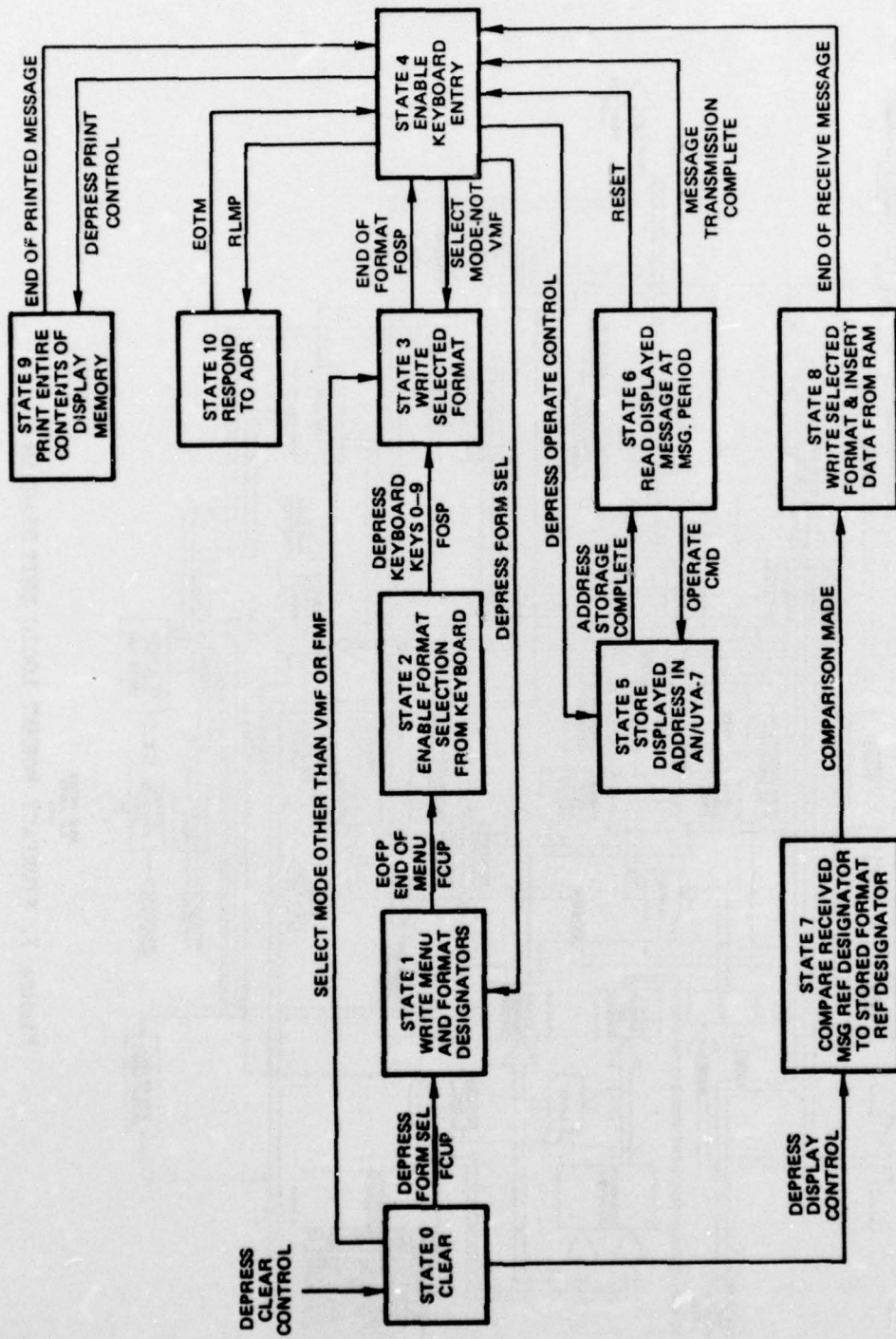


FIGURE 6. FORMAT LOGIC UNIT SEQUENTIAL STATE DIAGRAM

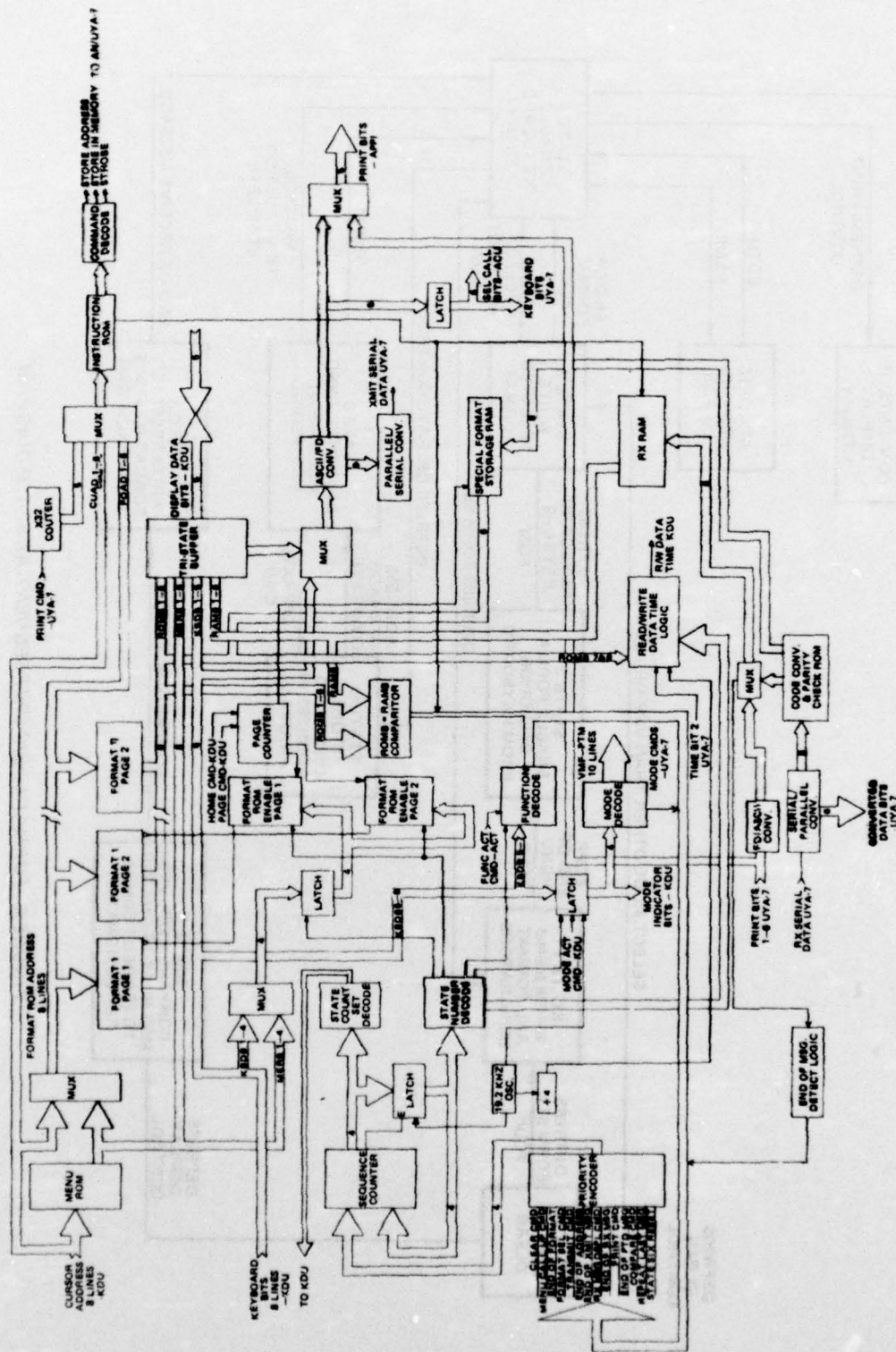


Figure 7. STORFACT FORMAT LOGIC UNIT DIAGRAM

(CLEAR) is the basic state and all operations are originated from State 0. After power is applied to the system, the CLR (Clear) control on the Keyboard/Display Unit (KDU) must be depressed. This operation causes a unique code to be generated by the Keyboard Output ROM (Read Only Memory) in the KDU. A clear pulse is generated within the KDU. This clear pulse causes spaces to be written in all display character locations and forces the display cursor to the home position (Cursor Address 0). This clear pulse is also sent to the first input of the PRIORITY ENCODER in the FLU. This output of the PRIORITY ENCODER is a four bit binary code unique for the clear pulse input. The SEQUENCE COUNTER (U37 on FLU A1 Board) is addressed by the output of the PRIORITY ENCODER. The SEQUENCE COUNTER is programmed such that its output when fed back through a latch to its address inputs, alters the address producing a different output code. In this way, the state sequence is maintained; e.g., the STORFACT system will go into State 2 only from State 1. (State Diagram, Figure 6) The output of the LATCH is sent also to the STATE NUMBER DECODE circuit, which in this case will decode State 0. The STORFACT system is now in State 0 and will remain so until other action forces a change of state. The STORFACT system will be forced into VMF mode each time the Clear Control is depressed. The KDU FORM SEL indicator will also be illuminated. This indicates to the operator that a transmit sequence may be begun.

4.2 TRANSMIT SEQUENCE

