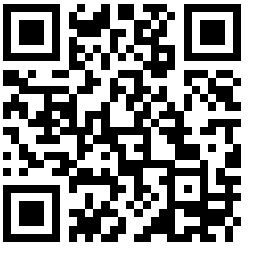


MAINTENANCE OF TELETYPEWRITER SYSTEMS

AN FAA HANDBOOK

FEDERAL AVIATION AGENCY
Washington, D. C.

NOTICE TO HANDBOOK USERS

Upon Receipt of a Handbook Change:

1. Check to be sure you have the preceding change—check for gaps in change numbers.
2. Examine transmitted materials, and note new or revised text enclosed in asterisks.
3. Follow instructions in the page control chart in the transmitting notice, for removing and inserting pages.
4. When you need to keep replaced pages, staple them to the change notice that directed their removal. Ordinarily, replaced pages will not be kept, except in master files.
5. Read the transmitting notice carefully; note items requiring immediate action.

Page and Paragraphs Numbering. The basic pages and paragraphs of this handbook are numbered in straight sequence. Tables of contents and appendix pages are numbered in straight sequences. When it is necessary to insert new pages or paragraphs, the new pages or paragraphs will be numbered by "dash" numbers. For example, a paragraph (or page) to be inserted between 26 and 27 will be designated as 26–1 and 26–2, etc. In some cases, two dash numbers will be used (e.g., 26–10, 26–11, 26–12, etc.) because of a large number of insertions.

Keep This Handbook Up-to-date. It is extremely important that you keep this handbook up-to-date. Remove and insert pages promptly as prescribed by change notices. No issuing system or distribution action can offset the failure of handbook users to keep their handbooks current.

THE ONLY GOOD HANDBOOK IS AN UP-TO-DATE HANDBOOK

ORDER

FEDERAL AVIATION AGENCY
WASHINGTON, D. C.

6620.1

10/31/66

SUBJECT: MAINTENANCE OF TELETYPEWRITER SYSTEMS

1. PURPOSE.

This order transmits and places into effect the subject handbook which governs the activities of all personnel engaged in maintenance of teletypewriter systems.

2. CANCELLATIONS.

The following directives are cancelled:

AF P 6620.13 Evaluation of Data Handling Equipment (Teletypewriter)

AF P 7330.1 Systems Maintenance Crypto Handbook

3. OBJECTIVES.

The objective of this publication is to provide the necessary information for Airway Facilities personnel to obtain optimum performance of the teletypewriter systems. The handbook covers technical standards, tolerances, theory, schedules and procedures. It supplements information contained in instruction books and general maintenance handbooks.

4. REFERENCES.

Additional information on the maintenance, operation, and interrelationships of the teletypewriter systems may be found in the references listed in paragraph 4 of the handbook.

APPROVED OCTOBER 31, 1966

Distribution: Item 78, List F–3, W–3

TABLE OF CONTENTS

CHAPTER 1. GENERAL INFORMATION AND REQUIREMENTS

CHAPTER 2. TECHNICAL CHARACTERISTICS

Section 1. Description

Section 2. Theory

TABLE OF CONTENTS—*Continued*

Section 2. Theory—*Continued*

CHAPTER 3. MAINTENANCE PROCEDURES

Section 1. General Teletypewriter Equipment

Section 2. BDIS Equipment

Section 3. Reserved

CHAPTER 4. STANDARDS AND TOLERANCES

CHAPTER 5. PERFORMANCE CHECKS

Section 1. General Teletypewriter Equipment

Section 2. BDIS Equipment

Section 3. Reserved

TABLE OF CONTENTS—*Continued*

CHAPTER 6. PREVENTIVE MAINTENANCE

CHAPTER 7. MISCELLANEOUS

CHAPTER 8. RESERVED

CHAPTER 9. PERIODIC INSPECTIONS AND EVALUATIONS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS—*Continued*

Chapter 1. GENERAL INFORMATION AND REQUIREMENTS

1. PURPOSE.

This handbook establishes policies, technical standards, tolerance and maintenance procedures applicable to the maintenance of teletypewriter systems equipment. It also provides information on special methods and techniques which will enable maintenance personnel to obtain optimum performance from the system. This information augments information available in instruction books and other handbooks.

2. CANCELLATION.

AF P 6620.13 ____ Evaulation of Data Handling Equipment (Teletypewriter).
AF P 7330.1 _____ Systems Maintenance Crypto Handbook.

3. EFFECTIVE DATE.

The effective date of this handbook is the date of the order which promulgates it.

4. REFERENCES.

1600.20 _____ Communications Security Handbook (Classified).
OA P 1600.1 ____ Personnel Security Handbook.
AF P 4441.4 ____ Practices Concerning Leased Telecommunication Services.
SM P 4623.1A ___ Scheduled Overhaul of Equipment.
4650.2 _____ Facility Equipment Records Handbook.
SM P 6000.4 ____ Chapter 1, FAA–419 Equipment Failure Report.
SM 6030.4A _____ Preparation of FAA Form 406c, Facilities Maintenance Log.
AF P 6030.5 ____ Maintenance of Electronic Equipment.
SM 6030.11A ____ Service Interruptions of FAA Facilities.
SM 6040.3 _____ Technical Evaluation of Facilities and Equipment.
SM P 6040.6A __ Employee Activity Report FAA Form 3294.
SM 6040.7 _____ Quarterly Report on Status of Technical Inspection and Evaluation Program (RIS SM 6040–8).
6200.4 _____ Standard Allowance of Test Equipment Handbook.
6930.1 _____ Fire Prevention and Maintenance of Fire Protection Equipment.
7300.7 _____ Aeronautical Communications and Pilot Services.
7330.5 _____ Service A Weather Schedules.
7330.3B _____ Service C Weather Schedules.
7330.6A _____ International Weather Schedules Service O.
Unnumbered ____ Applicable Test Equipment Instruction Books, Drawings, and Diagrams.
Unnumbered ____ Applicable Equipment Instruction Books, Drawings, and Diagrams.
Manufacturer Numbered ____ Teletype Bulletins, Wiring Diagrams and Specifications. First Air Manual.
MIL STD 188–B _ Military Communication Technical Standards.

5. REVISIONS.

It is intended that all maintenance handbooks shall be accurate and adequate to meet the requirements of field personnel. Users of this handbook are encouraged to make suggestions for the improvement of the handbook and to report any errors. Suggestions and proposed corections shall be forwarded through regular channels to the Regional Office for evaluation and subsequent transmittal to Washington for action.

6. DEVIATIONS FROM PROCEDURES.

When necessary for the attainment of Agency objections, a Region may authorize, on a temporary basis, a deviation from a maintenance procedure specified in this handbook. A copy of each authorization, complete with justification, shall be forwarded to Systems Maintenance Service, Washington, D.C., not later than time of issuance to the field.

7. FORMS.

a. FAA FORM 3484, Crypto Maintenance Technician Training and Experience Record. A crypto maintenance training and experience record shall be established and kept current at the section level for all crypto maintenance technicians. Instructions for maintaining this form

are contained in Handbook 1600.20, Chapter 4, par. 51.

b. The following forms are to be used at Teletypewriter or Data Systems facilities:

FAA Form 406c Facility Maintenance Log.
FAA Form 419 Equipment Failure Report.

All other forms required will be at regional or local option or to meet the requirements of Handbook 4650.2.

8. SAFETY.

a. Introduction. Personnel shall at all times exercise care while working on equipment, particularly where high voltages are employed, and especially when inspection plates and dust covers are removed or access doors are open exposing internal wiring. Contact with ac, dc, or RF potentials can result in severe shock, burn, or loss of life. All individuals are expected to be thoroughly familiar with general safety practices prior to working on equipment so as not to endanger themselves or others. Ignorance and carelessness are predominant factors involved in most accidents. Particular attention shall be given to proper use of a grounding cable prior to working on high voltage circuits.

b. Danger to personnel from selenium.

(1) Raw selenium powder is a poison when ingested into the body, as for example by contaminated hands touching food or cigarettes. It is not probable that one will obtain selenium powder contamination from manufactured rectifiers but the user may be subjected to extremely poisonous fumes given off when an arcover occurs in a selenium rectifier. These fumes have a very putrid odor.

(2) When selenium fumes are present, inhalation is to be avoided. Open windows and doors promptly to remove fumes. Take the equipment containing the burned rectifier outside as soon as possible. Do not handle damaged portions of the rectifier with bare hands as absorption of the selenium powder is possible through burns or cuts in the skin. Even when thermally cold, it produces a form of burn, such as do caustics.

c. Hazards of working with Teflon insulation. Teflon material is used in many types of equipment either as an insulator or as a dielectric material. When working with a soldering iron on equipment that contains Teflon material, certain precautions shall be observed. When Teflon is heated above approximately 400 degrees centigrade (752 degrees Fahrenheit) small quantities of toxic gases are given off. Maintenance personnel are cautioned to avoid breathing the fumes and to make sure adequate ventilation is provided when soldering or heating cables of components which contain Teflon material. The tip temperature of most soldering irons ranges from 500 degrees to 1,000 degrees Fahrenheit and will produce toxic gases if the tip comes in contact with Teflon material.

d. Danger to personnel from some cleaning solvents. The inhalation of fumes from some solvents, such as carbon-tetrachloride, is extremely hazardous to the respiratory system and some may have a caustic effect on the skin. Personnel shall not use these types of solvents. Any chlorinated or petroleum base solvent, such as trichloroethane or stanisol, that meets health and safety requirements may be used for cleaning. Whenever any solvents or cleaners are used, adequate ventilation shall be provided.

9. SECURITY.

a. All personnel shall be thoroughly familiar with current security directives. They shall take the necessary precautions to insure the security of all classified equipments, materials and documents.

b. Agency Handbook 1600.20, Communications Security Handbook, contains the Agency policy regarding secure communications. This handbook (classified) should be obtained and used at all locations where secure communications facilities are maintained.

10. POLICY REGARDING MODIFICATIONS.

a. No unauthorized modifications to standard equipments, facilities, or procedures are permitted. It is recognized that there will be occasions when certain temporary repairs will be necessary due to an emergency or in event permanent repairs cannot be effected immediately because approved parts are not available. In this case, a complete report shall be submitted to the appropriate supervisor at the first opportunity explaining the nature of the emergency, describing the changes which have been made, and estimating when the equipment will be re-

stored to its original condition. The equipment so modified shall be restored to its original condition at the earliest practicable date.

b. Prior Washington Headquarters approval is required before Regionwide, or systemwide, modifications are undertaken. A Regional Office may grant approval for a temporary modification of a single equipment for test purposes, or to determine the feasibility of a proposed improvement. In this case, the test period will enable the Region to obtain data on which to base a fully documented request to Washington Headquarters for approval of a systemwide modification.

c. Proposed Modifications to improve system performance, increase reliability, minimize safety hazards, or facilitate maintenance may be suggested by field personnel. Such proposed modifications shall be described in detail and submitted in the format of an appropriate equipment modification instruction.

d. Modifications to crypto equipment are not permitted, except as approved by the National Security Agency. Modifications to FAA COMSEC equipments shall be requested and performed in accordance with AFR 66–21. Modification instructions and kits required for approved modifications will be supplied by USAFCD. (See 1600.20, Communications Security Handbook)

11. DIRECTIVE VERBS.

This handbook contains policy statements and other guidance material, wherein directive verbs are used, such as SHALL, SHOULD, WILL and MAY. In this handbook, the word—

a. "SHALL" is used to denote compulsory or mandatory action which the person being directed is obliged to take.

Example: The equipment *shall* be adjusted to operate in accordance with handbook tolerances.

b. "SHOULD" is used to denote an action which is strongly recommended but left to the discretion of the person being directed.

Example: The equipment *should* be shut down, if in the opinion of the technician, catastrophic failure is imminent.

c. "Will is used to denote action in the future tense.

Example: Obsolete equipment *will* be replaced as soon as funds can be made available.

d. "MAY" is used to denote permission.

Example: At navigational aid facilities, certain maintenance activities *may* be performed without recourse to flight inspection.

12. TRADEMARK "TELETYPE".

"TELETYPE" is a registered trademark belonging to the Teletype Corporation. "TELETYPE" shall be capitalized, and always used as a company identification. Publications or correspondence originating within the Agency pertaining to data handling equipment will be referred to as data handling equipment, teletypewriter equipment, or by the individual unit name, such as M28/RO or M28/ASR, etc.

13. EQUIPMENT GUARANTEE.

a. The Teletype Corporation places a ninety (90) day (from shipping date) no cost warranty on all parts and components. The Teletype Corporation has an agreement with the FAA to mark each box or carton with the shipping date immediately prior to pick-up at the factory. FAA will use this date to compute the guarantee period. Requests for free replacement parts which fall outside the guarantee period shall be discontinued. ANY MODIFICATION OR REPAIRS PERFORMED BY FAA PERSONNEL ON DAMAGED PARTS OR COMPONENTS WILL AUTOMATICALLY VOID THE WARRANTY.

b. Summarizing the agreement between the Teletype Corporation and the FAA, the following guarantee clause applies to equipment purchased from the Teletype Corporation: All items furnished on this contract shall be guaranteed to function properly when installed, operated without abuse, and maintained in accordance with the contractor's instructions. The contractor shall agree to furnish the Government transportation charges prepaid, a new part for or repair, without charge, all parts which fail to give satisfactory service due to defects in material or workmanship provided that parts show defects and the contractor is notified thereof, in writing, ninety days after delivery of apparatus, and such parts are returned to the contractor at Chicago, delivery charges collect, and fur-

ther provided that contractor's examination of such parts confirm Government's claim.

14. COORDINATION.

a. Any maintenance operation or activity performed on data handling equipment that may affect normal operating procedures shall be coordinated with the user of the system, such as Air Traffic Management, Weather Bureau, or Military operations personnel.

b. Equipment removal, operations or shutdown that may affect the long-line service shall be coordinated with the associated serving company or organization, such as the telephone company, Western Union company, or the Military Services.

15. GROUND RULES.

AF P .4414.4, provides uniform guidelines covering the standardization and modernization of Leased Telecommunication Services and serving companies. In quarters other than FAA, the ground rules are applicable only at the demarcation cabinet and to the installation on the equipment side of the demarcation strip.

16. EXTENSION OF LEASED TELETYPEWRITER SERVICES.

The telephone company has found at some locations that two drops were being served from one telephone company local channel. The additional extension had been wired in from the FAA demarcation strip by AF personnel. The Washington Office has been notified by AT&T that while tariff imposes no limitation on the number of customer-owned machines connected to a circuit at one location, it does provide that any extension of a circuit to a separate location must be installed by the telephone company.

17. SERVING COMPANY LINE SERVICE.

All agency teletypewriter switching and system interconnection are designed to utilize neutral operation only. The agency policy has been standardized and no deviations are anticipated. Operation of the serving company's portion of the system is at their discretion; however, the extension from the FAA demarcation terminal is always required to be neutral.

18. STANDARDIZATION.

It is the policy of the Agency that all teletypewriter equipments, used for a specific purpose, be standardized both electrically and mechanically. To this end, modification instructions and kits for weather printers have been issued. Teletypewriter equipments overhauled at the depot are now configured to FAA standards. Information regarding the standard configuration is contained in this handbook. New and/or rebuilt installations will be designed for the FAA standard teletypewriter equipments. Upon completion of the standardization program it will be possible to interchange equipments between locations without the necessity of reconfiguring the equipments.

19. MAINTENANCE SHUTDOWN.

The removal of all data handling equipment from a circuit will be very rare due to the standby equipments provided. When the occasion should arise, the shutdown will be coordinated with the operations personnel at the facility concerned.

20. MAINTENANCE WORK ON OPERATING EQUIPMENT.

Maintenance work shall not be performed on equipment while in operation or in the operations area where it might interfere with operations personnel except in special cases and then only when coordinated with operations personnel. Line relays may be removed only when the equipment is disconnected from the line circuit or when the equipment is turned off.

21. SERVICE INTERRUPTIONS.

Service interruptions of less than one minute duration ordinarily will not be reported to the serving company's test room unless the interruption occurs several times during an eight-hour watch. Garbling, line running open, or similar interruptions, which occur frequently or continue for periods in excess of one minute should be reported to the serving company's test room. Operating personnel should be reasonably certain that the trouble is not due to malfunctioning of FAA equipment before notifying the serving company.

