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Satellite Control Facility Equipment Augmentation

Design Criteria: Satellite Test Annex Data Subsystem

31 AUGUST 1962

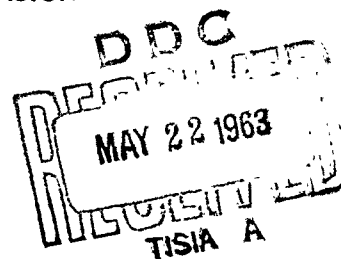
Prepared by

SATELLITE CONTROL OFFICE

Prepared for COMMANDER SPACE SYSTEMS DIVISION

UNITED STATES AIR FORCE

Inglewood, California



ENGINEERING DIVISION • AEROSPACE CORPORATION
CONTRACT NO. AF 04(695)-169

SATELLITE CONTROL FACILITY EQUIPMENT AUGMENTATION

Design Criteria, Satellite Test Annex Data Subsystem

Prepared by
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Satellite Control Office

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Col. Walter R. Hedrick, Jr., Chief
Satellite Control Office, SSZC
30 Apr 62

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AEROSPACE CORPORATION
El Segundo, California

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AUGMENTATION DESIGN CRITERIA
SATELLITE TEST ANNEX DATA SUBSYSTEM

1. SCOPE

This document established the design criteria for augmentation and reconfiguration of the data handling equipment of the Satellite Test Annex (STA) under the Augmentation Program. The document is an amplification of the STA portion of the Design Criteria for the Data Subsystem of the Satellite Control Facility (SCF) described in Appendix G of Aerospace Report No. TOR-930(2110)-1. The data subsystem described herein shall support the satellite control, acquisition, tracking, commanding, telemetry, and STA control operations as required for each applicable project. It will be integrated with the timing subsystem, control consoles, and the inter- and intra-facility communications subsystems. /END

2. GENERAL CONCEPT

In order to support a number of vehicles in orbit simultaneously, it is necessary to reconfigure and augment the present satellite control capability at the Satellite Test Annex (STA). The additional data processing, control, communication, and display equipment furnished as part of the Augmentation Program will have the capacity to permit the STA to control simultaneously as many as ten (10) satellites in various stages of operation, with expansion capability of at least 50%. The re-configuration implementation will not cause a shut-down of the STA. The present PICE-Computer complex will remain operating until a partial reconfiguration is implemented such that the new configuration is proven capable of supporting satellite programs.

At that time the present PICE equipment will be removed and the re-configuration completed. All equipment constructed as a part of augmentation will be designed with particular emphasis given to modularity, simplicity, flexibility, reliability and maintainability.

3. STA DATA SYSTEM DESCRIPTION

3.1 Computing Equipment

The reconfiguration of the computing equipment in the STA as shown in Figure 4, will consist of individual, vehicle oriented, CDC-160A computers serving as buffers to receive, store, and disseminate data transmitted between the STA and the remote tracking stations. The buffer computers will, at the appropriate time, discharge accumulated data into a large volume magnetic storage unit where the data can then be extracted by the CDC-1604 Data Processing Computers and/or for Display purposes. A particular buffer computer will receive data communicated from the various tracking stations on a scheduled basis depending on the orbit of the particular satellite under its cognizance. The switching of various communications lines from the tracking stations into particular buffer computers will be accomplished by the Communication Data Select and Cross-Connect Unit (CDSCCU). The outputs from the buffer computers into particular magnetic disc file (tape unit temporarily) attached to a 1604-computer will be accomplished by the Computer Select and Cross-Connect Unit (CSCCU). The Select and Cross-Connect Units will be controlled by the Automatic Switch Controller which will be a CDC-160A computer. This 160-A will operate using a schedule provided as a output of a Multicon type program run on a 1604. The Select and Cross-Connect Units will also be provided with manual control for back-up and over-ride capabilities.

3.1.1 Data Processors (CDC 1604)

Four Control Data Corporation 1604 computers arranged in identical configurations will be utilized to perform the data processing required to support satellite programs. The computer configuration is shown in Figure 2. Until magnetic disc files become available, 1607 magnetic tape units will be used as the medium through which data is passed between the buffer computers and the data processing computers.

3.1.2 Data Buffers (CDC 160-A)

Initially two Control Data Corporation 160-A computers will be utilized as vehicle oriented buffers. As the number of simultaneously orbiting satellites increases, additional 160-A computers will be added to the system. Figure 1 shows the 160-A equipment configuration which will be identical for all units. Logical extension for at least 16 buffers will be provided.