When the STORFACT system is in State 0 (Clear), the operator may choose one of three operations (Figure 6). Two of these operations will result in a transmit sequence, the third is to display a received message and will be covered later. By depressing the FORM SEL control on the KDU, the operator will cause a "menu" to be displayed. This menu advises the operator of the formats available to be transmitted. The keyboard output code and a function activity command is sent from the KDU to the FLU FUNCTION DECODE circuit. This circuit will decode the FORM SEL control and send a pulse to the PRIORITY ENCODER causing the SEQUENCE COUNTER to change from State 0 to 1. The MENU ROM (U34 on FLU A1) will be enabled and its contents written on the display.

All STORFACT formats have a three character format designator. As the menu is being written, this three character designator is read directly from the FORMAT ROMS and inserted into the proper locations in the MENU. After the last character of the MENU has been written, the SEQUENCE COUNTER will change from State 1 to State 2.

State 2 allows the operator to have any available format written on the display. This is accomplished by depressing one of the write numeral keys (1 thru 0) on the KDU corresponding to the number of the desired format designator as shown in the MENU. When the numeral key is depressed, the SEQUENCE COUNTER will change from State 2 into State 3, and the selected format will be written on the display. As the last character of the selected format is written, the SEQUENCE COUNTER will change from State 3 to State 4.