22. INSTRUCTIONS AND DRAWINGS.

All instruction books and publications should be on hand, properly filed and available for use when needed. All related books and documents should be revised whenever changes have been made and should be kept up to date at all times.

23. FACILITY RECORDS.

a. Maintenance Log, FAA Form 406c. Irregularities of operation, corrective action taken, and equipment maintenance shall be recorded in accordance with the instructions contained in SM 6030.4A. Equipment should be identified by type and serial number. A unit or position number may also be used following type and serial number, Example: ASR S/N 6620 (position A2).

b. Facility equipments records. Instructions for the accountability and control of equipment are contained in Handbook 4560.2.

24. PROGRAMMING CHANGES.

A change is the programmed addition or deletion of stations and/or the order and frequency in which stations are called. A request for change shall be made in writing by the BDIS Air Traffic Control supervisor to the Airway Facilities BDIS supervisor. A request for change shall provide three (3) working days advance notice for minor ADSEL and/or APULS changes. A two (2) week advance notice shall be given for extensive ADSEL and/or APULS changes or if stunt box configuration changes are required. If parts must be ordered to accomplish the requested changes, an additional time allowance shall be made is deemed appropriate.

25. MUFFIN FAN LUBRICATION.

There are two ventilating fans on top of each Converter Cabinet (LCAC 291), which shall be lubricated on a quarterly basis. The needle oiler called an "Oiler Injector," is listed in Teletype Corporation Bulletin 1124B, bearing the part number 194853. The word OIL is located on the gold label of the muffin fan; in the center of the "O" is a very small hole into which the needle oiler is inserted (at a 45-degree angle) to a depth of ¼ inch. Approximately ⅛ inch of oil is injected.

26. STATIC ELIMINATOR.

The tape handling stands (LTHS) have static eliminators located between the Low Speed Reperforator (LRPE) and the High Speed Tape Reader (CX), and between the High Speed Reperforator (DRPE) and the Low Speed Transmitter-Distributor (LBXD). The high voltage power supply for these eliminators is mounted in the base of the cabinet. Be certain that the latter is de-energized and the interconnecting cables disconnected when tape is to be changed or the tape handling stand (LTHS) is removed for servicing. Several instances of severe electrical shock have been reported when this precaution was not observed.

27. NOTIFICATION OF CONTROL STATION OF SYSTEM FAILURES.

Whenever difficulties occur between BDIS facilities that affect the network, the controlling station shall be notified of the difficulty. The controlling station is usually able to render assistance in determination of the location of the faulty equipment or through coordination with the serving company to isolate faulty segments of the line.

28–35. RESERVED.

Chapter 2. TECHNICAL CHARACTERISTICS

Section 1. DESCRIPTION

36. SERVICE A.

a. The Service "A" teletypewriter system consists of 15 area circuits for the collection and dissemination of aviation weather reports and Notices to Airmen (NOTAMS); 14 supplemental circuits for the dissemination only of this information and various local circuits all associated with the Automatic Data Interchange System (ADIS). The ADIS interconnects the area, supplemental and local circuits. Up to nine circuits are terminated at a single geographical location. The terminating equipment is grouped into two configurations which are designated as Interchange Centers (IC) and Send/Receive Centers (S/RCs). ICs and S/RC's are located at major cities throughout the US. Each S/RC terminates two receive-only circuits and is equipped with a high speed transmitter to permit transmission of traffic at periods other than the hourly weather collections. All IC and S/RC installations are interconnected with a high speed (857 WPM) party line circuit.

b. The sequence of operation of the system begins with operators at each of the outlying weather observation stations preparing a perforated tape containing weather information and placing this tape in a transmitter at that location, except at AMOS (Automatic Meteorological Observation Station) locations where reports originate in electromechanical equipment. Six Automatic Program Units Low Speed (APULS) 3 main and 3 standby, are provided at each IC, to provide coverage on the three Area circuits terminated at the IC. These units are started locally at all ICs to initiate operation of the system. If required they may be started remotely by recognizing an APULS start signal generated by the Master IC on the High Speed Circuit. The APULS polls each of the 40 or more transmitting stations associated with its Area circuit. As each station is polled, the transmitter at that location is started and its weather data is transmitted to that Area circuit. At the conclusion of each transmission by an outlying station, the APULS restarts and calls the next station. This continues until all 40 stations have had an opportunity to transmit their weather data. Teletypewriters at all stations connected on each Area circuit record all informated transmitted on the circuit, and the standard speed reperforator (100 WPM) at the IC reperforates the data for retransmission on the high speed circuit. At some predetermined time after the start of the APULS units, the Automatic Program Unit High Speed, (APUHS) located at the Master Interchange Center is manually started. The APUHS polls each of the fifteen area circuits sequentially for traffic which has been reperforated by the standard speed reperforators and is ready for transmission by the associated high speed transmitters.

c. The calls from the APUHS are detected by the common circuitry at each IC, and as each Area circuit is polled, the high speed transmitter serving that circuit is turned on. Information stored in the tape is transmitted over the high speed circuit. In this manner, all traffic originated on all of the Area circuits appears on the high speed circuit for a period of time. Means are provided in the Message Director Unit at each IC and S/RC for identifying the prefix of each message as it appears on the high speed circuit. This unit also provides for programming the high speed reperforators associated with each standard speed Area, Supplemental and Local circuit to reperforate only the data destined for the standard speed circuit. Consequently, as each weather observation appears on the high speed circuit, the IC and S/RC, after detecting the message identifying prefix,

unblinds the high speed reperforators which have been programmed to receive the weather information. It is possible, by inserting or removing a small diode plug, for an operator to change the program for each reperforator. Each IC and S/RC is capable of recognizing up to eleven hundred message identifying sequences as well as other high speed line control sequences. Priorities are applied on the Area Circuits to the delivery of information collected from the high-speed circuit back to the Area, Supplemental and Local Circuits. The APULS, when started, calls all stations in the order prescribed in the Service A Weather Schedules. While provision has been made for *collecting* data from polled stations in three priorities, this feature is not used. Consequently, all data is collected in a single priority.

d. Transmission of the weather and NOTAM information from all 15 Area Circuits is then made on the high-speed circuit and read-out on standard-speed circuits is in accordance with priorities programmed at the ICs. Traffic from a given Area Circuit transmitted on the high speed circuit ahead of traffic from other Area circuits may not necessarily be considered of primary importance to all other standard speed circuits. Consequently, three high speed reperforator-standard speed transmitters are connected on the high speed and Area circuits. As each message prefix appearing on the high speed circuit is detected at the IC, the Center common circuitry decides, according to its program, which reperforator, if any is to receive the subsequent traffic. The reperforator selected is unblinded and reperforates the incoming information. The three standard speed transmitters are arranged so that the transmitter labeled "one" always has precedence over the ones labeled "two" and "three" in retransmitting the information stored in tape. Likewise the transmitter labeled 2 has precedence over the one labeled 3. The transmitter labeled 3 may therefore only transmit after all traffic has been cleared by units 1 and 2. Should unit 2 or 3 be transmitting, and additional traffic is received by reperforator-transmitter 1, the transmitting unit stops at the conclusion of the message being transmitted and gives unit 1 access to the circuit.

e. Weather observation stations may transmit information at times other than during the scheduled weather collection and these transmissions are referred to as "unscheduled traffic". The operator at the outlying station "breaks" the standard speed line (if busy) in order to gain access to the circuit as the transmitters associated with the high speed reperforators may still be transmitting information received from the high speed circuit. (All such transmitters are designed to stop on line breaks.) He then transmits the unscheduled traffic which begins with a special "reperforator unblind" code followed by the station identifying sequence and an "end-of-message" sequence. The "unblind" code serves to unblind the standard speed reperforator associated with the Area circuit at the IC (it is normally blinded to unscheduled traffic on the Area Circuit) while the "end-of-message" code reblinds the reperforator. The "end-of-message sequence is detected at the IC and after 37 subsequent message or feed out characters have been reperforated, a mechanical counter is driven to a count of one. Subsequent messages, as they are received, cause the counter to be driven to higher counts. IC circuitry, upon recognition of one or more unscheduled messages in storage, will initiate a two second spacing signal on the high speed circuit.

f. At the Master IC this signal is detected and used to start a high speed program. The APUHS then conducts an "unscheduled" scan, polling each Area circuit in turn. As each Area circuit is polled, it transmits on the high speed circuit any traffic which is in storage. This traffic is subsequently recognized, recorded and retransmitted at all IC and S/RCs in a manner identical to scheduled traffic. In this manner, it is possible for an outlying station to originate traffic at any time and, within a short period, have that traffic distributed by the system. During an unscheduled scan, the APUHS first polls all IC Area circuit high speed readers and then polls the high speed readers at each S/RC.

g. The ADIS makes use of special code groups to initiate various operations. The codes and their functions are as follows:

(a) Condition Code (CR CR LTRS)—This code appears at the beginning of every message preceding the select code. The condition code

alerts the equipment to "look" for the select code immediately following.

(b) Select Codes—These may be alphabetical 2, 3, or 4 letter station identifications calls or 3-digit numerical codes followed by a "space" sequence and are used to identifying a message originating station.

(c) End-of-Message Code (LF CR LTRS)—This code appears at the end of each message following the text. It is essentially a "disconnect" code.

(d) End-of-Block Codes—These codes are generated by the APULS and are used to indicate that all of a specified "priority" of traffic has been collected on the associated Area circuit. The code are: End of priority block one, CR CR LTRS SP; End of priority block two, CR CR LTRS, CR; End of priority block three, CR CR LTRS BLANK. Currently only end of priority block three is used since all collections are made in single priority.

(e) Unblind Code (FIGS FIGS)—This code is used to unblind the ADIS input reperforator on unscheduled traffic transmissions during periods of the APULS shut-down. The ADIS uses solid state and electromechanical techniques and core storage memory units to accomplish the switching functions.

37. SERVICE B.

a. General. Service B consists primarily of two separate continental networks for data transmission. The Area B network is used to interconnect stations in Air Route Traffic Control Center (ARTCC) areas. At the more active terminals on the Area B network, outlets are provided to Supplemental B Circuits. The Center B network is a separate network linking ARTCCs, and ARTCCs with International Flight Service Stations so that intercenter traffic and center—IFSS traffic can be handled expeditiously. Service B related circuits are: a. Military B circuits used to link base operations with ARTCCs, b. Air Carrier B circuits used to link local air carrier offices with ARTCCs, and c. Tributary Circuits which are located off-net.

b. Service B Data Interchange System (BDIS).

(1) General.

(a) The Service B Data Interchange System (BDIS) is a high speed data-handling network for the transcontinental distribution of flight movement messages between approximately 450 airports and 25 air traffic control centers located throughout the United States.

(b) A number of standard speed teletypewriter circuits (hereinafter referred to as low speed (LS) circuits) serve designated localities throughout the United States. The low speed circuits terminate at Area Centers located in major cities. These centers consist of transmitting, receiving and switching equipment housed in a number of cabinets. The Area Centers are, in turn, connected by a high speed (HS) circuit.

(c) The data is collected and distributed on the low speed circuits at 100 WPM and on the high speed circuit at 1071 WPM (750 baud) using five-level (7 unit) start-stop code. Provisions have been made for future expansion to eight-level code.

(d) Since it is very important that no Area Center be incapacitated at any time, spare equipment is provided. Should any part of the equipment be disabled, a spare can be quickly switched in by means of a patch panel.

(e) Alarm facilities keep operating personnel informed both by eye and ear of conditions that might need attention. Alarms include buzzers, chimes and lamps and cover such things as low tape supply, tight tape, certain malfunctions, etc.

(2) Configuration.

(a) The BDIS system comprises ten Area Centers, plus one spare, each of which serves a specific geographical area. Each Area Center can accommodate a maximum of three low speed area loops and three low speed send-receive loops. Each center is capable of handling 120 low speed send-receive units in any distribution within its associated loops. Six Area Centers control two area circuits, and the other four centers control three area circuits. In addition eight special receive-only circuits are employed. The spare Area Center is arranged to interconnect three area circuits. The present assignment of Area Centers is as follows:

Atlanta, Georgia
Boston, Massachusetts
Longmont, Colorado
Fort Worth, Texas
Jacksonville, Florida

Joliet, Illinois
Kansas City, Missouri
Bakersfield, California
*Oklahoma City, Oklahoma
San Francisco, California
Cincinnati, Ohio
*Spare Area Center.

(b) The terminal equipment for the BDIS at the Area Centers is housed in cabinets of uniform design, suitable to be seen by the general public. The system permits selective communication between send-receive units located on the various low speed loops throughout the country. Direct communication is possible where communicating send-receive units are situated on the same low speed area or send-receive loop.

(3) Basic Operation.

(a) Each Area Center contains a low speed reperforator which records (in paper tape) information originated on that circuit designated for relay. A high speed transmitter, physically coupled to the reperforator by means of the tape loop, retransmits, on the high speed circuit, information collected on an associated low speed circuit.

(b) High speed reperforators, located throughout the country, selectively record the transmitted information. Low speed transmitter distributors, tape coupled to associated high speed reperforators, retansmit, on the various area circuits, the recorded information.

(4) Summary System Functional Description.

(a) A BDIS Area Center copies in perforated tape at 100 words per minute, any message originating on a circuit it serves when the message is addressed to one or more stations which are *not* on that circuit. The tape is transmitted on an interconnecting data circuit at the high speed rate and the transmission is received simultaneously at all Centers in the system. The message is selected by the Area Centers serving the circuits of the addressed stations, where it is copied in tape and transmitted on the destination circuits at 100 WPM. The message is only copied in print at the addressee and origin stations. The entire operation is automatic, from the moment the operator places a message tape in his transmitter until it is printed at the destination stations. Preparation of the message tape is the only manual operation required.

(b) Automatic data interchange is achieved by including code groups within the data to be handled. The codes used are groups of characters representing machine functions which do not print on page copy, and are extremely unlikely to appear accidentally in circuit traffic (see paragraph 55). These codes indicate the beginning and end-of-message and are called "start-of-message" (SOM) and "end-of-message" (EOM) codes. In the Area B network, the address codes (three-letter station identification codes) direct the messages to the specified destinations.

(c) Area Centers equipped with Automatic Program Units-High Speed (APUHS), can assume control of the entire system. Control is effected by the APUHS transmission of a selective calling program. In this program, the Area Centers are polled in sequence by the transmission of discrete codes which they individually recognize as instructions to transmit any messages on hand.

(d) APUHS control may be exercised in one of 4 modes: (1) automatic (on request), (2) scheduled (under control of an external clock), (3) continuous, and (4) manual. The current mode of operation is automatic, in which the APUHS selective calling program is used only when a request is received from an Area Center. A request is generated by an Area Center when it has a message completely recorded in tape, ready for transmission on the high speed circuit. The request signal is recognized at the control Area Center as a "start program" signal, and at all Area Centers as a "motor start" signal.

(e) The BDIS equipment provides a feature which is currently reserved for emergency use, but was used during the initial testing. This feature is the rejection of data addressed to a station on a circuit having low speed relay facilities with the origin circuit. It was intended to use these low speed relay facilities for messages addressed only to stations on adjacent circuits which had a common intercircuit low speed relay station. The high speed circuit would be reserved for messages having at least one address which could not be reached through a single stage of low speed relay. The number of low speed relay stations have been greatly reduced. Therefore the use of low speed relay has been discontinued except for emergency back-up.

38. SERVICE "C".

The Service "C" system is comprised of six individual circuits covering the contiguous United States. Transfer of information between area circuits is accomplished by means of low speed relays. The operation of the individual area circuits is the same as Service "A" except that a large number of the scheduled collections are not controlled by an APULS but are manual entries. Information on the collection schedules is contained in "Service C Weather Schedules", 7330.3B.

39. SERVICE "O".

The Service "O" system is comprised of domestic 100 WPM circuits and international circuits operating at a variety of speeds. Information received from the international circuits is entered on the domestic circuits and vice-versa. Relay between stations is accomplished by the torn tape method. Implementation of AFTN will provide automatic relay of Service O internationally. All printers and reperforators operate in the local condition and transmitter-distributors are operated manually according to the schedules contained in 7330.6A.