3.1.3 Off-Line Data Processors

There are presently two Control Data Corporation 160-A computers at the STA being used in an off-line capacity to relieve the 1604 computers of some of the mundane and time consuming operations required to support satellite programs. These computers which are configured as shown in Figure 3 will be retained for this function.

3.1.4 Select and Cross-Connect Units

The Select and Cross-Connect Units (SCCU) will provide solid wire signal paths between the various sources and receivers communicating through them. Switching of the signal paths

3.1.4 Select and Cross-Connect Units (Continued)

in a SCCU will be controlled automatically by the Automatic SCCU Controller (CDC 160-A Computer). Each SCCU will have manual back-up and over-ride facilities. The SCCU will be constructed with the features of modularity, simplicity, flexibility, reliability, and maintainability of utmost consideration. Failure of one switch module shall not effect operation of adjacent modules.

3.1.5 Automatic SCCU Controller (CDC 160-A)

The Select and Cross-Connect Unit (SCCU) will be controlled by the computer program in the CDC 160-A Automatic SCCU Controller (ASCC). Using function codes, the ASCC will address individual cross-points or sets of cross-points in the switching matrix of the SCCU as if they were pieces of peripheral equipment. Computer interrogation of cross-point status shall be required. The ASCC will be provided with the capability to accept system time inputs.

3.1.6 Computer Communication Converter (CCC)

A data buffer (CCC) shall be provided for each CDC 160-A buffer-computer to accommodate the data to or from the transmitting modem.

3.1.7 Master Data Control Console

A master data control console shall be provided to operate in conjunction with the Select and Cross-Connect Units and the Automatic Select and Cross-Connect control computer.

The control console shall display the status of all logical cross-points within the Select and Cross-Connect Units. Manual

3.1.7 Master Data Control Console (Continued)

back-up and over-ride controls shall be provided on these consoles.

3.2 Computer Programming

3.2.1 Data Processor Programs (CDC 1604)

The Data Processor Programs for the CDC 1604's will support Satellite Projects by providing ephemeris calculations; acquisition and command data for tracking stations; telemetry processing; real time Select and Cross-Connect Unit switch listings and schedules; and any other services deemed necessary by the Project Offices.

3.2.2 Data Buffer Programs (CDC 160-A)

Data Buffer Programs for CDC 160-A vehicle oriented buffer computers will provide support to the particular satellite project with which each buffer is associated. Each program will provide the capabilities of decoding and reformatting incoming and outgoing data, driving display equipment, driving printing equipment, storing data on CDC 163 magnetic tape systems for later recall, and transferring data to and from disc files or 1607 magnetic tape systems.

3.2.3 Off-Line Data Processing Programs (CDC 160-A)

Off-Line Data Processing Programs will be available to perform such off-line processing functions as are deemed necessary.

3.2.4 Automatic Select and Cross-Connect Controller (ASCC) Computer Programs

The ASCC Computer Programs will provide the capability to drive the Select and Cross-Connect Switching Units according to a schedule precalculated on a CDC 1604 from data based on require-

3.2.4 Automatic Select and Cross Connect Controller (ASCC)

Computer Programs (Continued)

ment of orbiting satellites under control of the SCF. They shall also provide a human language printout of the assigned switching tasks and schedules.

3.2.5 Diagnostic Programs

Programs for equipment checkout, subsystem integration and daily maintenance will be required.

3.2.5.1 Equipment checkout and Subsystem integration

Diagnostic routines will be required for checkout and integration of the Tracking/Telemetry Data Buffers, the Select and Cross-Connect Units, and the Automatic Select and Cross-Connect Controller.

3.2.5.2 A working set to Diagnostic Programs for daily maintenance of the Data Subsystem will be required.

3.3 Communications Equipment

The STA serves as the central hub for all communications for the entire SCF including voice, data, and administrative messages. As such, the STA must provide adequate termination and switching facilities to accommodate all tracking stations in the SCF.

The communications subsystem at the STA shall consist of a Technical Control Facility for the termination of all incoming and outgoing inter-station lines. The subsystem shall interface with the Communication Data Select and Cross-Connect Unit. It shall also contain all the intrastation communication equipment required for the STA operations.