State 4 is the only state allowing characters to be written from the keyboard directly to the display. After any format is written, the display cursor will appear in the first variable data position of that format. In all

cases, this will be the first character of address of the receiving station. Variable data positions as well as characters of the format to be transmitted are determined by the program in the FORMAT ROM.

Transmission of messages other than VMF or FMF may be accomplished by changing the mode while in State 0 (Clear) or State 4. The operator may choose any AN/UYA-7 Mode (SPL, MRC, etc) by depressing the corresponding key on the KDU. Depressing any mode control on the KDU other than VMF or FMF causes the keyboard output code and a mode activity command to be sent to the MODE DECODE circuits in the FLU. The desired mode command is decoded and sent to the AN/UYA-7, the corresponding indicator on the KDU is illuminated, and the SEQUENCE COUNTER changes from State 0 or 4 to State 3. Changing into State 3 causes a format for the selected mode to be written on the display. After the last character of the mode format is written, the sequence ROM will cause the SEQUENCE Counter to change from State 3 into State 4. The operator may now enter the address of the receiving station and fill in any information required by the format. Variable data may be edited by writing over errors. The display cursor will not stop on any part of the fixed format, therefore, the operator cannot alter the format in any manner. The message is now ready for transmission.

RTT (Ready-To-Transmit) is the normal mode of operation for STORFACT, however, by depressing the DIRECT control on the KDU, any message may be transmitted in the direct mode. The system will reset to RTT mode after any transmission.