40. AMOS.

The Automatic Meteorological Monitoring Station is an unattended facility with input, through a teletype writer transmitter-distributor, to the A circuits. Weather information such as wind direction, wind velocity, dew point, altimeter, precipitation and temperature are sensed and stored within the AMOS coder unit. This weather information is requested by the control station via the teletypewriter circuit. The AMOS coder then supplies coded Baudot characters, which represent the current weather information at that location, to the teletypewriter transmitter-distributor. Pulses from the TD step the coder through its sequence of operation to read out to the line the complete weather observation. Operation of the coder in reading out the current information is controlled by a Model 28 printer and its associated stuntbox switches. Additional information can be added to the weather information furnished by the AMOS Coder automatically, through three methods, if required:

a. Through the manual operation of push buttons on the AMOS Coder panel (pre-set prior to AMOS transmission).

b. Through tape transmission placed in the AMOS transmitter-distributor.

c. Through tape transmission from an associated Flight Service Station (FSS) transmitter-distributor. That is, information to make up the complete report may be transmitted automatically by the AMOS Coder followed by transmission originated by the AMOS Coder push buttons, if pre-set, followed by transmission by tape from the AMOS transmitter-distributor or an associated FSS transmitter-distributor tape gate.

41. AUTODIN.

The Defense Communications Agency AUTODIN network is a fully automatic electronic switching system with the capability of handling many types of data communications. In the continental United States, eight switching centers are configured to permit switching of discrete teletypewriter messages, punch card information and/or transmission of binary information from magnetic tapes. Several bit rates are used throughout the system to accomplish the data interchange. Circuit switching allowing subscriber to subscriber direct communications is included in this system. Link encryption is used thereby making the system secure for classified information exchange. The several types of terminals and modes used in this system are:

a. Teleprinter (TPR). This type of subscriber terminal consists of any one of a series of teletypewriters. The most common types used are the RO, KSR and ASR. They operate at rates up to 75 bit/second in standard teletypewriter Baudot code. The TPR terminal does not include any means of error detection or correction.

b. Compound Terminal (CT). This type of terminal provides the subscriber with both a punched card and teleprinter capability. The terminal consists of two IBM 536 card machines, a modified ASR Set and an IBM 7283 Control Unit. The terminal is capable of:

(1) Simultaneous sending and receiving of teletypewriter data.

(2) Simultaneous sending and receiving of card data.

(3) Simultaneous sending of card data and receiving of teletypewriter data.

(4) Simultaneous sending of teletypewriter data and receiving of card data.

(5) Sending or receiving card data on an alternate basis with one of the card machines while the order card machine is used off-line to prepare punched cards. The average rate of transmission is approximately 187.5 WPM. Error detection and retransmission is used with the CT.

c. High Speed Card Teletypewriter Terminal (HSCTT). This terminal consists of an IBM 1931 High Speed Card Machine for high volume punched card subscribers, an ASR and an IBM 1946 Control Uunit. Essentially the same functions as obtained with the CT are available with the HSCTT, however, at a much higher rate. The terminal operates at a bit rate of 1200 per second in Fieldata Code equalling 1500 WPM.

d. Magnetic Tape Terminal (MTT). The magnetic tape terminal is specifically designed to accommodate a computer installation as a subscriber. This terminal consists of two Magnetic Tape Transports, a teleprinter and a control unit. It operates at a rate of 2400 bits per second using the Fieldata Code which is equal to 3000 words per minute. Transmission to and from the MTT is done through the use of reading and writing magnetic tape units.

e. Modes of Service. There is a choice between the four basic modes of service available with the previously described terminals, these are:

(1) Mode I—Traffic in both directions simultaneously with error control used with either CT, HSCTT or MTT.

(2) Mode II—Full duplex teleprinter operation—two independent one-way paths (no error control).

(3) Mode III—Traffic in one direction only. Return channel carrying only error control signals. Used with either CT, HSCTT or MTT.

(4) Mode IV—One-way path send or receive only teleprinter operation (no error control).

(5) Mode V—The AUTODIN can serve uncontrolled teleprinter terminals (Mode II), however, a traffic surge could cause the overloading of the equipment necessitating that traffic be serviced off line. In order to preclude this, Mode V operation is used. This combines the Mode II teleprinter terminal operation with Mode I procedures. To accomplish this a control unit is installed at the terminal to provide control of the teletypewriter equipment according to the control signals sent from the AUTODIN switch. All FAA teletypewriter terminals in the DCA AUTODIN use Mode V operation. A Mode V—B control unit is installed at the teletypewriter to perform the necessary control functions.

42. PLAN 59.

The Plan 59 Fully Automatic Switching System provides a means of automatic relaying of messages received on circuit at a switching center, to as many other circuits as appear in the address portion of the message on a simultaneous basis. Messages are received at incoming circuit speed transmitted cross-office at 200 WPM, another tape is made and retransmitted to the outgoing circuit at the speed associated with that circuit. Traffic can be switched to a maximum of eighty circuits and 4300 locations served by up to forty sending positions. Messages may contain a line of routing indicators and each indicator may contain as many as 8 characters. Provision is also made for group codes which consist of a single routing indicator serving two or more destinations for the same message. The equipment uses transistors, vacuum tubes and electro–mechanical units to accomplish the switching functions. Plan 59 switching systems are presently in use in the Panama Canal Zone and Hawaii.

43. PHILLIPS ES–3.

This switching system, installed at Anchorage Alaska, handles the switching of FAA teletypewriter circuits both in the Alaskan Region and point-to-point AFTN circuits terminating outside of the region. The system has the capability to function with 60, 75 and 100 WPM send/receive terminals. The network may be configured for half or full duplex, point-to-point or party line service. The switching system utilizes solid state electronic and electromechanical techniques and has the capability of storing 1000–2000 characters using ferrite matrices. Magnetic tape storage devices are used to additionally store up to 40,000 characters. The electronic control circuits are completely transistored. Mechanical switching is accomplished by high speed stepping switches. The switching center may operate fully

automatic or semi-automatic with a service position torn tape relay to handle all traffic which requires the special attention of the operator.

44. TELETYPEWRITER TERMINALS.

Teletypewriter terminals are comprised of one or more of the following types of equipment. More detailed descriptions may be found in the associated equipment instruction books and bulletins.

a. Receive-Only (R/O) Printer. The R/O is a message receiving unit (without keyboard) to accept electrical signals for reproduction in printed page form. The unit features a built-in control system for automatic station selection and remote control of auxiliary equipment.

b. Keyboard Send-Receive (KSR) Set. The KSR is a message originating unit to send and receive electrical signals for reproduction in printed page form. The unit features a built-in control system for automatic station selection and remote control of auxiliary equipment.

c. Automatic Send/Receive (ASR) Set. The ASR is a composite message receiving and transmitting station. All messages received or transmitted may be typed in printed page form and/or punched in paper tape with or without printing of the message or the tape, depending on the equipment combinations and options used. The unit features a built-in control system for automatic station selection and control of auxiliary equipment.

d. Typing Reperforator (LPR). The LPR is a message receiving unit to accept electrical signals punch a paper tape, and print the message on the tape alongside the perforated message. The unit features an output to control auxiliary equipment. At present, this output is not used in the FAA systems.

e. Transmitter Distributor (TD). The TD is a message transmitting unit for reading punched tape for sequential (serial) transmissions to local or remote receiving equipments.

f. Reperforator Transmitter Distributor (RT) Set. The RT is a complete punched tape message relay set that receives, punches, prints, stores, reads, and transmits messages from one circuit to another.

g. Transmitter Control Device (Relay Group). The Relay Group is an auxiliary unit with a printer set to provide visual indications of circuit conditions and to control automatic transmissions to the circuit. (Relay control group #179472 with modification AF P 6620.1 Chapter 78 is the FAA standard.)

h. Line Switching Unit (LSU). The LSU provides a means of manually switching a given unit of receiving or transmitting equipment with its ten control leads to any one of ten teletypewriter signals lines that may be connected to that LSU.

i. Telegraph Loop Terminal Jack Panel (TLT). The TLT is a jack panel designed to terminate teletypewriter signal circuits in a manner that will facilitate testing.

j. Miscellaneous Equipment. Other associated equipments include fuse and alarm panels, direct current rectifiers, cabinets, and tables for fusing, mounting, and power furnishing capabilities.

Table 1 FAA TELETYPEWRITER EQUIPMENT

Apparatus Cabinet:	
LAC205AB137	for M-28/RO Printer
LAC205AB247	for M-28/RO Printer
LAAC206AB	for M-28/ASR Assembly
AC-273AB	for mounting 1 TD Set or TD Sets
LBAC-200AB	for mounting multiple LBXD Sets
LBAC-201AB	for mounting R-T Sets
LBAC-202AB	for mounting multiple LPR Sets
LBAC-203AB	for mounting Monitor LPR, with Monitor door, Tape Guides and Tape Winders 3-unit LPR Set Accommodation)
Table:	
LT-200-AB	for mounting single LPR Set
Switching Unit:	
CA-1696	10-push-keys, for line switching
Telegraph Loop Terminal Jack Panel:	
CA-1713	Patch Panel
Power Supply:	
CA-1715	48VDC, 5 amp.
Electrical Service Unit:	
LESU7/134	for M-28/RO Printer & M-28/S-R Printer
LESU7/246	for M-28/RO Printer
LESU21	for M-28/ASR Assembly
LESU12	for M-28/ASR Assembly
Typing Unit:	
LP6RE/AL132	for M-28/RO Printer
LP12RE/AEY	for M-28/RO Printer

Fuse & Alarm Panel:
Lynch Type B124–48 .. for 48V Alarm System

Base:
LB4/133 ..... for M–28/RO Printer
LAK6XL ..... for M–28/ASR Assembly, Keyboard Base
LCXB6 ..... for M–28/ASR Assembly, Trans-Dist. Base
LRXB1 ..... for M–28/R-T (Reperforator-Transmitter) Base
LRBX9 ..... for M–28/Typing Reperforator Set, Reperforator Base
LRBX3 ..... for M–28/Typing Reperforator, Reperforator Base
LRB ..... for M–28/Multiple Reperf., Reperforator Base
LMRB200AB ..... for M–28/Multiple Reperforator, Multiple Base
LBXB1 ..... for Transmitter-Distributor
LMXB200AB ..... Multiple TD Base

Motor Unit:
LMU3 ..... for M–28/RO Printer
LUM12 ..... for M–28/RO Printer & Send-Receive Printer M–28/ASR Assembly, Typing Reperforator Set, Multiple Reperforator Set, M–28 T-D Set, Multiple T-D Set

Line Relay:
255A ..... for use as spare
HGSX5066 (Clare) ... for use as required
33RY (A.E.–203) ..... all equipment as required.

Relay Control Group:
#179472 ..... Modified per AF P 6620.1 Chap. 78 FAA Standard

Keyboard:
LK11ARE ..... for M-28/Send-Receive Printer
LE5RE127 ..... for M-28/Send Receive Printer

Keyboard Base:
LAK6XL ..... for M–28/ASR Assembly

Transmitter-Distributor:
LBXD4 ..... for M–28/ASR Assembly
LBXD6 ..... for M–28/Multiple Transmitter, 2-Gate

Perforator:
LPE1 ..... for M–28/ASR Assembly

Transmiter-Distributor Base:
LCBX6 ..... for M–28/ASR Assembly
LMXB200AB ..... for M–28/Multiple T-D
115932AB ..... for Type 14 T.D.

Typing Perforator:
LPR6/ARE ..... for M–28/ASR Assembly

Typing Reperforator:
LPR3ARE ..... for R-T Set, M–28
LPRI2ARE ..... for M–28/Typing Reperf. Set
LPR4RAA ..... for M–28 / Typing Reperforator Set

Base, Reperforator Transmitter:
LRBX1 ..... for M–28/R-T Set

Tapewinder:
TW–14 ..... for M–28/Reperforator

Paperwinder:
PW201AB Universal
Motor W/brushes ... for M–28 Printer
PW206AB Synchronous
Motor ..... for M–28 Printer

Table 2 TELETYPEWRITER TECHNICAL CHARACTERISTICS

Signal Requirement—sequential, five intelligence levels, with start-stop pulses, sixty (60) milliampere neutral operation.

Operating Speed.
(1) Characters per minute—600.
(2) Unit code—7.42.
(3) Bauds (Bits per Second)—74.2.
(a) One character—100.
(b) Unit pulse—13.5.
(c) Stop pulse—19.1.

Power Requirements from External Source—115 VAC, 60 cycles, single phase.

Characteristics Peculiar to Page Printers:
(1) Type Pallet Arrangements—standard, upper case arrangements include:
(a) Communications punctuation symbols (used in Secure Communication only).
(b) Weather symbols.
(2) Type Styles and Spacing.
(a) Style—Gothic.
(b) Character height—.103 inch.
(c) Communications. Horizontal characters per inch—single space, 12.
(d) Weather. Horizontal characters per inch—single space, 10.
(e) Vertical lines per inch—single feed—6 and double feed 3.
(3) Platen.
(a) Type—friction feed.
(b) Communications. Maximum character per line—80.
(c) Weather. Maximum characters per line—72.
(4) Typing Unit Ribbon.
(a) Style—black record.
(b) Length—33 feet.
(c) Width—½ inch.
(d) Thickness—0.0055 inch.
(5) Typing Unit Paper.
(a) Type—standard yellow paper roll.
(b) Outside diameter—4½ inches.
(c) Width—8.45 inches.
(d) Length—325 feet.
(e) Core diameter—1 inch.
(f) Core thickness—0.125 inch.

Characteristics Peculiar to Tape Perforators, Reperforators, Readers, and Typing Units.
(1) Tape.
(a) Type—standard communications.

(b) Width—11/16 inch.
(c) Code perforations—Chadless.
(d) Characters or feed holes per inch—10.

(2) Printed Characters.
(a) Height—0.120 inch.
(b) Width—0.075 inch.
(c) Location of print—along upper edge of tape.

Dimensions (Major Equipment Units—approximate in inches)

	Height	*Width*	*Depth*
(1) R/O			
(a) Floor model	39	20½	21
(b) Multiple	72	21½	28
(2) KSR	39	20½	24
(3) ASR	39	36	23
(4) LPR (Table Model)	9¼	13	14⅛
(5) RT	60	28	27
(6) TD (LBXD Table Model)	6½	9	16
(7) TD (M-14)	10	9	16½

Table 3 TELETYPEWRITER EQUIPMENT POWER REQUIREMENTS.

Equipment	*120VAC*
M-28 R/O	95W
M14 T.D.	65W
M-28 ASR	135W
M-28 LBXD	65W
M-28 LPR	65W
M-28 R-T	65W
AC-273 w/2-14 T.D.	120W
AC-273 w/2-LBXD	120W
CA-1696	0
APULS	85W
ADIS R/O	2500W
ADIC I/C	8760W
MULTIPLE LPR	65W
MULTIPLE LBXD	65W
MULTIPLE LBXD	65W
CA-1715	250W Max.

45-49. RESERVED

Section 2. THEORY

50. TELETYPEWRITERS GENERAL.

a. To obtain maximum utilization, flexibility, accuracy, and reliability of the teletypewriter equipment, maintenance personnel must have a general understanding of the basic principles of start-stop telegraphy. It is assumed that the reader is familiar with the conventional telegraph, systems, so this review of the fundamentals of start-stop telegraphy will call special attention to certain specific features. More details of the fundamentals of start-stop telegraphy may be found in various equipment instruction books and other publications. The code of electrical impulses in start-stop telegraphy systems consists of a start signal, normally a space (no current) to notify the receiving equipment of the start of the character; a series of bits that convey the intelligence to the receiving station; and stop signal normally a mark (current), to notify the receiving equipment of the end of the character.

(1) The selecting mechanism of the teletypewriter receiver translates the signalling code combinations into corresponding mechanical arrangements which ultimately result in the performance of the desired function. Although start-stop codes exist that employ different numbers of intelligence or information bits and different types of stop signal, the 100 word-per-minute (WPM) FAA system uses one of the most common (illustrated in figure 1). It contains a start signal (start-space), five intelligence bits (marks or spaces or combinations of marks and spaces), and a stop signal (stop-mark) having a time duration of 1.4 times the duration of one information bit. This particular code is called 7.42 unit code, derived from the total of the start-space (1 bit), the information bits (5 bits), and the stop-mark (1.42 bits). The start pulse, which is always a space added to the beginning, and the stop pulse, which is always a mark added at the end of each combination of intelligence bits, are used to insure synchronization between the transmitting and receiving equipments.