3.3.1 Interstation Communications

It is required that communications links be provided to all SCF tracking stations. The exact quantity and types of lines are listed in the design criteria for the interstation communication subsystem. Capabilities shall be provided to include the following modes of communication:

3.3.1.1 Data Transmission

All data transmission to and from the STA will be accomplished by secure duplex 1200 bps lines. The normal mode of operation will be direct transmission between the CDC 160-A buffer computers at the STA and the CDC 160-A computers at the tracking stations.

3.3.1.2 Additional lines will be provided as required to the augmented stations for simultaneous control of two or more satellites.

3.3.2 Technical Control Facility

All incoming and outgoing lines to and from all tracking stations will be terminated in the Technical Control Facility. Adequate facilities are to be provided to monitor and determine the operational status of all lines and to provide an adequate level of maintenance capability. The Technical Control Facility shall provide the interface between the lease line carrier and the master control operator at the Master Data Control Console.

3.3.3 Intra-Station Communications

Intra-station communications and equipment facility shall be provided as required to support the operation requirements of the STA. The primary mode of intra-station communications will be voice; however, the feasibility of

3.3.3 Intra-Station Communications (Continued)

providing other signaling and switching devices shall be studied as required.

3.4 Data Display Equipment

3.4.1 Remote, computer driven, CDC 166 page printers will be provided in the Project Control Areas. These printers are driven by the CDC 160-A Buffer Computers and the data is routed through the Computer Select and Cross-Connect Unit.

3.4.2 A closed circuit TV system for presenting data in addition to computer printouts shall be required.

4. GENERAL DESIGN REQUIREMENTS

4.1 Basic Approach

Although every detail of equipment performance is not necessarily described in this design criteria, the responsible contractor shall consider the intent of this document and shall produce an adequate subsystem. Maximum use shall be made wherever possible of general purpose commercial test equipment (signal generators, receivers, etc.) for the subsystem checkout. Special purpose test equipment already commercially available shall be given preference for testing the S-band and telemetry tracking subsystems before a new checkout equipment design is initiated.

Wherever possible, all equipment shall be designed with MIL-E-4158B as a guide and shall be constructed using materials and methods which have Air Force approval.

Insofar as feasible, equipment shall be designed to use materials which are not nutrients for fungus. If materials which are nutrients for fungus must be used, they shall be suitably protected. The contractor shall provide shelter and environmental control facilities compatible with the specified operation of the system element.

4.2 Definitions

Because of the location of certain sites, extreme tropical conditions of heat and humidity and extreme cold will be encountered. Therefore, for purposes of such sites, the following definitions are given:

4.2.1 Ground Sheltered Equipment

"Ground Sheltered" indicates the various equipments, racks, and cables contained within a building proper and which are either supplied conditioned air or surrounded by conditioned

4.2.1 Ground Sheltered Equipment (Continued)

air furnished by the air conditioning systems.

4.2.2 Ground Unsheltered Equipment

"Unsheltered" applies to equipment that may be protected by a radome or other protective cover but not supplied complete conditioned air nor surrounded by such conditioned air.

4.3 Environmental

4.3.1 Ground Sheltered Equipment

Shelter shall be provided for equipment in inhabited portions of buildings so as to give protection from precipitation, wind, salt spray, direct solar radiation, or sediment. Equipment shall operate within specifications in temperatures from 10 to 30°C, at pressures from 610 to 775 mm Hg, and with relative humidity of from 10 to 98 percent but without condensation conditions.

Non-housed equipment, such as cables, shall be capable of operation within specification under temperature, moisture, salt spray, direct sunshine, wind, and other environmental conditions encountered in arctic or tropical regions.

4.3.2 Ground Unsheltered Equipment

The antenna reflector, pedestal, and contained equipment shall operate satisfactorily over a temperature range from -40 to +71°C, which includes the effects of direct solar radiation of 360 BUT per square foot, for a period of four hours per day at normal sea level atmospheric pressures.

4.3.2 Ground Unsheltered Equipment (Continued)

The equipment shall operate satisfactorily when subjected to relative humidities ranging from 10 to 98 percent over a temperature range from -40 to +54°C, including the effects of condensation due to temperature change.

The equipment shall operate satisfactorily at any atmospheric pressure from 610 to 774 mm Hg.

4.3.3 Explosive Atmospheres

The electrical equipment, switches, lights, motors, and contacts located in the close vicinity of the hydraulic portions of an antenna drive system shall be designed to minimize arcing or unsafe conditions.