Depressing the OPERATE Control on the KDU causes a transmit command to be generated by the FUNCTION DECODE circuit in the FLU. This command is sent to the AN/UYA-7 and causes the system to go into operate. The OPERATE Indicator on the KDU will illuminate. The transmit command also causes the SEQUENCE COUNTER to change from State 4 to State 5. The INSTRUCTION ROM (U92 on FLU A2) generates a Store Address command for the AN/UYA-7. The display cursor will then step through the four address characters and advance to the first variable data position in the displayed format. Four address characters will be stored in the AN/UYA-7 as the sync portion of the preamble is being transmitted. After four address characters have been stored by the AN/UYA-7, the INSTRUCTION ROM will generate an End of Address command. This command is sent to the PRIORITY ENCODER and causes the SEQUENCE COUNTER to change from State 5 into State 6.

After the STORFACT system has changed into State 6, the display cursor will wait at the first variable data position for message period. At message period the display cursor will advance through data to be transmitted at the AN/UYA-7 character rate, and through non-transmitted data at 4.8 KHz. As the display cursor advances, transmitted characters are read from the display memory and sent to the FLU. These characters (six bit ASCII) go through an ASCII/FIELDDATA CONVERTER and into a PARALLEL-TO-SERIAL CONVERTER. They are then clocked into the AN/UYA-7 (8J3) by data rate clock pulse.

The STORFACT system uses the AN/UYA-7 internal memory only in Test 3. It would, therefore, be classified as an external device. To prevent all STORFACT originated messages from having an external label (777) and thus

requiring an EMP or EMA to process the messages, logic within the FLU changes the AN/UYA-7 from Internal Source to External Source at message period. At the end of message period, the AN/UYA-7 is switched back to Internal Source. Hence, all STORFACT originated messages are transmitted with standard internal AN/UYA-7 labels. VMF messages are terminated by detection in the FLU of three EOM (End of Message) characters (###). FMF messages will be 147 characters in duration regardless of text content. Three EOM characters or three SFX (Suffix) characters (\$\$\$) must be inserted by the operator at the end of the text portion of VMF and FMF messages, respectively.

The End of Transmit message command is detected by the PRIORITY ENCODER causing the SEQUENCE COUNTER to change from State 6 into State 4. At this time the operator may select a new format, retransmit the message, re-address and transmit the message, or alter the contents of the message, etc.

As shown in the sequential state diagram, two conditions other than end of transmit message will force the STORFACT system out of the transmit state. At any time during the transmission of a message (when the OPERATE Indicator is illuminated), depressing the RESET Control on the KDU will force the state counter to State 4. The OPERATE Indicator will extinguish, transmission will cease, and the display cursor will appear in the first variable data position of the format. In State 4, data may be written from the Keyboard onto the display. In the case of a RTT message when no RTR (Ready-To-Receive) is received, depressing the OPERATE Control on the KDU will force the SEQUENCE COUNTER into State 5. A Store Address-Transmit Message sequence will be initiated. No keyboard entry is allowed during this operation.

4.3 RECEIVE SEQUENCE

Receive messages are stored in a 1024 character Receive Random Access Memory (RX RAM). Reception of an incoming message has no effect on the composition or editing of a formatted message. Serial data is received from the AN/UYA-7 and routed to the CODE CONVERTER/PARITY CHECK ROM. This ROM converts the FIELDATA code to six bit ASCII and checks for parity errors. During receive preamble time, print bits from the UYA-7 are taken by the FLU and converted into ASCII. On command of the INSTRUCTION ROM, Address Two and Time are stripped from the preamble and stored in the RX (Receive) RAM. During message period, the output of the CODE CONVERTER ROM is stored in the RX RAM.

When three stop symbols are detected in a receive message, the MSG IN Indicator on the KDU will illuminate. If no stop symbols are detected and the BUSY indicator extinguishes, the FLU will insert EOM characters in receive memory and the MSG IN Indicator will illuminate.

Preamble length message (RTR, MRC, etc.) and ADR (Automatic Data Request) messages (ROEM, etc.) are not stored in receive memory. At times when the MSG IN Indicator is illuminated, indicating a message has been received but not displayed, and the STORFACT system detects Receive Gate, a BUSY indicator, SELECAL Receive Indicator, and Message Period, the OVRFLW (Overflow) Indicator on the KDU will illuminate. In the overflow condition, no data will be stored in receive memory and the AN/UYA-7 will not respond (MRC). This is to prevent a message in memory from being written over and destroyed before it

can be viewed by the operator. However, a second incoming message will be printed on hardcopy so message is not lost. No response should alert the transmitting station that the message was not properly received. When the MSG IN Indicator illuminates, the message should be displayed as soon as the display is available.