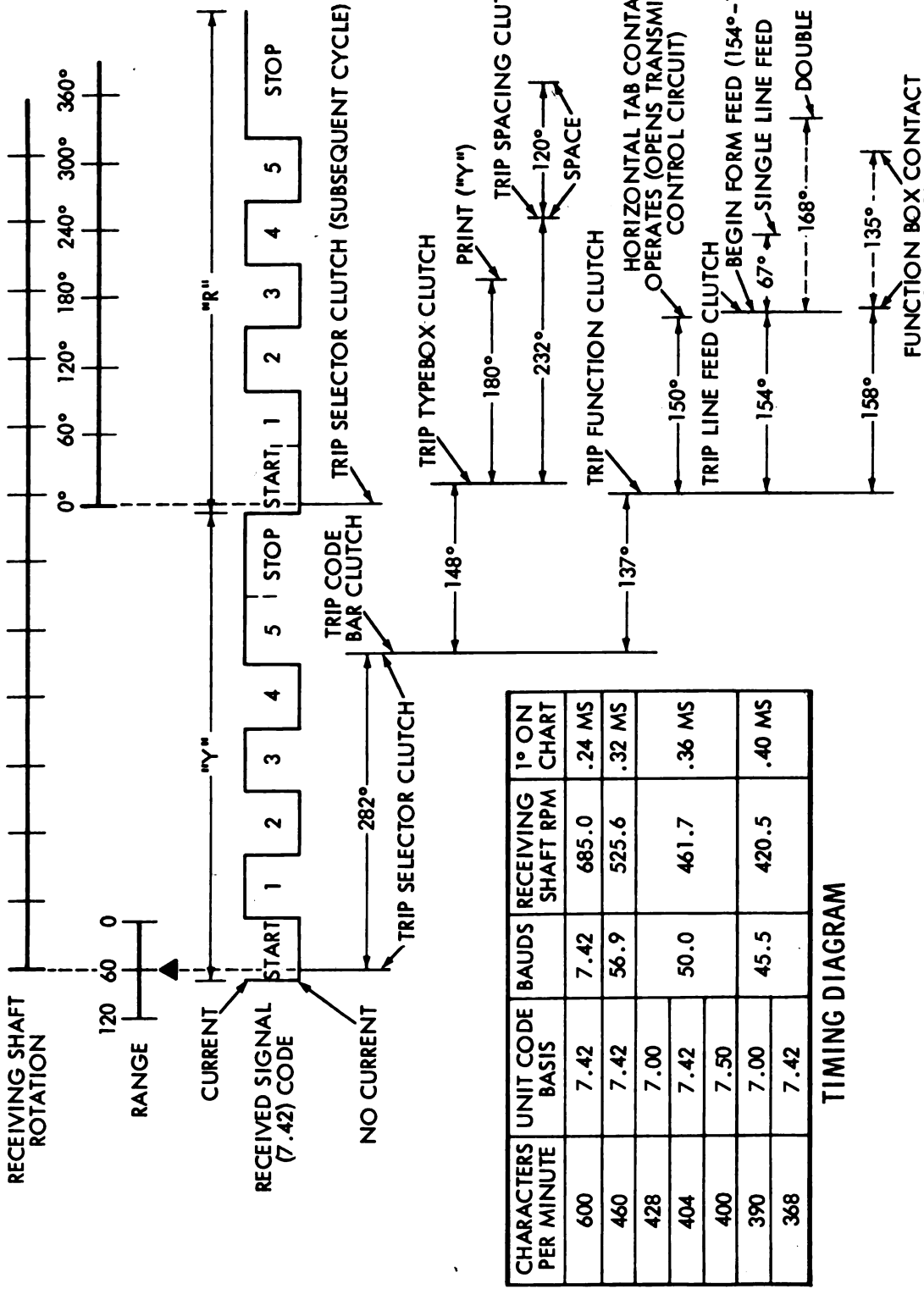
(2) Each operation is initiated by a mark-to-space (M-S) transition at the beginning of the start bit of the received character. The speed of the receiving equipment should be such that it arrives at the stop position before the end of the stop mark. Since it is restarted by the succeeding M-S transition, any speed difference between the transmitting and receiving machine is prevented from accumulating for more than the duration of a single character. When a message begins, the first bit of signal (start pulse) is identified to the receiver by the first M-S transition. The receiver starts anew at each start transition and samples the intelligence bits in times relative to the transition.

(3) The start transition acts as the reference time point to which all other instants of time during the selective cycle are referred. In start-stop systems, it is not the duration of signal intervals that is of primary importance, it is the time of signal transition relative to the start transition. Departures from perfect timing are known as start-stop displacements and are defined as signal distortion.

(4) When the receive station equipment receives the start space, it begins to measure time to determine the beginning and ending of each bit within the character being received. A properly designed and adjusted start-stop teletypewriter actually requires only a small portion of the time of each signal element to make a selection; i.e., to determine whether the signal bit is a mark or a space. The remainder of the signal bit gives an operating margin and serves as a reserve to take care of imperfections in the receiver or distortions which the signals may suffer between the transmitting and receiving stations during transmission. The greater the signal distortion, the smaller will be the margin to overcome the effect of such factors as wear of parts, variation of adjustments, or differences in speed between the transmitting and receiving equipments.

b. Signal distortion may result in four types of transition displacements from their normal times of occurrence relative to the start transition as follows: See figure 2.

(1) S-M advance is the advance of a space-to-mark transition, and is called a marking beginning displacement. (MB)



TIMING DIAGRAM

CHARACTERS PER MINUTE	UNIT CODE BASIS	BAUDS	RECEIVING SHAFT RPM	1° ON CHART
600	7.42	7.42	685.0	.24 MS
460	7.42	56.9	525.6	.32 MS
428	7.00	50.0	461.7	.36 MS
404	7.42			
400	7.50			
390	7.00	45.5	420.5	.40 MS
368	7.42			

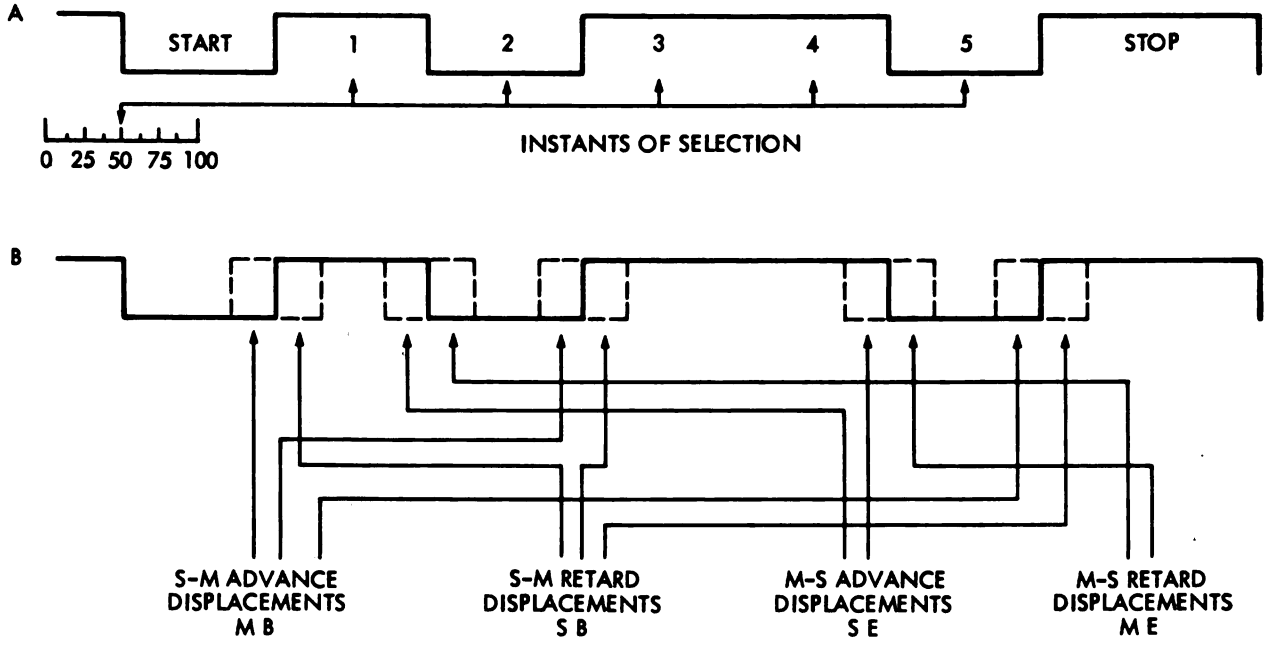
FIGURE 1. Code Representation of Letters R and Y.

(2) S-M retard is the delay of a space-to-mark transition, and is called a spacing beginning displacement. (SB)

(3) M-S advance is the advance of a mark-to-space transition, and is called a spacing end displacement. (SE)

(4) M-S retard is the delay of a mark-to-space transition, and is called a marking end displacement. (ME)

c. The orientation range of a teletypewriter receiver is the total range through which the selective periods may be shifted relative to the start transition without producing an incorrect selection. All types of displacements affect the orientation range of the receiver. Its limits are read on a scale calibrated from 0–100 in percent of a unit signal element. The effect of each type of transition displacement upon the orientation is shown in figure 3. Diagrams of this type are called end and bias distortion "parallelograms." The lines indicate the boundaries, determined by the various displacements, of the area of operation outside of which printing errors would occur.



NOTE: THE GENERAL TERMS "BIAS" AND "END DISTORTION" ARE USED TO SIGNIFY S-M AND M-S DISPLACEMENTS, RESPECTIVELY, AND THE GENERAL TERM "DISTORTION" IS USED TO SIGNIFY ANY TYPE DISPLACEMENT.

FIGURE 2. Four Possible Types of Transition Displacements.

d. Measurements of distortion, the time displacement of the signal transitions from their correct time position, are further described by specifying the magnitude of the transition displacement (normally expressed as the percent of the relationship of the displacement to the normal bit time duration), the affected transition (M-S or S-M), and the sign of the displacement (early or late in respect to the zero distortion time position). Teletypewriter signals may be analyzed conveniently by using one of various types of distortion measuring instruments connected in series with the signal circuit. For purposes of classification, distortion may be broken down into five categories; bias, end, characteristic, fortuitous, and speed. It is important to note that a signal may be the composite result of the effects of one or more of these types of distortion.

(1) Bias distortion (bias) is a uniform displacement of the S-M transitions resulting in a uniform lengthening or shortening of all marking or spacing bits. The S-M advance occurring at the beginning of the marking element in-

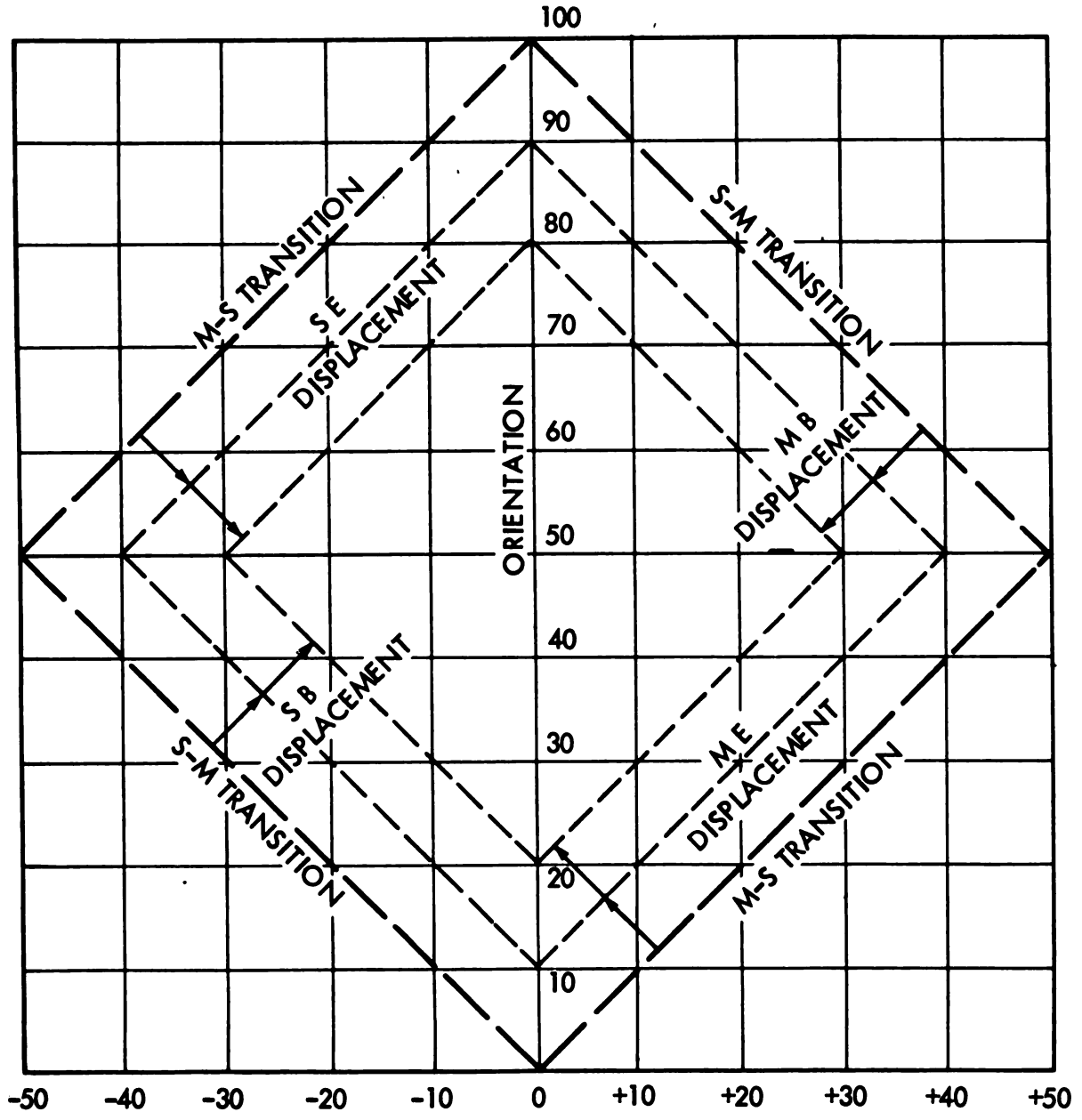


FIGURE 8. Bias and End Distortion Parallelogram.

creases the marking time and is designated as "marking bias" or "positive bias." See figures 3 and 4. The S-M retard occurring at the beginning of the marking element increases the spacing time and is designated as "spacing bias" or "negative bias." Bias will result when a system element (whether electrical or mechanical) possesses asymmetry toward marking or spacing; for example, a mechanical element may travel more slowly from spacing to marking than from marking to spacing, thus causing spacing bias, or its range of travel may be divided unequally into marking and spacing portions, thus producing an equivalent effect.