4.3.4 Wind Loading

The equipment shall be capable of satisfactory operation under steady state winds of 52 knots. It shall be designed to withstand winds of 120 knots without permanent damage or deformation while in stowed condition, in event radomes are removed. Radomes will be capable of protecting equipment to withstand winds of 130 knots.

4.4 Reliability

Reliability of operation shall be considered of prime importance in the design and installation of this system. All possible means shall be employed to ensure quality and maximum reliability consistent with the state of the art. The contractor shall specify, in his Reliability Program Plan, the documents to be used as design goals.

4.4.1 Point Availability (A)

The point availability design goal is at least 0.998 as defined by the formula:

$$A = \frac{MTBF}{MTBE + MTR}$$

4.4.2 Mean-Time-Between-Failure (MTBF)

The reliability design goal is MTBF of at least 500 hours.

Failure is defined as the inability of the system to perform as required by this specification when the system is operated and adjusted in the manner specified herein.

4.4.3 Mean-Time-to Repair (MTR)

MTR is defined as the arithmetic mean of the time intervals during which the system is not capable of performing its operational function because of failures.

5. GENERAL CONTRACTUAL REQUIREMENTS

5.1 Agencies Responsible

The contractor has primary responsibility for procurement and subsystem specifications and procedures. The Space Systems Operations (SSO) of the Air Force Systems Command (AFSC), assisted by the Aerospace Corporation, shall exercise subsystem test monitoring and final approval authority over the subsystem and acceptance specifications.

5.2 Conduct of Tests

Complete acceptance test of all subsystem components shall be conducted at the contractor's plant. This test shall be designed to verify all of the requirements of this criteria and include a complete system evaluation test. Exceptions to this statement must

5.2 Conduct of Tests (Continued)

be individually justified by the contractor and must be approved by SSO/Aerospace representatives. The contractor shall design similar tests for the complete system to confirm that its overall performance, when integrated, is as required. Successful completion of subsystem and system acceptance tests shall be based on the acceptance team's evaluation of any failures that occur.

5.3 Submission of Data

In lieu of monitor tests during the acceptance test, test data may be submitted to the acceptance team upon prior approval of each submission. This approval will be implicit in approval of the acceptance test plan.

5.4 Rejection and Retest

In the event of failure of a subsystem, or the complete system, to pass the acceptance test, acceptance of the subsystem shall be withheld until the extent, cost, and significance of the failure has been determined and acceptable remedial action taken. Appropriate portions of the acceptance test shall then be rerun to show compliance with the test specification. Contractual implications of the failure of the contractor to meet specified performance requirements shall be the subject of separate negotiations.

5.5 Test Records

Complete records of acceptance test data and events shall be kept by the contractor and submitted to SSO/Aerospace after completion of the test. These records shall include a tabulation of repairs and adjustments made during the test.

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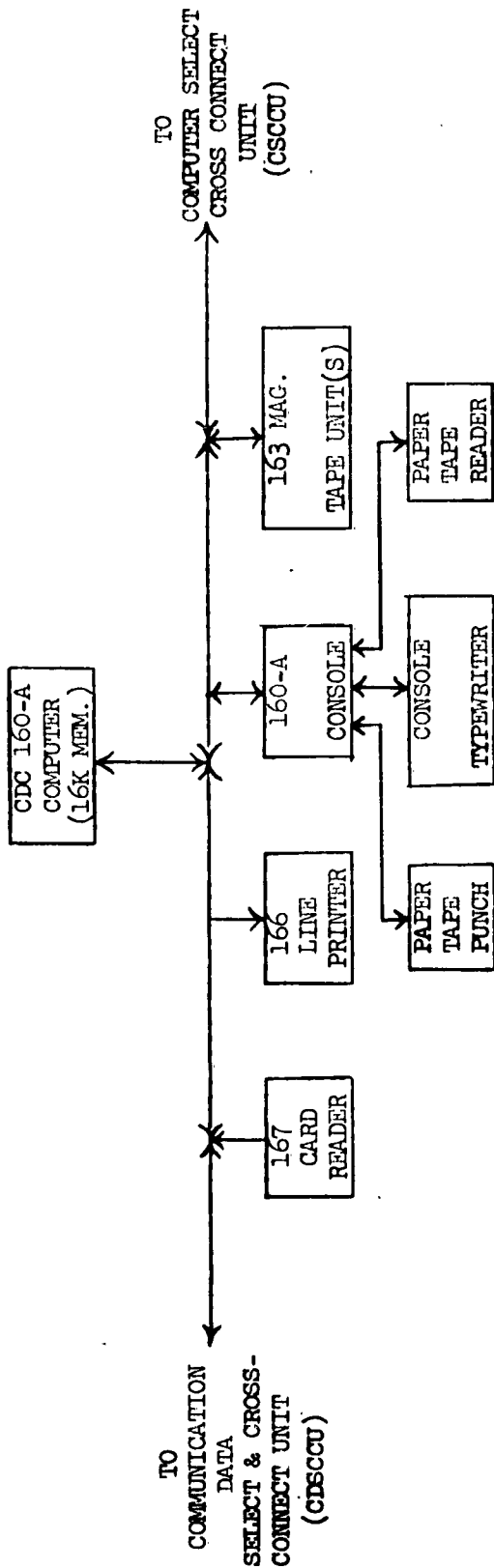