4.4 DISPLAY SEQUENCE

Messages should be displayed from the clear state (Figure 6). Depressing the DISPLAY Control on the KDU forces the State Counter from State 0 into State 7. All FORMAT ROM's are enabled sequentially and the three character format designators are compared with the format designator of the message in the receive RAM. This is accomplished by scanning through the MENU ROM, enabling each FORMAT ROM format designator at a time determined by the MENU ROM. Simultaneously, the RX RAM is enabled at the correct time on command of the INSTRUCTION ROM. When the format designator of the received message matches one of available formats, the State Counter is changed from State 7 into State 8. If the received message is a non-formatted message and no comparison can be made, the State Counter will change into State 8 after all formats have been checked.

When a comparison is made, the selected format is enabled and written on the display. Data from the RX RAM is written into all variable data positions in the format. The address of the transmitting station and time will be inserted in proper locations on command of the INSTRUCTION ROM. End Of Receive Message is detected and the State Counter changes from State 8 into State 4. Displaying a stored message will not erase the RX RAM. A stored message may be displayed any number of times. A message stored in the receive memory will be erased only when written over by an incoming message after having been displayed at least once or by removing power from the system.

4.5 PRINT SEQUENCE

As shown in the sequential state diagram (Figure 6) print sequence may be initiated only from State 4. Depressing the PRINT Control on the KDU causes the FLU State Counter to change from State 4 into State 9. The display cursor will home, then start stepping through all displayed information. As the cursor advances, each character is read from the display memory and routed by the FLU through the Auxiliary Page Printer Interface (APPI) to a teletype. EOM characters will be detected by the FLU causing the State Counter to change from State 9 to State 4. Display information may be printed any number of times. With an APPI connected to the STORFACT system, the teletype will print all transmit and receive messages; however, STORFACT State 9 (Print) will inhibit printing of TX and RX messages.

4.6 RESPONSE TO ROEM (STATE 10)

The STORFACT system will not respond to a ROIM message. The fact that STORFACT is essentially an external device makes answering a ROIM impossible. Messages transmitted by STORFACT are not stored in the AN/UYA-7 internal memory. If a ROIM message is received by a STORFACT system, the RLM (Repeat Last Message) Indicator on the KDU will illuminate and a RESET command

will be sent by the FLU to the AN/UYA-7 inhibiting any response.

The STORFACT system will respond to a ROEM message from State 4 only. After a message is transmitted by a STORFACT system, the State Counter will be in State 4. Should a ROEM message be received when the STORFACT system is not in State 4, the RLM Indicator will illuminate and a RESET command will be sent to the AN/UYA-7.

With the State Counter in State 4, receiving a ROEM message will cause the State Counter to change into State 10. The display cursor will advance to the first variable data position in the text portion of the displayed format. The OPERATE Indicator will illuminate, and at message period the cursor will advance through the variable data positions at the AN/UYA-7 character rate. End of Message characters are detected causing the State Counter to change from State 10 into State 4. Messages transmitted in response to ROEM messages carry an external label (777).

4.7 SPECIAL FORMAT

Format ten on the MENU is Special Format (SPF). A Special Format is received by a STORFACT System under unique conditions and stored in a separate Random Access Memory (RAM). The format may be displayed by depressing the 0 numeral keyboard key when in State 2. The SPF format may be displayed, variable data filled in, and transmitted as any other format. The purpose of a special format is to permit seldom used, short term formats to be employed in a STORFACT net at the direction of a Command Center.

A special format may be transmitted to a STORFACT system only by a terminal capable of being programmed to send six bit Fielddata code with bits seven and eight variable. An AN/UYA-7 or a STORFACT system is not capable of sending a special format to be stored by a STORFACT system since bits seven and eight are fixed rather than variable. This will require a computer or specially controlled terminal. In order to be stored as a special format by a STORFACT system, a format must meet the following conditions:

- 1) Must be transmitted with an external label (777).
- 2) The first character must be an ASCII ESC () character.
- 3) The format will be six bit Fielddata code with bit seven a one for a variable character or zero for a Format Character and bit eight a one for a transmitted character or a zero for a non-transmitted character.