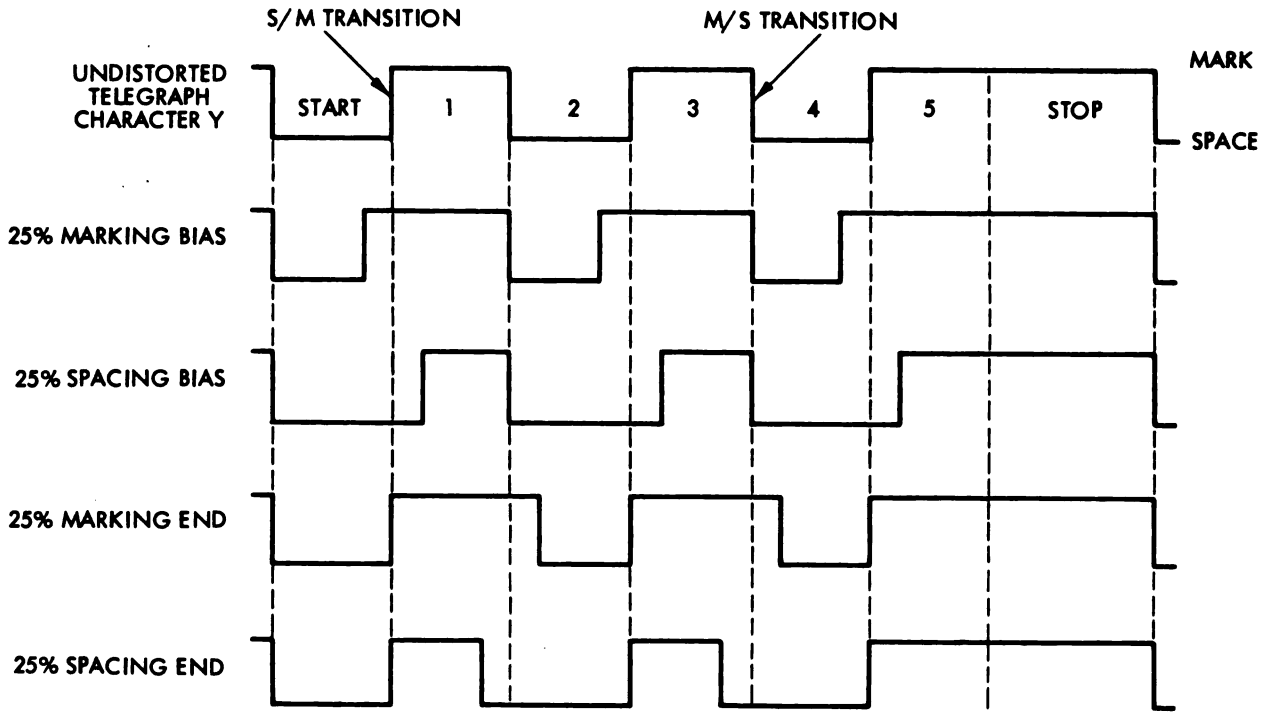


FIGURE 4. Types of Distortion.

(2) End distortion (E.D.) resulting in a uniform lengthing or shortening of all marking or spacing bits. The M-S advance occurring at the end of the marking element increases the spacing time and is designated as "spacing end distortion." See figures 2, and 4. The M-S retard occurring at the end of the marking element increases the marking time and is designated as "marking end distortion." Frequent causes of end distortion are unusual line and equipment conditions or the overall effect of various other types of distortion.

(3) Characteristic distortion does not affect all signal transitions alike because the effect on each transition depends on the signal impulses that have previously been sent over the circuit. Hence, the start transition and the other transitions of a character are, in general, shifted by varying amounts. It is convenient for purposes of description, since the start transition is made the point of reference for the remaining transitions of each character, to assume that any delay in the start transition is, in effect, the lag in the circuit for that character. Any shifts in the positions of subsequent transitions of that character are then of interest only as they change the transition from its proper relationship to the start transition. Any of the four types of displacement may occur depending on whether the transition is M-S or S-M and whether it has been delayed more or less than the start transition. Because characteristic distortion delays the start transition by different amounts from character to character, it causes the character length to vary during continuous automatic transmissions. Characteristic distortion will result when

an element, whether electrical or mechanical, of a system fails to attain a steady state before being acted upon by a succeeding transition or otherwise has its action dependent upon the previous history of the signal.

(4) Fortuitous distortion causes the start transition to be delayed more or less than normal and has the same effect on the selective transitions. Since it is usually equally probable that the maximum fortuitous effects will occur on either M-S or S-M transitions and will increase or decrease their delay, this type of distortion generally produces the four types of displacement. When the M-S and S-M transients give the wave different slopes at the point where the receiving device operates, the fortuitous effect is different on M-S and S-M transitions. Fortuitous distortion will result when some mechanical element is irregular in its action. For example, irregular action of a mechanical element affecting the selector alike on all selective transitions appears as fortuitous distortion. Fortuitous distortion may occur because of indecision during the passage of a selective element past a locking member at which time the choice between marking and spacing is largely fortuitous.

(5) Speed distortion or speed bias occurs when the transmitting and receiving equipments are not synchronized in speed relationship. This condition is generally caused by a different power line frequency at the transmitting and receiving ends.

e. Internal Distortion.

(1) Distortion may occur within the receiving machine. It is convenient to define the components of internal distortion in terms of equivalent values of external signal distortion from suitable measurements with known values of distorted input signals. It is possible to determine the value and type of internal distortion, but very elaborate test procedures are required to separate its effects. The upper end of the orientation range is determined by which ever of the displacements, SB or ME, is the greater. To discover the magnitude of the smaller type displacement, it is necessary to increase the smaller by a known value or to reduce the larger displacement by a known value by, distorting the transmitted signals.

(2) If a receiver has a large internal marking bias, the upper limit of orientation is determined by the MB displacement; hence, the amount of SE displacement caused by internal distortion is concealed. However, by transmitting signals affected by SB displacement (signals bias to spacing), the total MB displacement may be decreased until it is less than the internal SE displacement whose effect on margin can then be found. Thus, the internal distortion may be determined by observing the effect of external distortion on the margins of operation.

(3) To determine internal distortion and other information of start-stop receivers, test equipment is used to transmit signals having any of the four types of displacement: MB, SB, SE, or ME. When fixed values of the four types of displacement are transmitted in turn, the limits of orientation, range arm settings (RAS), for each are measured by means of the range scale of the receiver. For example, consider a receiver for which measurements were made with the test signals having four types of displacement of equal magnitude as follows:

(4) *Displacement*	*Signal Contains 35%:*	*Orientation Range Limits (RAS)*
MB	Marking bias	65
SB	Spacing bias	49
SE	Spacing end distortion	58
ME	Marking end distortion	40

(5) The upper and lower RAS with, respectively, marking bias and spacing bias, are 65 and 49. The upper and lower RAS with, respectively, spacing end distortion and marking end distortion, are 58 and 40. These results will enable one to construct a bias and end distortion parallelogram, predict the receiver's performance under specific signal conditions, and calculate various internal characteristics. See figure 5.

f. The following equations are listed for reference:

(1) $Ub = 65 + 35 = 100$ $\quad Ue = 58 + 35 = 93$

$Lb = 49 - 35 = 14$ $\quad Le = 40 - 35 = 5$

Ub and Lb represent upper and lower limit RAS affected by internal bias distortion. Ue and Le represent upper and lower limit RAS affected by internal end distortion.

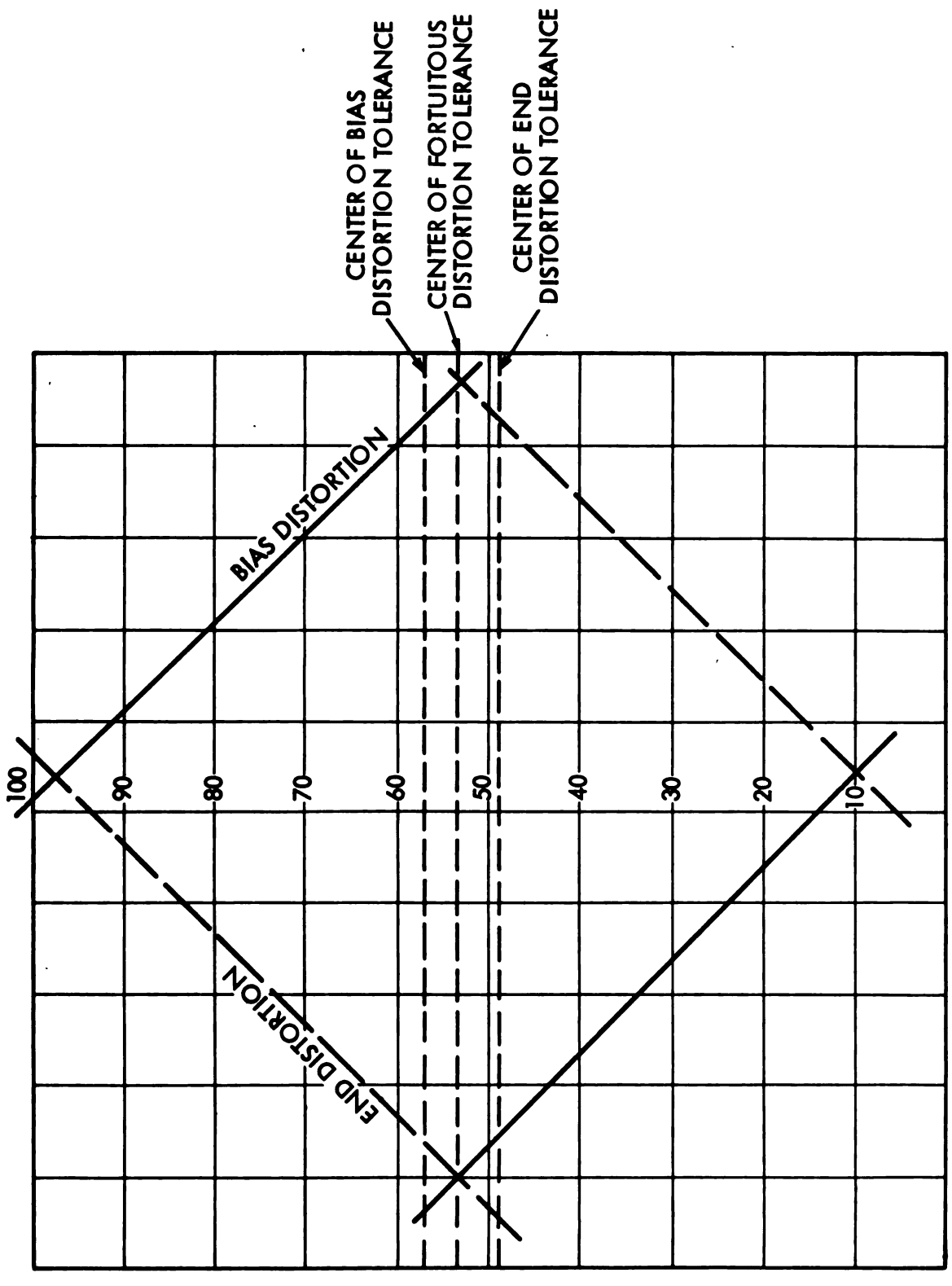


FIGURE 5. Bias and End Distortion Parallelograms for a Receiver.

(2) The following relations may be used to determine various optimum RAS:
ORB represents optimum RAS for bias.
ORD represents optimum RAS for end distortion.
ORF represents optimum RAS for fortuitous distortion.

$$ORB=\frac{Ub+Lb}{2} \quad ORD=\frac{Ue+Le}{2} \quad ORF=\frac{ORB+ORD}{2}$$

$$=\frac{100+14}{2} \quad =\frac{93+5}{2} \quad =\frac{57+49}{2}$$

$$=57 \quad =49 \quad =53$$

$$\text{Bias tolerance}=\frac{Ub-Lb}{2}$$

$$=\frac{100-14}{2}$$

$$=43\%$$

$$\text{E. D. tolerance}=\frac{Ue-Le}{2}$$

$$=\frac{93-5}{2}$$

$$=44\%$$

$$\text{Fortuitous distortion tolerance}=\frac{Ue-Lb}{2}$$

$$=\frac{93-14}{2}$$

$$=39.5\%$$

$$\text{Internal bias}=ORD-ORB$$

$$=49-57$$

$$=-8\%$$

Although part of it may be due to the effects of internal characteristic distortion, the difference between the maximum distortion tolerance and 50% (the tolerance of a perfect receiver) is due to internal fortuitous effects and is defined as internal fortuitous distortion.

g. Practical Considerations.

(1) In practice, the relationship between displacement and reduction of margin in sometimes not linear. This effect is due to internal characteristic distortion caused by some element not attaining a steady state condition before the occurrence of a succeeding transition.

(2) The best range arm setting (RAS) is that which permits the receiver to tolerate the greatest amount of any type displacement expected. From figure 5, the optimum RAS for fortuitous distortion would be 57, and for end distortion 49.

(3) Because of the nonlinearity of characteristic distortion, it cannot be assumed that the ultimate tolerance of the receiver is that calculated or derived from the parallelogram. To obtain exact performance, the tolerance must be determined with the RAS adjusted to the center of tolerance.

(4) A study will show that the principal interest is not so much the shape of the parallelogram as in the ultimate tolerance to signal distortion at the optimum RAS. This is the reason for using signals containing fairly large displacements for testing receiving teletypewriters.

(5) In practice, bias tolerance is generally considered to be more desirable than end distortion tolerance. The reason is that most transmission systems suffer from some bias distortion, but little or no end distortion. Generally, the RAS for a teletypewriter is adjusted to the center of bias tolerance.

(6) To give a reasonable operating margin to take care of imperfections in the complete teletypewriter system from the initial transmission to the final action resulting from the reception of the signal, it is desirable to specify a minimum bias tolerance about 5% greater than the minimum permissible end distortion tolerance when the RAS is adjusted to the center of bias tolerance for both measurements. This is the reason for a maximum ±5% internal bias and an orientation range spread of 80 specified for FAA teletypewriters.

51. USE OF M28 PRINTER IN SELECTIVE CALLING.

a. General. The Model 28 page printer operates in three basic functional modes: (1) The first mode is referred to as LETTERS. In this mode the printer types alphabetical characters and performs functions as indicated on the lower portion of the printer's green keytops. (2) When the typebox shifts to FIGURES the second area, *symbols and numerical characters* as indicated on the keytops will be printed, and (3) In the third mode, SELECT -NON-PRINT, direct printing is suppressed while the signal selector

and stunt box actively monitors the circuit. This last mode of operation, under which selective calling is performed will be described in brief form. A complete technical description is beyond the scope of this handbook and will not be attempted herein.

b. Stunt (Function) Box.

(1) There are many different methods of utilizing the stunt box. Some make use of conditioning codes, some use single character directing codes and others use two or more characters in a pre-determined sequence. Used with and without conditioning codes, sequential character directing code call-ups are one of the most valuable features provided by the stunt box and a general example will be presented without evoking the amount of detail already provided in the equipment specifications.

(2) Generally, a sequential code directing call (hereinafter referred to as a CDC) can be used without a conditioning code if the sequence of characters does not occur as a valid combination used in the particular system under consideration. Since such possible combinations are necessarily limited in number, one of them is usually employed as a conditioning code to "open a gate". During the time the gate is open, many CDC's composed of combinations that may also be employed elsewhere in the data or message traffic, can be utilized. A further automatic convention—a character or sequence of characters—is used to de-condition or "close the gate" so that regular system operation can continue without activating the automatic controls associated with the CDC's. A CDC, of course, can be used for many purposes—to call in a printer or a reperforator, to start a transmitter-distributor, to actuate relays controlling lights, motors, emergency power supplies and so on. The CDC accomplishes this by causing the operation of a Form C (one swinger, one front, one back contact) contact assembly mounted on the stunt box.

(3) Sequential Selection. Sequential selection is then, the most useful feature of the stunt (function) box and latching-unlatching is the key to sequential selection. Sequential selection is defined as *selection on, and only on,* a specific group of characters, arranged in a particular order and time. For the purposes of this discussion, "character" is used to include both graphic and non-graphic teletypewriter operations.

(4) Coding the Stunt Box. Blocking and latching type function levers permit a function to be performed when a sequence of two or more characters is received by the teletypewriter. To illustrate the principle of sequential selection, assume that a function is to be performed upon receipt of the sequence "Carriage return, line feed, letters (CR LF LTR), *in that order only.* In order to accomplish this, three consecutively numbered slots in the stunt box must be used. The first, or lowest numbered, slot is then equipped with a function bar coded for carriage return, a standard function pawl, a function lever with both a blocking projection and a latching projection, and a function latch with an unlatching projection operated by the stripper blade. Function bar, pawl, and lever extension springs must also be used to complete the function mechanism in this slot. The second, or adjacent higher numbered, slot is equipped with an identical set of parts except that the function bar is coded for line feed. The third, or highest numbered of the three slots is equipped with a function bar coded for letters, a standard function pawl, a function level without either blocking or latching projections, and a spring plate, plus the associated extension springs.

(5) Stunt box operation for CR LF LTR coding set-up.