FIG. 1 CDC 160-A BIRD BUFFER EQUIPMENT COMPLEX

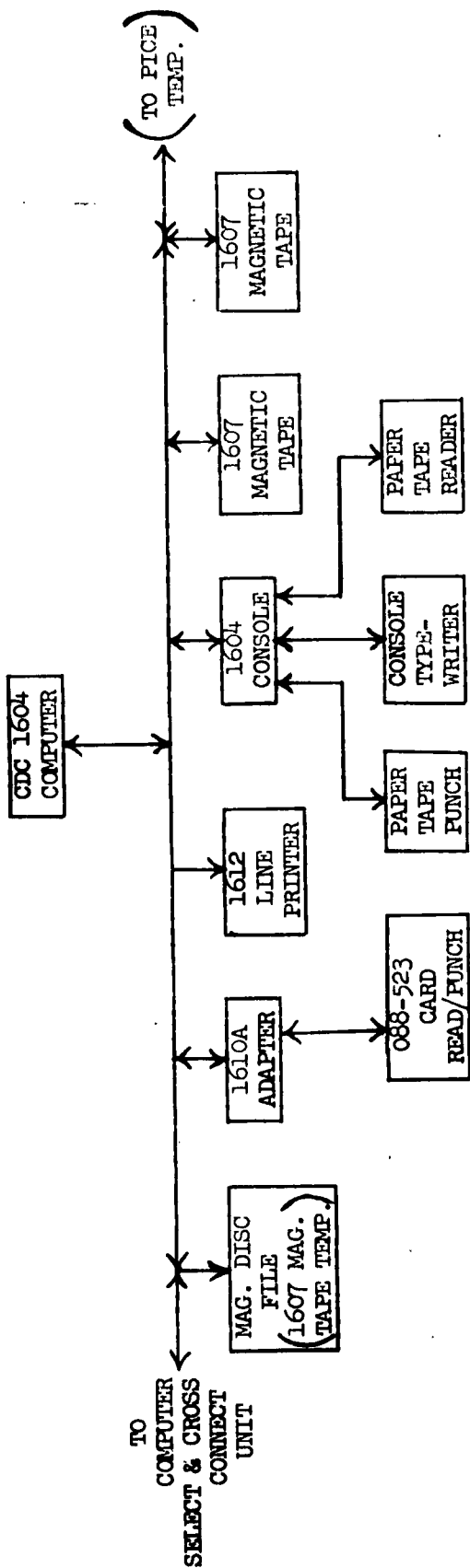


FIG. 2 CDC 1604 COMPUTER COMPLEX

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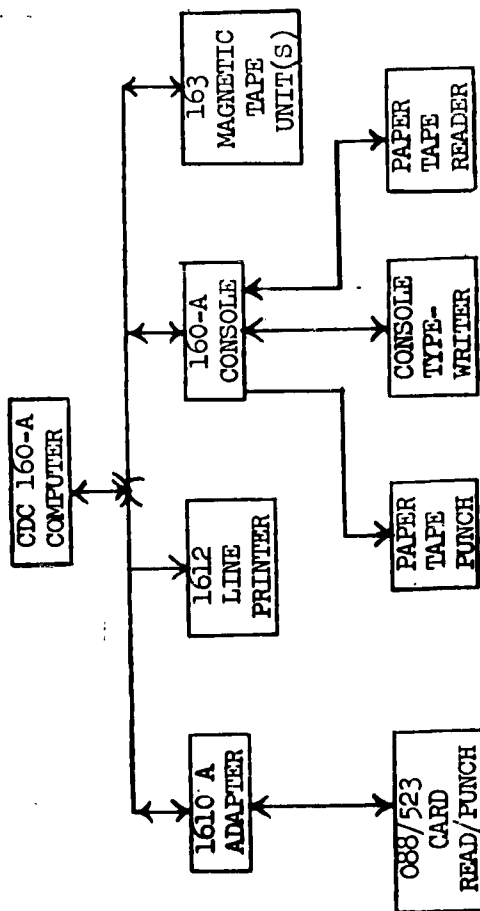