Removing power from the STORFACT system will erase a stored Special Format.

4.8 SYSTEM SELF-TEST

Three system tests are provided in the STORFACT/AN/UYA-7 System. Test modes are controlled by the XMIT/TEST Switch and three associated LED Indicators on the ACU. Available test mode functions are as follows:

TEST 1 - Loop Tests System

TEST 2 - Operates system in transmit mode without keying transmitter.

TEST 3 - Operates system in receive mode.

Successive depressions of the XMIT/TEST Switch cause the system to sequence through XMIT, TEST 1, TEST 2, TEST 3, XMIT, etc.

5.0 ACCEPTANCE TESTING ANOMALIES

During the acceptance testing of the four STORFACT experimental models some five deviations from the Acceptance Test Procedure (ATP) were experienced. The following is a description of each and the corrective action required:

- 1) Anomaly: The cursor appeared to fade out on serial number 75E4.
Corrective Action: The problem was found to be an intermittent IC on the KDU A1 board. The IC was replaced.
- 2) Anomaly: Running paragraph 4.3.4.17 of the ATP, the MSG IN Indicator was observed to extinguish when the FTA Indicator extinguished in the test for OVERFLOW on serial number 75E6.
Corrective Action: The problem was found to be a solder splash on the KDU A5 board (indicator assembly). The short was cleared and normal operation resulted.
- 3) Anomaly: The printout contained extra characters on serial number 75E5.
Corrective Action: The KDU power supply +5v and -12v outputs were found to be low. The voltages were adjusted to their nominal values and the problem was corrected.
- 4) Anomaly: Repeated depressions of the DISPLAY switch resulted in different information being displayed.
Corrective Action: The problem was traced to a loose pin in the connector between the KDU harness and the flex strip connecting it to the display tube. The pin in question was one of the data lines and when it intermittently opened the result was incorrect data being written on the tube.
- 5) Anomaly: When running a TEST 3 (characters stored in the UYA-7 memory for test) some characters did not get stored properly.
Corrective Action: The problem was traced to the UYA-7 memory. Since the UYA-7 was not under test and the problem was not caused by the STORFACT, no corrective action was taken.

6.0 SAFETY

A preliminary hazards analysis has been conducted on the STORFACT system. The first is primarily a personnel hazard which may be classified as Category III-critical. When the KDU cover is open, the terminals of the power supply are accessible. No personnel hazards exists for either the +5 or -12v outputs, but the -250v output could conceivably cause injury. It is doubtful that, given the location of the terminals, an individual could get his fingers on the terminals without, at the same time, grounding himself to

the chassis with the same hand. A similar situation exists when the cover over the back of the display is removed. Many of the transistors, while the system is on, will result in a shock.

The second hazard is an equipment hazard. The KDU display tube is equipped with latches on both sides which secure the tube in both the raised and down position. Within its range, the latches provide for continuously adjustable operator viewing angle. Either latch will hold the tube in the raised position, but if both are released, causing the tube to fall into the down position, the result will likely be tube failure. Since the display is an evacuated grid, the shock of the tube falling to the down position is likely to result in cracking the glass face of the tube and thus rendering it inoperable. This may be classified as Category IV - Catastrophe, since it will result in system loss.

7.0 CONCLUSIONS

The STORFACT has been designed as an alternate input/output device for use with the AN/UYA-7 system. It provides a display panel, editing and composition controls, physical and electronic compatibility with existing UYA-7's, and it utilizes fixed, selectable formats in all transmissions. The STORFACT terminal can store up to 9 non-volatile formats in ROM and one volatile format in RAM. It is expected that field tests will show that it will also reduce transmission time by transmitting only pertinent data, rather than format plus data, and that it will significantly reduce message composition time for those systems reporting from the field.