(a) When a carriage return character is received by the teletypewriter, the code bars are positioned to correspond to the carriage return code. As the function bar reset bail moves forward, the function bar in the first slot is pulled forward by its spring and finds an opening in the code bars opposite each tine on the function bar. The function bar in the second slot is blocked from moving forward by the code bars. (It a line feed is received, but not immediately preceded by a carriage return, this function bar will be blocked by the blocking projection on the function level in the first slot). As the reset bail moves to the rear, the selected function pawl in the first slot is moved to the rear by its function bar. The pawl rotates its associated function lever counterclockwise and the lever is latched in its operated position by the latch plate. This removes the blocking projection on

the lever from the path of the function bar in the second slot so that this function bar is now unblocked. When the stripper blade rises and unlatches the function pawl in the first slot, the function lever remains latched in its operated position and the function bar in the second slot remains unblocked.

(b) If the next character is not a LF, the function bar in the second slot will not be selected and when the stripper blade moves downward during this cycle, it will unlatch the function in the first slot and restore it to its normal unselected position. However, if the next character is a line feed, the function bar in the second slot will be selected and the function lever in this slot will be operated and latched in its operated position by the latch plate. This unblocks the function bar in the third slot. During this cycle of operation, the function lever in the first slot will be unlatched but only after the function bar in the second slot has been selected.

(c) If the third character is not LTRs, the function bar in the third slot will not be selected, the function lever in the second slot will be unlatched during this cycle of operation, and the function mechanisms in the first and second slots will both then be restored to their normal unoperated positions. However, if the third character is letters, the function bar in the third slot will be selected and the function lever in this slot will be rotated counterclockwise when the function bar and pawl are moved to the rear. The motion of this function lever is used to perform the required function. The standard function lever and spring plate in this slot can, of course, be replaced by a latch-unlatch or latch-release type of function mechanism if desired. Consequently, mometary operation of the contacts or desired function, lock-up of the contacts or desired function, and unlock of the contacts or desired function is made available as required for the particular application of the CDC. Technical part nomenclature and operating theory of the M–28 printer will be found in Teletype Corporation Bulletin 216B—Description and Theory, and Bulletin 1149B—Parts, M28.

52. OPERATION OF A PRINTER FUNCTION.

a. The basic operation performed by the stunt box is the initiation of functions within the printer. Assume that "Line Feed" is the function to be performed. When the code combination for "Line Feed" is received by the signal selector of the page printer, the "Line Feed" combination is set up in the code bars. When the function clutch is tripped following the selection cycle, all the function bars in the stunt box follow the function bail forward and feel for an opening in the code bars. In this case a free path is found only by the function bar containing the "Line Feed" code.

b. Entry into the code bars permits the function bar to travel forward far enough to allow its associated function pawl to become engaged with the function bar. The function bar, actuated by the function bail, then carries the function pawl rearward. The function pawl in turn engages its companion function lever which, through a suitable mechanism, trips the line feed clutch to perform the line feed function. The function pawl is then disengaged from the function bar by the stripper blade and the operation is completed. It should be noted that the lower projection of the function lever engages the space suppression bail and pushes the bail forward to suppress spacing. This extension of the function lever is omitted when spacing on a function is desired.

53. SEQUENTIAL SELECTION OF A FUNCTION.

a. Selection of a function can be accomplished on a sequential basis by using a sequence of code combinations. Assume that it is desired to perform a function upon reception of a two-character code sequence consisting of "Figures", "J". Further assume that final operation of the function is to be performed only when the sequence is received in proper order without the interposition of another character. In this case two function bar mechanisms in addition to those required for the regular functions must be provided. In other words, the "Figures" function bar mechanism employed in the shift operation cannot be re-employed in this special function sequence.

b. This sequential method of selection can be expanded to any practicable limit; that is, the sequence of code combinations required to perform the desired operation can be made in any

desired order. In effect, the first function bar mechanism of a sequence opens a gate for the function bar mechanisms to the right (as viewed from the rear) for the following cycle only and then immediately closes the gate unless the next function bar takes advantage of the opening. Therefore, unless the sequence is selected in exact order, the desired operation will not be performed. By using a sequence of code combinations not ordinarily encountered in a message text, local and remote functions can be performed without sacrificing character code combination.

54. CONTROL OF REMOTE APPARATUS.

a. Remote control of auxiliary apparatus such as reperforators, indicating lamps, signal bells, motor controls, etc., may be accomplished by the addition of electrical switches to the stunt box. These switches are assembled in molded plastic blocks which will accommodate four switch mechanisms. The stunt box will accommodate eight blocks or a total of 32 switch mechanisms.

b. Each switch contains an arm, a contact, and a spring. Electrical contact is completed between the arm and the contact. Wiring connection is made to the contact and to the spring.

c. Each switch mechanism is controlled by the top of a function lever, may be either normally open or normally closed. Operation of the functoin lever associated with the switch arm either opens or closes the contact pair. A break-before-make or make-before-break transfer may be obtained by employing two function bar mechanisms and two associated switch mechansims.

d. These electrical switches may, of course, be operated whether on a single-character code or a sequential basis. Also, the switch may be operated and returned to normal during the character cycle or it may be locked either closed or open.

55. BDIS RELAY OPERATION, GENERAL CONCEPTS.

a. General. The Service B Data Interchange System (BDIS) Area Center selective receive and transmit high speed (1071 WPM) traffic on the transcontinental circuits and distributes messages at low speed (100 WPM) to the cricuits it terminates. Each Area Center is equipped with low speed reperforators which record (in paper tape) information originated or a circuit and designated for relay. A high speed transmitter, physically coupled to the reperforator by means of a tape loop, retransmits, on the high speed circuit information collected on an associated low speed circuit. High speed reperforators located at the Area Center selectively record the high speed transmissions. The tapes resulting are retransmitted to the area circuits by low speed transmitters coupled to the high speed reperforators.

b. Basic Concepts of Message Coding. The users of BDIS are able to control the routing of their messages by using a prearranged system of coding which the equipment is designed to recognize. These character code groups, which are entered at the beginning and ending of the messages are made up of certain combinations of teletypewriter character symbols. The following symbols are used and perform specific functions related to message direction and handling.

< Carriage return
↓ Letters
≡ Line feed
↑ Figures
□ Blank

(1) Code groups and their purposes are:

(a) Condition code (<<↓)—This group causes the equipment to recognize the select code which immediately follows it.

(b) Select code—This group is a two-, three-, or four-character code which causes the equipment to react as follows:

***1* Two-letter codes** beginning with "K" or "Q" activate T/D's having traffic.

***2* Three-letter location identifiers**—This group start printers at the identified location and also start selected BDIS components.

***3* Four-letter codes**—This group, beginning with the letter "X" start reperforators at low-speed relay stations.

***4* The two-figure code** (the last two figures of a circuit number)—This group is used to divert traffic to an area circuit when failure occurs on a supplemental circuit.

(c) Synchronization code (↓<≡)—This group, sent immediately following each select code, synchronizes the equipment and prevents the next impulse from garbling.

(d) End-of-line code (↓<≡)—This group terminates intervening lines of a multi-line message.

(e) End-of-message code (≡<↓)—This group, somtimes called the "unlock" code, turns off the equipment that has been in use.

(2) The following examples illustrate the use of codes to accomplish certain functions. The examples codes used in this part are further identified as:

A—Condition code.
B—Select code.
C—Synchronization code.
D—End of message code.

(a) Message to a station on the same circuit:

Example:

"<<↓ (A) AUS (B) ↓<≡ (C) (Message) ≡<↓" (D)

(b) Message to two stations on the same circuit:

Example:

"<<↓ (A) AUS (B) ↓<≡ (C) <<↓ (A) SAT (B) ↓<≡ (C) (Message ≡<↓" (D)

NOTE.—In the above examples, the word "message" includes line feeds before the message, the preamble, the text, the signature, and the line feeds which follows.

56–60. RESERVED.

Chapter 3. MAINTENANCE PROCEDURES

Section 1. GENERAL TELETYPEWRITER EQUIPMENT

61. GENERAL.

The continuous and reliable operation of teletypewriter equipment is directly dependent upon uniform adjustment and measurement procedures. Technicians performing these adjustments should become thoroughly familiar with the test equipment and techniques involved. When improper adjustments are found, they shall be corrected to bring the equipment within prescribed tolerances.

62. PREVENTIVE MAINTENANCE.

Preventive maintenance is a routine of periodic inspections, cleaning, adjustments, and lubrication. The use of these procedures on a periodic basis will prevent many failures and allow optimum performance from the equipment.

63. INSPECTION.

Inspection is one of the most important operations in the preventive maintenance program. Maintenance personnel shall be trained to check for the required clearances, tensions, and adjustments of the various assemblies without overlooking the evidence of imminent failures. Inspection includes feeling for excessive heat, carefully observing and checking with tools, gauges, etc. all parts of the equipment. Inspect for following conditions:

a. Accumulations of dust, dirt, oil, grease corrosion, and other foreign materials.

b. Inadequate lubrication.

c. Excessive wear of all bearings, fittings, or moving parts.

d. Signs of abnormal adjustments or attitude of parts from their correct position.

e. The tightness of parts or assemblies that are fastened in a rigid position.

f. Clearances and spring tensions in accordance with specifications.

g. Overheating as indicated by feeling, discoloration, blistering oxidation of metal contact surfaces, etc.

64. LUBRICATION.

Lubrication requirements are covered in the applicable sections of the Teletypewriter Instruction Bulletins. The increase of operating speed to 100WPM has emphasized the problems caused by improper lubrication. Close adherence to the lubrication instructions specified in Teletype Corporation Bulletin is essential to prevent irregularities of operation or failure due to improper lubrication. The use of non-approved lubricants on Teletypewriter Equipment is prohibited, therefore, *no substitutes are authorized for the standard teletypewriter equipment lubricants, KS-7470 oil and KS-7471 grease.* At some locations, cleaning and lubrication may be required more frequently. Where this is necessary, the immediate supervisor should adjust the schedule to satisfy the need.

65. ADJUSTMENT.

Each adjustment shall meet all requirements as specified in the manufacturer's bulletins or instruction books. Where operational tolerances require a deviation from the manufacturer's specifications, the adjustment may be varied to meet the operational tolerance.

66. CLEANING.

This operation applies to all covers, panels, cabinets, internal equipment, electrical and mechanical parts. Cleaning is normally performed as part of the preventive maintenance schedule and should be accomplished when inspection reveals that it is required. Care must be exercised to prevent damage to plastic or rubber parts.

67. TROUBLE SHOOTING ON MODEL 28 PRINTER.

Most adjustments on the Model 28 will remain within specified limits for the life of the equip-

ment and do not require checking unless trouble becomes evident. Missing springs are the most common troubles. A list of failures and their probable causes follow:

a. Failures:

(1) Motor fails to start:

(a) Power Failure—Check for 115V 60 cycle applied voltage.

(b) Reset motor thermal cutouts.

(c) Fuse Failure—Check power distribution fuses. If open, rotate motor by hand to check for excessive load.

1 Stop magnet, line shunt relay and signal bell magnet—check for shorted windings.

(d) Check start relay and capacitor.

(e) Motor—shorted windings.

(2) Short on Selector Range:

(a) Line current—high or low.

(b) Shorted selector magnet coils.

(c) Armature dirty or oily. (Clean with a clean piece of paper).

(d) Check LSU, DC output voltage and percentage of ripple.

(e) Binds in code bar linkage. (Check for freeness).

(f) Adjustment—

1. Selector magnet bracket
2. Selector armature bracket
3. Selector armature spring
4. Latch lever spring
5. Start level spring

(3) Intermittent Errors:

(a) Range finder set beyond limits.

(b) Line current—high or low.

(c) Shorted selector magnet coils.

(d) Armature dirty.

(e) Binds in selector and code bar linkage.

(f) Adjustments—

1. Selector magnet bracket
2. Shift lever link guide
3. Code bar detent
4. Selector push lever spring
5. Selector transfer lever spring

(4) Gaining or Losing a Pulse:

(a) Binds in moving parts of selector and code bar linkage on particular pulse in trouble.

(b) Adjustments—

1. Selector magnet bracket
2. Shift lever guide link
3. Code bar detent
4. Selector push lever spring
5. Selector transfer lever spring

(5) Garbling:

(a) Incorrect line current.

(b) Defective selector magnet coils.

(c) Range finder setting out of range.

(d) Armature dirty.

(e) Binds in moving parts of selector and code bar linkage-check for freeness.

(f) Adjustments—

1. Selector armature
2. Code bar detent
3. Armature spring
4. Latch lever spring

(6) Spacing Incorrectly:

(a) Binds in moving parts of spacing chain of linkage-check for freeness.

(b) Adjustments.

1. Spacing lever bail cam plate
2. Spacing clutch trip lever
3. CR lever
4. Spacing trip lever spring
5. Spacing trip lever bail spring
6. Spacing feed pawl spring
7. Clutch trip shaft set collar
8. Function stripper blade cam position
9. Function bar spring

(7) Failure on LTRS-FIG Shift:

(a) Binds in moving parts of LTRS-FIG shift linkage—check for freeness of selector and code bar linkage, and LTRS and FIGURES function slide.

(b) Check left and right breaker slide bails and springs.

(c) Adjustments.

1. Function stripper blade driving link
2. Shift code bar operating slides
3. Function lever spring
4. Function pawl spring
5. Function bar spring

(8) CR Failure: Probable causes.

(a) Binds in moving parts of linkage for CR function. Check for freeness of selector and code bar linkage, function bar reset bail and function bar linkage in stunt box and CR bail and slide.

(b) Adjustments.

1. Function reset bail blade
2. Function lever, function pawl and function bar springs

3. CR lever
4. CR latch bail
5. CR spring

(9) LF Failure: Probable causes.

(a) Binds in moving parts of linkage for the LF function. Check for freeness of selector and code bar linkage, function bar reset bail and function bar linkage in stunt box, LF function slide arm and LF clutch trip lever, LF bars and LF stripper and stripper bail, position of single-double LF lever.

(b) Adjustments.

1. LF clutch trip lever eccentric post
2. LF clutch trip lever adjusting screw
3. Stripper blade arm
4. Function bar, pawl
6. Single-double LF stripper bail

(10) Signal Bell Failure:

(a) Electrical contacts on stunt box.

(b) Open magnet in signal bell.

(c) Low voltage.

(d) Bell armature dirty.

(e) Binds in moving parts of signal bell linkage—check for freeness of selector code bar linkage—function bar reset bail, function bar linkage and armature in signal bell assembly.

(f) Adjustments.

1. Function reset bail blade
2. Bell contact
3. Remote signal bell
4. Remote signal bell armature spring
5. Function bar, pawl and lever spring

(11) Stunt Box Switch:

(a) When installing a new stunt box switch, if too much heat from soldering iron is applied to the contact spring the spring pressure will be decreased and eventually cause intermittent contact failure.

(12) Irregular Left Hand Margin:

(a) Overwriting or irregular left margin. Check the dashpot cup for scored edge and replace if necessary.

(b) Adjustments.

1. Dashpot
2. Spring drum pressure. Adjust this pressure to approximately 2 lbs.
3. Adjust wire rope tension
4. Front plate.

68. RELAY ADJUSTMENTS.

a. Object. To adjust the relays of the transmitter control group relay panel.

b. Discussion:

(1) This paragraph outlines a procedure for maintenance and adjustments of the Busy-Line (BL) Relay and provides instructions on how to correct a deficiency in the relay.

(2) The "BL" Relay used in the transmitter control group relay panel has presented many problems due to the drop out time intermittently exceeding 500 milliseconds. These adjustment procedures and the instructions for trueing the pole face will improve the relay operation. If it becomes necessary to replace either the "BL" or "OL" relay, the relay group shall be modified per Teletype Corporation specification 501525, Issue 1 dated June 1963 and AF P6620.1 Chapter 78. The relay group will then meet the FAA standard.

(3) The general instructions and techniques outlined in this paragraph are applicable to other relays of the group.

c. Test Equipment Required:

Model 14 or ED-200—Transmitter-Distributor.

Printer.

Miscellaneous relay maintenance tools.

d. Conditions.

(1) Relay removed from cabinet and adequately supported for ease of adjustment.

(2) Performance tests to be conducted on dummy circuit using a special test tape.

e. Detailed Procedures.

(1) **Armature airline adjustment.** The clearance between the end of the heelpiece and the armature when the armature is closed against the polepiece, is known as the airline. The following steps outline airline adjustments procedures: See figure 6.

(a) Loosen the clamping screw that holds the armature to the heelpiece.