FIG. 3 OFF-LINE 160-A COMPLEX

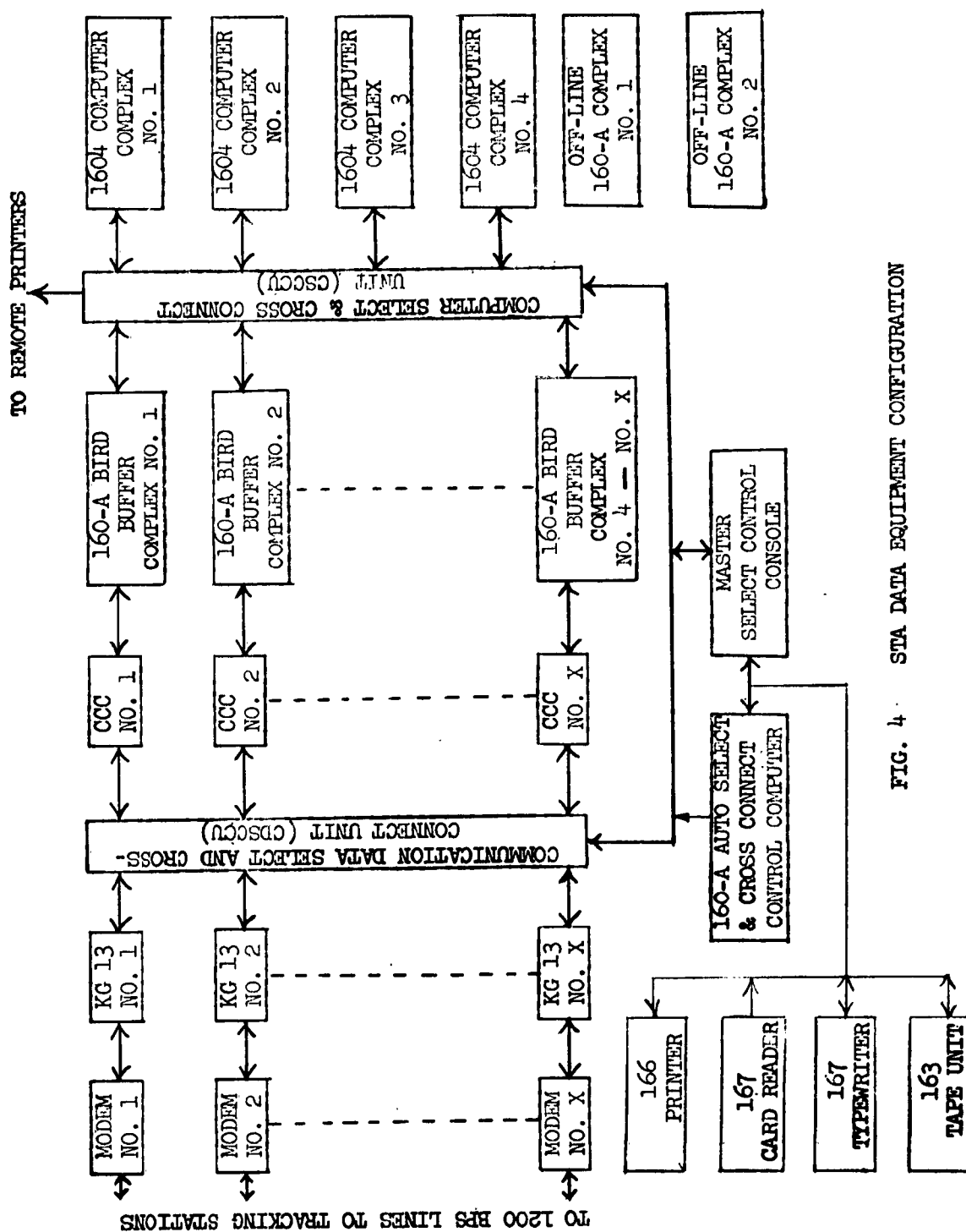


FIG. 4 STA DATA EQUIPMENT CONFIGURATION