As functional test and evaluation is performed on these experimental models, some desired improvements to the design will undoubtedly be identified. The STORFACT system is a compromise; i.e., the system is not optimized because it relies on an existing piece of hardware, the AN/UYA-7(V). However, it solves that problem which it was designed to solve. In that STORFACT is an I/O device for the AN/UYA-7, it functionally improves the operation of that system. The STORFACT experimental models give the UYA-7 additional features without changing system operation materially. Subsequent development is required to optimize and militarize STORFACT.

8.0 RECOMMENDATIONS

The STORFACT system should be tested functionally to establish whether it can serve as the short-term solution to the airlift reporting problem. It is an approach that could result in a solution to the problem that requires minimum new equipment and utilize existing equipment to the maximum degree. Since STORFACT is not an optimized solution to the problem, follow-on development is required. Since the QFM modem of the UYA-7 system is a proven, reliable unit, that portion of the existing system could be retained and repackaged as a stand-alone $\frac{1}{2}$ ATR unit. The processor portion of the system could be a general purpose microprocessor programmed to use the same system protocol as the UYA-7 plus a protocol to interface with DCS. E-Systems currently has a wire-wrap version of the QFM modem; therefore, that unit only needs packaging. The microprocessor could be any of a number commercially available, but E-Systems has a paper design for an Intel 8080.

system and a preliminary mechanical design for packaging it in a 1/2 ATR unit. E-Systems has already developed the software for the UYA-7 protocol on a processor very similar to the 8080 which could easily be converted. All terminals would then be under firmware control and the firmware could be packaged such that functions could be added as desired. No compromises for existing systems would have to be made and the system could be optimized for the particular problem addressed.

APPENDIX A

TECHNICAL REPORT SUMMARY

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1.0 TECHNICAL PROBLEM

To provide a system which would operate in a formatted-message-mode, making maximum use of existing AN/UYA-7(V) systems, that could significantly improve reporting accuracy and speed, with a corresponding increase in system throughput.

2.0 GENERAL METHODOLOGY

A special-purpose hardwired processor was developed, along with appropriate custom logic for interfacing, to build an input/output device around a plasma/discharge display panel and keyboard. The display would provide for convenient composition and editing features while other logic caused the system to operate using predetermined, fixed, user-specified formats.

3.0 TECHNICAL RESULTS

The result of the program was four units, the Keyboard/Display Unit (KDU), the Auxiliary Control Unit (ACU), the Format Logic Unit (FLU), and the Power Supply Unit (PSU), designed to convert an existing AN/UYA-7(V) terminal into a STORFACT (Stored Format Automated Communications Terminal). The system was packaged such that a STORFACT may be installed in any of the three AN/UYA-7(V) terminals; suitcase configuration, jeep configuration, or TALCE configuration.

The STORFACT system provides up to nine selectable, predetermined non-volatile formats, and one special purpose volatile format which may be generated and transmitted to a given station. The operator, after selecting a format and having it displayed on the screen, then uses the keyboard to complete the message. The formats are protected such that no data may be entered into non-variable positions. During the formulation of the format, the determination is made as to what format data should be transmitted; consequently only the minimum amount of non-variable data along with the variable data is actually transmitted, and thus transmission time is minimized.

Received messages are stored in a separate 1024 character memory, so that receipt of a message will not interfere with message composition. A visual indicator on the KDU illuminates when there is a received message to be displayed. When the operator displays a received message, it is automatically examined to determine if it is in format and if the receiving terminal has that format; if a comparison is found, the received message will be displayed in the proper format. If no comparison is found, the message will be displayed as received.

Each format is limited to 512 characters, or two pages on the display. The total capacity of the display memory is 1024 characters or four pages, including format data and variable data. The operator has control over

cursor position, subject to constraints of the format, and page location.

4.0 IMPLICATIONS FOR FURTHER RESEARCH

The STORFACT system is a compromise; i.e., the system is not optimized because, in the interest of low-cost development of a source data automation device, the system makes maximum use of the existing AN/UYA-7 terminals. Subsequent development is required to optimize and militarize STORFACT. The modem of the AN/UYA-7(V) could be updated and repackaged as a stand-alone unit. The processor portion of the AN/UYA-7(V) could be replaced by a packaged microprocessor with appropriate firmware to provide both system protocol functions and formatted message functions. A system with these basic units could provide the ruggedness and flexibility that a tactical source data automation system demands.