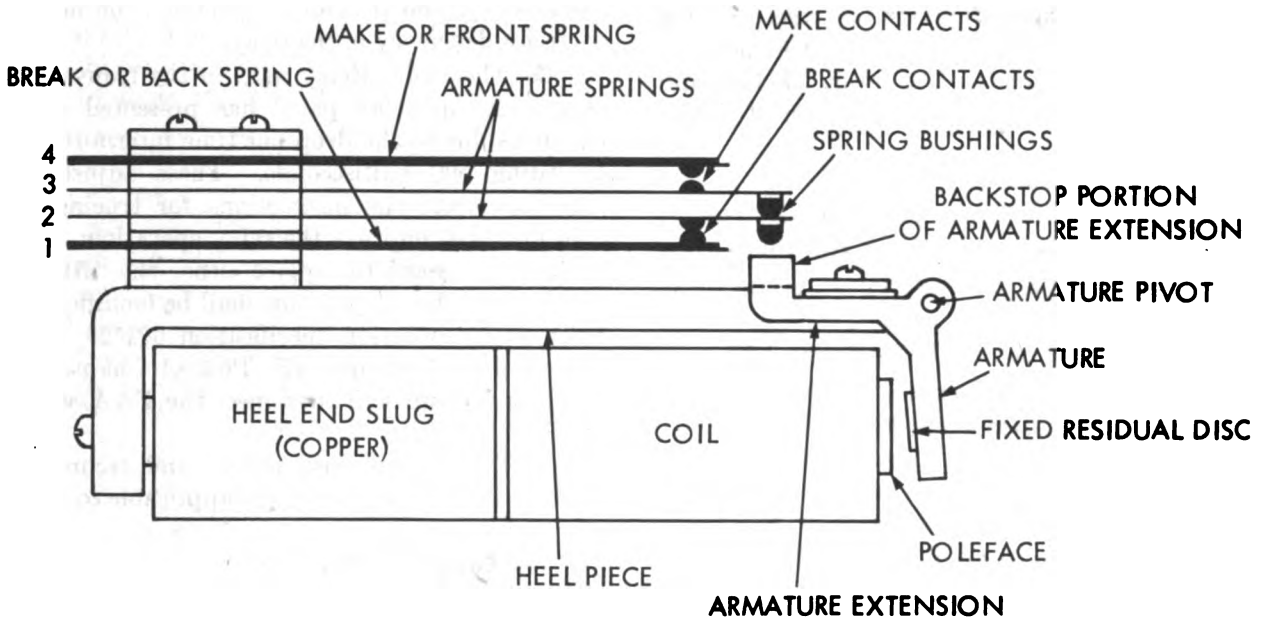
(b) Place a .0015 inch thickness gauge in the airline gap so that it extends over the entire width of the heelpiece.

(c) Press the armature firmly against the gauge and heelpiece.

(d) Tighten the armature clamp screw.

(e) Remove the gauge and check the airline visually while holding the armature closed.

"BL" RELAY



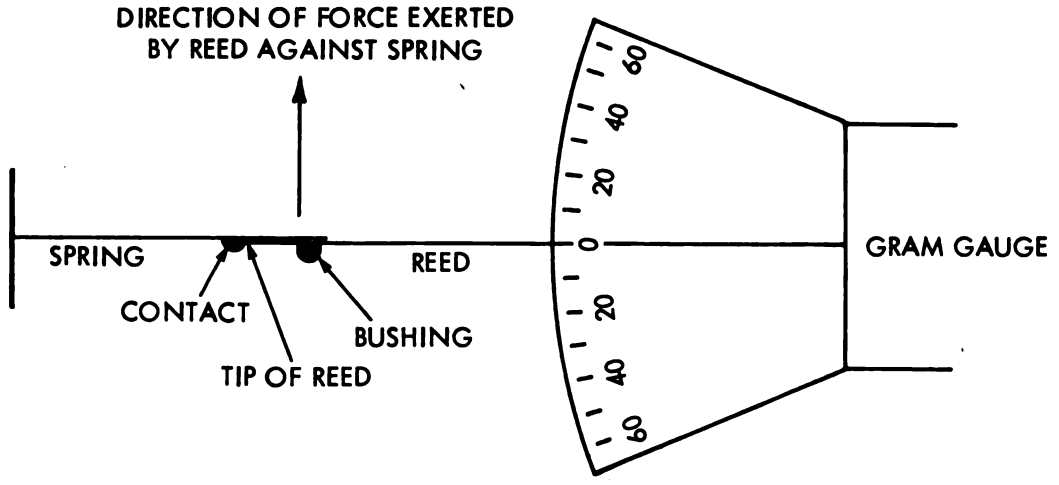
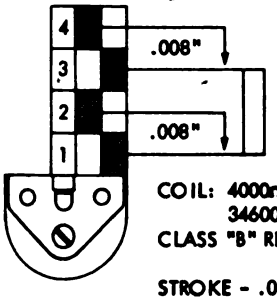


FIGURE 6. BL Relay.

ALL RELAYS (VIEWED FROM THE REAR)
NOMINAL VOLTAGE 48 VOLTS D.C. -60 ma CURRENT
CONTACTS: 18 GAUGE
RATING: 135 WATTS (NON- INDUCTIVE)
3 AMPS.

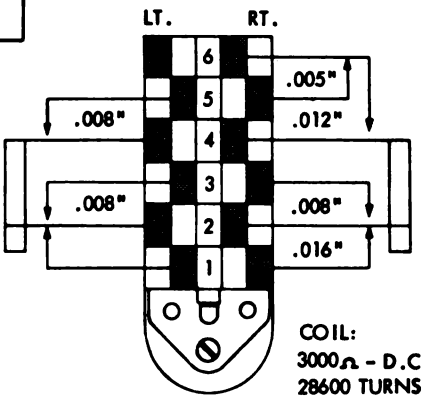


COIL: 4000Ω- D.C. RESISTANCE
34600 TURNS - #38 E.C. WIRE
CLASS "B" RELAY - TYPE 57 AL

STROKE - .014"
RESIDUAL DISC - .003"
TEST FOR: (CURRENT VALUES IN AMPS)
OPEN .00301 (READJUST) .00324 (TEST)
NOT OPEN .00254 (READJUST) .00231 (TEST)

160325 - "RS 1" RELAY

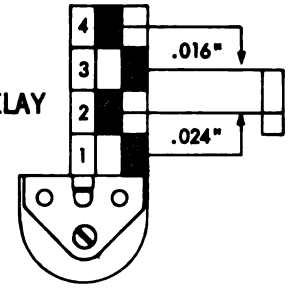
160326 - "ST" RELAY



COIL:
3000Ω - D.C. RESISTANCE
28600 TURNS - #38 E.C. WIRE

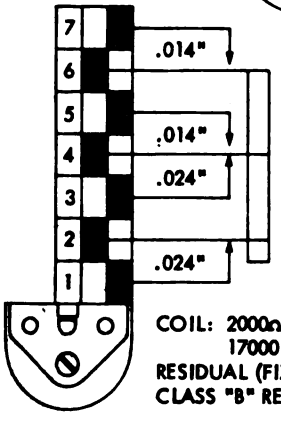
STROKE - .026"
RESIDUAL DISC - .003"
TEST FOR: (CURRENT VALUES IN AMPS)
OPEN .00682 (READJUST) .00435 (TEST)
NOT OPEN .00577 (READJUST) .00525 (TEST)

160329 - "BL" RELAY



COIL: 2000Ω- D.C. RESISTANCE
17000 TURNS - #39 E.C. WIRE
RESIDUAL (FIXED): 1 1/2" HEEL END SLUG
CLASS "B" RELAY - TYPE 57 AS

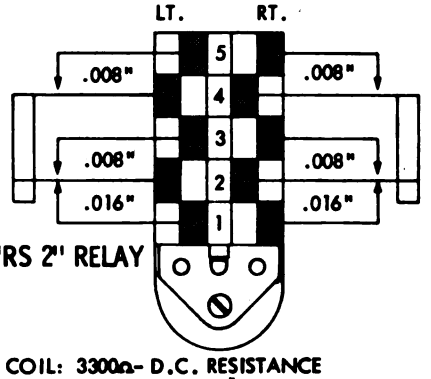
STROKE - .044"
RESIDUAL DISC - .003"
TEST FOR: (CURRENT VALUES IN AMPS)
OPEN .00705 (READJUST) .00735 (TEST)
NOT OPEN .00618 (READJUST) .00588 (TEST)
HOLD .00104 (READJUST) .001064 (TEST)



160328 - "OL" RELAY

COIL: 2000Ω- D.C. RESISTANCE
17000 TURNS - #39 E.C. WIRE
RESIDUAL (FIXED): 1 1/2" HEEL END SLUG
CLASS "B" RELAY TYPE 57 AS

STROKE - .044"
RESIDUAL DISC - .003"
TEST FOR: (CURRENT VALUES IN AMPS)
OPEN .0077 (READJUST) .0080 (TEST)
NOT OPEN .00617 (READJUST) .00588 (TEST)
HOLD .00152 (READJUST) .00156 (TEST)



160964 - "RS 2" RELAY

COIL: 3300Ω- D.C. RESISTANCE
28000 TURNS - #38 E.C. WIRE
RESIDUAL (FIXED): .003" HEEL END SLUG
CLASS "B" RELAY TYPE 57

STROKE - .026"
RESIDUAL DISC - .003"
TEST FOR: (CURRENT VALUES IN AMPS)
OPEN .00682 (READJUST) .00435 (TEST)
NOT OPEN .00577 (READJUST) .00525 (TEST)

FIGURE 7. Relay Group Adjustments.

(2) The armature residual disc should contact evenly on the pole face. The armature should NOT contact the pole face. If the armature does, the relay is defective and should be replaced. In the event a spare relay is not immediately available, the relay may be corrected by the following procedure:

(a) Loosen and remove the clamp screw that holds the armature to the heelpiece.

(b) Remove the armature.

(c) With a file or carborundum stone true the pole face at the point where the armature contacts the pole face. CAUTION: Do not overfile the pole face or the relay will be damaged.

(d) Replace armature and clamp screw. Tighten clamp screw friction tight and repeat (1) (a) through (e).

(3) Contact assembly adjustment. Before adjustments are made, all break and make springs should be set parallel to the heelpiece by bending them adjacent to the pile-up. Reference figures 6 and 7.

(a) The contact pressure should be measured as indicated in figure 7 and should be 30 ±1 gram.

(b) The contact pressure should be noted at the instant the break contacts open and the make contacts close.

(c) If contacts are only slightly out of adjustment, they should be corrected by using a spring bender to put a small bend in the spring adjacent to the pile-up. Avoid kinking or twisting the springs.

(d) Use only the proper relay tools. Damage may result from the use of any other tools for relay adjustments.

(4) Spring tension. Adjust the tension of all armature springs, starting with the one nearest to the heelpiece:

(a) Place the slot of the spring bender over the armature spring near the pile-up.

(b) Tilt the spring bender slightly toward the armature and draw it down the spring toward the contact end. This should produce a smooth curve in the spring with the concave side toward the armature.

(c) Again place the slot over the spring, and tilting the spring bender away from the armature, draw it toward the contacts. The spring will be straightened and tensioned toward the armature extension.

(d) Measure the spring tension and repeat the above procedure if the tensions are less than 30 ±1 gram. Reverse the procedure above by tilting the bender in the opposite direction if the tensions are greater than 30 ±1 gram.

(5) Armature stroke adjustment.

(a) Insert a .020″ and a .024″ feeler gauge (total .044″) between the armature and the poleface, and operate the relay manually.

(b) Bend the armature extension with an armature bender so that the backstop portion of the extension rests against the heelpiece.

(6) Contact gauging. The following gauging tests are subject to the requirement for a total contact spring pressure of 60 ±2 grams:

(a) Insert a .024″ feeler gauge between the armature fixed residual disc and the poleface.

(b) Operate the relay manually. The break contacts should just open.

(c) Adjust by bending the first or back spring near the pile-up.

(d) The break contacts should not open when the .024″ gauge is replaced by a .025″ gauge.

(e) Insert a .016″ feeler gauge between the armature fixed residual disc and the poleface.

(f) Operate the relay manually. The make contacts should just close. If not, adjust by bending the make or front spring near the pile-up.

(g) The make contacts should not close when the .016″ gauge is replaced by a .017″ gauge.

(7) Operational Evaluation.

(a) After completing the above adjustments, the operation of the relay should be checked under normal operation.

(b) Connect the relay group with its associated printer and a transmitter distributor to the dummy circuit. The ED–200 or Model 14 may be used to check the timing.

(c) When using the ED–200, the distortion switch should be set for "zero" distortion. Install a clip lead on the under side of the distributor between the STOP and START segments of the test T.D.

(d) Perforate a continuous tape with

enough blank characters between each group for separation. It should be made up as follows:

1. Alternately punch 1 blank and 1 letter character 10 times.

2. Alternately punch 1 blank and 2 letter characters 10 times.

3. Alternately punch 1 blank and 3 letter characters 10 times.

4. Alternately punch 1 blank and 4 letter characters 10 times.

5. Alternately punch 1 blank and 5 letter characters 10 times.

(e) Switch the printer with the relay group to be tested into the dummy circuit along with the testing T.D. Start the test tape transmission and observe the Busy-Line Indicator on the printer cabinet for an idle-line or busy-line condition. When the busy-line light is extinguished during the test tape transmission, the number of letters that were transmitted at that time will indicate the release time of the BL relay. Refer to step (f) for converting the letter characters transmitted into milliseconds elapsed time.

(f) At 100 WPM (600 RPM) each cycle of the T.D. distributor will represent approximately 100 ms. Strapping together the STOP and START segments and sending letter-blank impulse combinations, produces the following usable mark time intervals for checking the BL relay:

BL 1 LRT = 132.5 ms.
BL 2 LTRS = 232.5 ms.
BL 3 LTRS = 332.5 ms.
BL 4 LTRS = 432.5 ms.
BL 5 LTRS = 532.5 ms.

69. TEST AND ADJUSTMENT PROCEDURES FOR THE 33RY RELAY.

a. Object. To test and adjust the 33RY line relay.

b. Discussion. The following references should be consulted before performing the procedures. (Note, however that Bulletin 259B is written primarily for procedures using the Automatic Electric SK-27-35A Relay Test Set, which is not available in the FAA):

(1) Instruction Manual for Printer Test Set used, and

(2) Teletype Corporation Bulletin 259B, Description and Adjustments of 33RY Polar Relay. Evaluation of the unmodified CA-405 and the CA-1385 Printer Test Sets show that they have a definite application in the adjustment of the magnetic balance (armature) and the contacts of the 33RY relay. The "Contact Test" of the CA-405 results in a meter deflection in excess of ten divisions. This is due to the tungsten carbide contact material; therefore, this particular test feature will be disregarded.

(3) Do not install or remove the 33RY relay from the printer or test set with the relay cover off. Accidental pressure on the exposed armature spring holder will upset the armature adjustment (magnetic balance).

c. Test Equipment Required. Printer test set and miscellaneous relay adjustment tools.

d. Conditions. Relay removed from circuit and mounted on the test set.

e. Detail Procedures.

(1) Relay Test.

(a) Install a 33RY in the Printer Test Set and remove the cover. Arrange the Test Set for "Relay Test," but leave the ac off. Alternately hold the Mark and Space contacts closed with an orange-wood stick and adjust the potentiometer for full scale meter deflection on the contact giving the highest reading. Pitted or dirty contacts will cause unequal deflection or a wavering indication on the meter. Do not clean contacts at this time. Check the Test Set batteries if unable to obtain full scale deflection.

(b) Alternately close the mark and space contacts using the orange-wood stick. When the stick is removed, the armature should remain in the selected position. A further check is to turn the ac power On and Off repeatedly so that the armature will come to rest on the mark or space contact at random. If this test fails, then the armature magnetic balance is off. The unbalance may be caused by magnetic particles lodged between the pole piece and the armature or the armature spring being out of adjustment or damaged. A complete armature-pole spacing adjustment is required to correct unbalance.

(c) Turn the ac power On and adjust the current to the correct value. The meter should hold at zero $\pm\frac{1}{2}$ division. If the meter fluctuates, the contacts are dirty. If the meter holds two or three divisions from zero, the contact adjustment must be re-made.

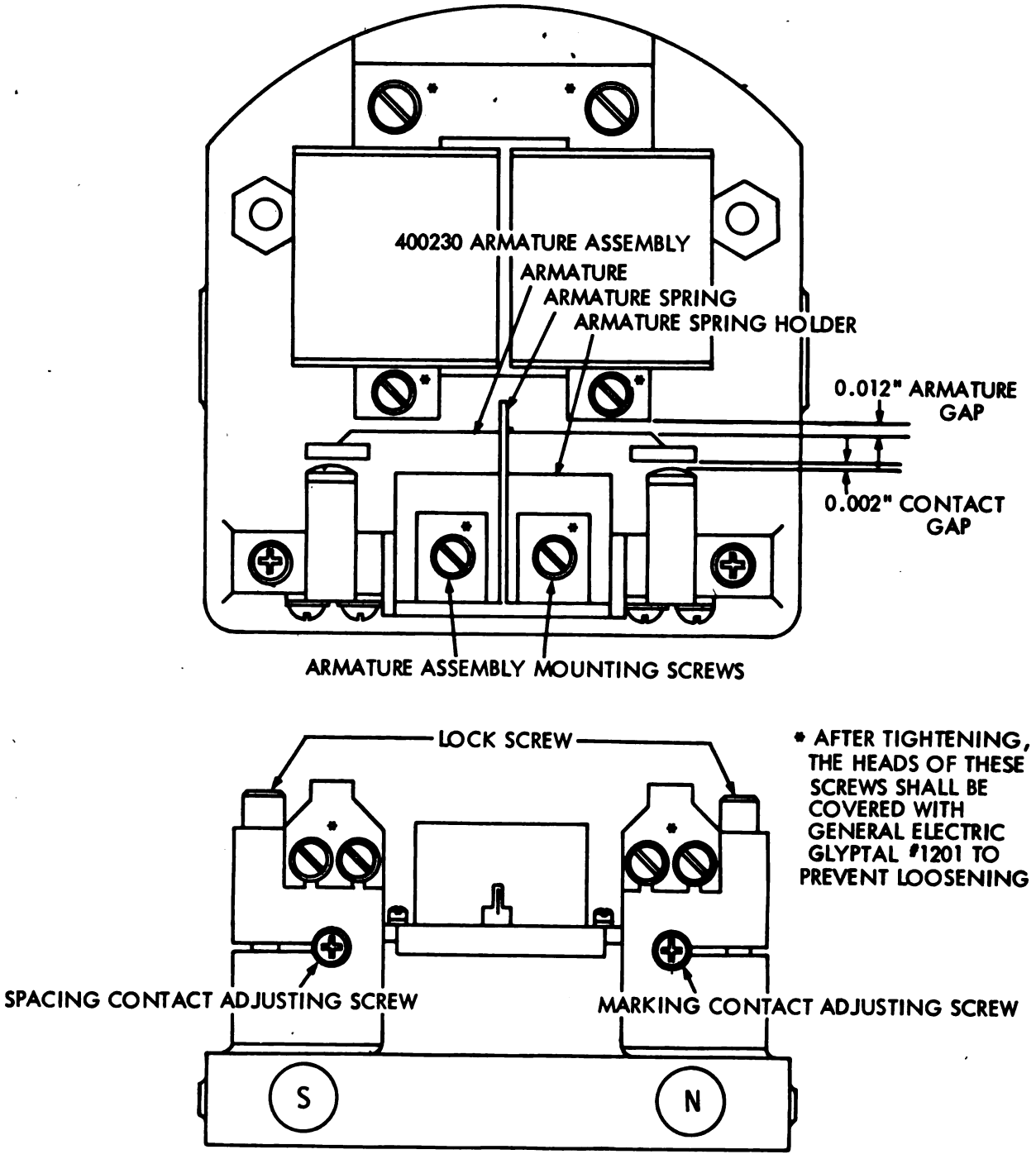
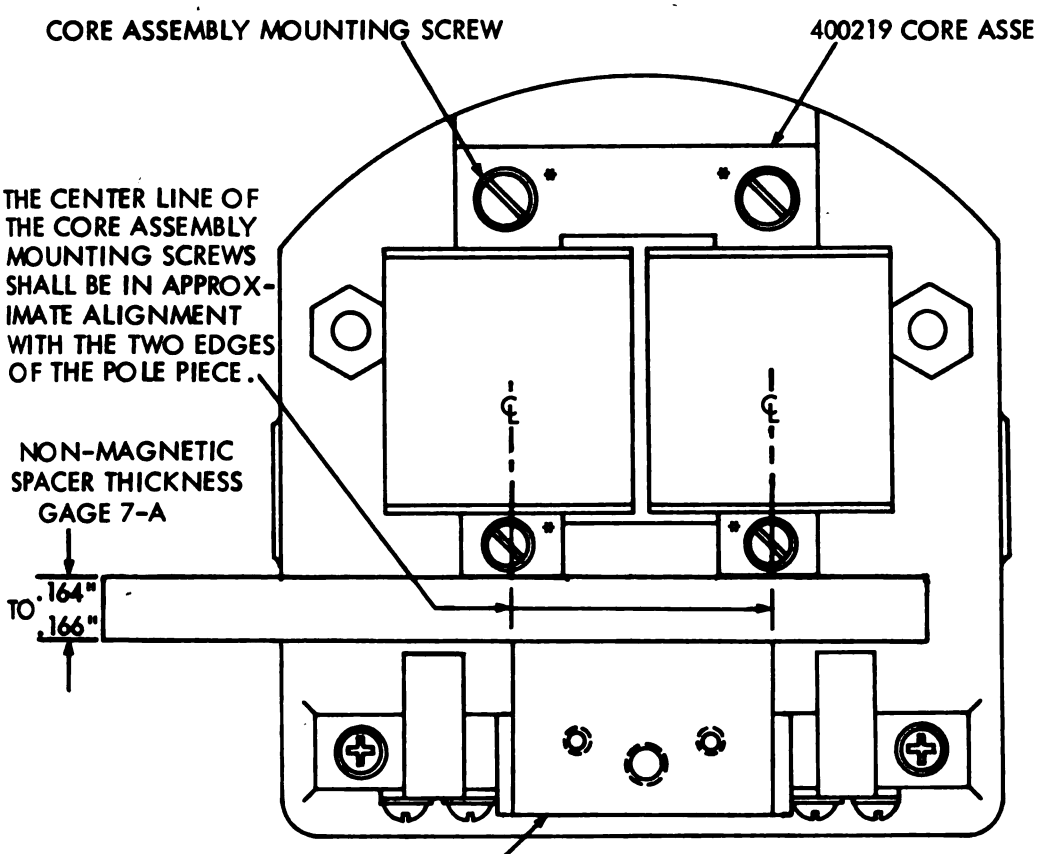


FIGURE 8. Maintenance Adjustments 33RY Relay.



INITIAL ALIGNMENT

THE ALIGNMENT OF THE CORE ASSEMBLY AND POLE PIECE TO THE RELAY BASE IS MADE WITH THE 0.164" SECTION OF THICKNESS GAGE 7-A AT THE TIME OF MANUFACTURE BY POSITIONING THE FOUR CORE ASSEMBLY MOUNTING SCREWS AND THE POLE-PIECE MOUNTING SCREW. WHEN THIS ALIGNMENT IS MADE, GENERAL ELECTRIC GLYPTAL #1201 IS APPLIED TO THE CORE ASSEMBLY SCREWS AND THE POLE PIECE IS BONDED TO THE RELAY BASE WITH MINNESOTA MINING AND MFRG. CO. EC-711 METAL TO BAKELITE CEMENT TO ASSURE TIGHTNESS OF THESE PARTS. THIS ALIGNMENT WILL NOT NORMALLY CHANGE AND THESE SCREWS SHALL NOT BE LOOSENED EXCEPT WHERE THIS ALIGNMENT IS FOUND TO BE OFF OR WHEN THE CORE ASSEMBLY IS DISMANTLED FOR REPAIR AND REPLACEMENT OF PARTS. WHEN THIS IS NECESSARY, THE RE-ALIGNMENT SHALL MEET THE ABOVE REQUIREMENTS AND THE PARTS SHALL BE SEALED AS DESCRIBED ABOVE.

FIGURE 9. Initial Alignment 33RY Relay.

(a) Alignment of the core assembly and coils requires a special non-magnetic gauge. Re fer to figure 9. Do not upset this adjustment except in an emergency; otherwise, an Exchange and Repair transaction will be in order.

(b) Refer to figure 8 for the armature and contact adjustment tolerances.

(c) Loosen the contact lock screws and back out the contact adjusting screws at least two turns.

(d) If the relay has been in use for some time, the contacts and the armature should be removed for a close examination. Inspect the contact surfaces with a magnifying glass. If it is worn smooth, the part may be reused, but if it is pitted or has a build up, the part should be discarded. Do NOT attempt to sandpaper, file, or use a stone on the contact surfaces. Wipe the contacts with a lint-free material.

(e) Remove magnetic particles from the pole piece and the core pieces by pressing a piece of friction tape on the surface and peeling it off. Use the tape only ONE time and do not wipe the surface with the tape.

(f) Install the armature with the mounting screws left loose. If the armature was not removed, loosen the mounting screws. Full freedom of movement is very important.

(g) Place the special dual .012″ armature gauge between the armature and both pole pieces. Press both ends of the armature against the gauge with the orange-wood stick. Align the armature symmetrically with respect to the core pieces. Do not press against the armature spring holder to align the armature. Tighten the armature assembly mounting screws carefully and leave the dual guage in place.

(h) Position the Mark and Space contacts symmetrically with respect to the contact surfaces on the armature. With the contact adjusting screws, move the Mark and Space contacts to within .002″ of the armature. Two .001″ thickness gauges may be used.

(i) Remove the gauges and check the relay as described in paragraph 4, RELAY TEST. If the armature magnetic balance is off,the adjustments will have to be remade. If the meter deflection from zero is greater than two divisions, the adjustment should be remade. If the meter deflection is less than two divisions, adjust for an indication of zero by increasing which ever contact gap will produce the desired results. Do not *decrease* the contact gap to less than .002″ because undesirable arcing may occur. If the meter deflection fluctuates several divisions rapidly or drifts several divisions slowly, the adjustments should be remade.

(j) Install the relay in a printer known to be in good condition and observe the printers' operation. Check the RAS range of the printer and compare it with previous operations.

70. CODE BAR TO FUNCTION TINE ALIGNMENT.

a. Object. To adjust the alignment of code bars for positive control of the stunt box functions.

b. Discussion. Proper alignment of code bars to function tines is required for positive control of the stunt box functions. Excessive misalignment is characterized by intermittent and extraneous function selections while the printing operation remains normal. Abnormal function selections may appear as infrequent intermittent misses and may be associated with functions on the left side, right side, or in the middle of the stunt box depending on the code bars to function tines alignment in those areas.

c. Test Equipment Required. Teletypewriter tools.

d. Conditions. Printer removed from circuit.

e. Detailed Procedures.

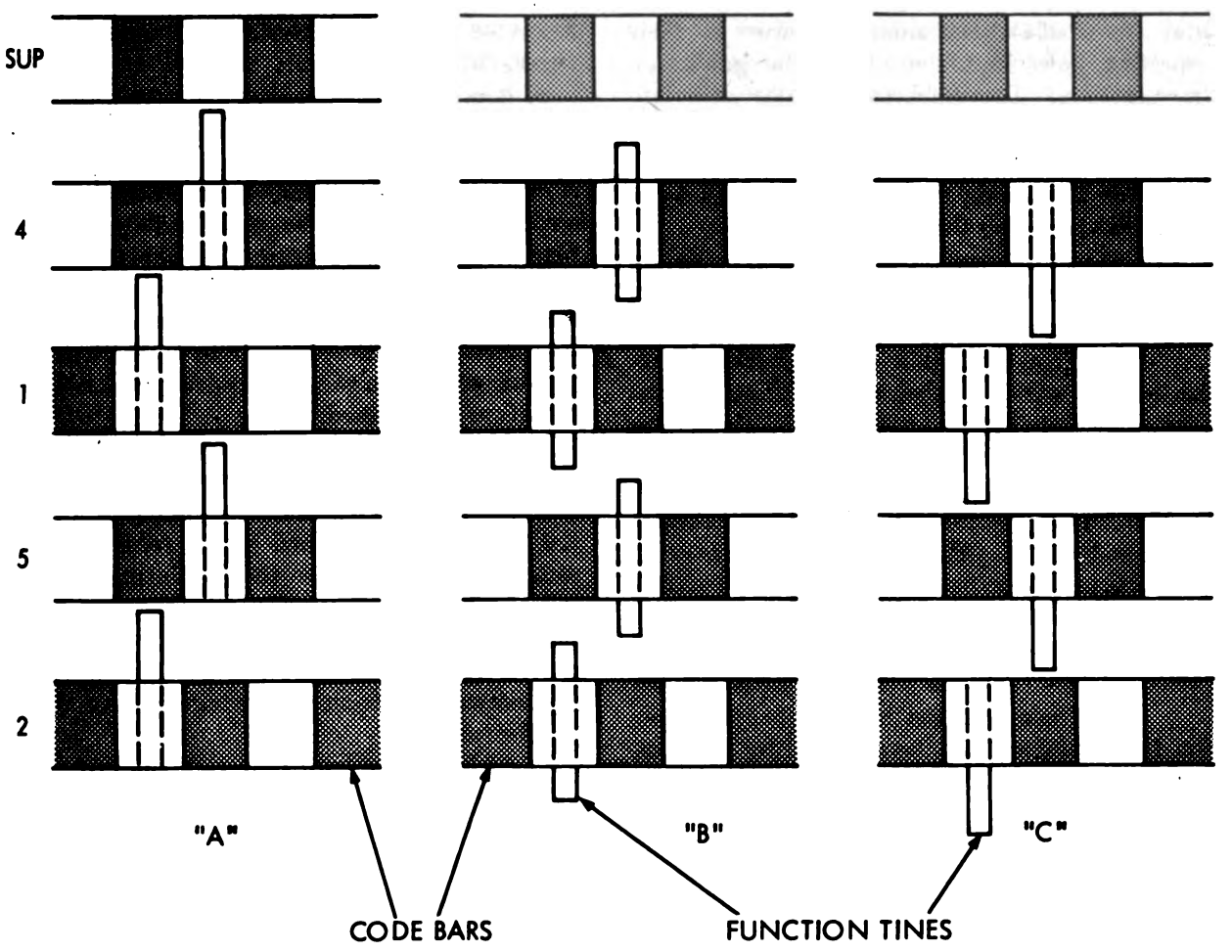
(1) Alignment of the code bars to function tines must be checked with the front plate removed. This adjustment should be such that each function tine clears the adjacent code bar by at least .020″ when the tine is positioned manually for minimum clearance. Adjacent code bars are those above or below the code bar used to operate the function tine in question. See figure 10.

(2) When correct clearances cannot be achieved, parts with excessive wear should be replaced. Excessive wear on the following parts affects clearances:

(a) The stunt box guide plate 152651 may wear in the bottom of the groove from the function tine sliding action.

(b) The function tines may wear at points of contact with the code bars and the guide plate.

(c) The code bar brackets 152576 (right



PARTIAL SKETCHES OF FUNCTION TINE - CODE BAR ALIGNMENT AS VIEWED FROM FRONT OF PRINTING UNIT, WITH FRONT PLATE REMOVED. SKETCH IS ENLARGED TO BETTER DISPLAY ALIGNMENT RELATIONSHIPS.

SKETCHES A AND C SHOW INCORRECT ALIGNMENT.
SKETCH B SHOWS OPTIMUM ALIGNMENT.

FIGURE 10. Alignment of Function Lever Tines to Code Bars—M28 Printers.

side) and 152575 (left side) may wear in their respective holes and slots from the guides on the stunt box. The brackets may also wear into the code bar slots from sliding action of the code bar.

(d) The guide bracket 150304 may wear in the slots receiving the code bars.

(3) When adequate clearance cannot be obtained by replacing worn parts, the following adjustments are applicable:

(a) When alignment of code bars to function tines is within tolerance at the left and the right sides but out of tolerance in the center portion, raise or lower guide bracket 150304. The guide bracket is *raised* by inserting spacers between tie bracket 153321 and code bar brackets 152575 and 152576. The guide bracket is *lowered* by inserting spacers between guide bracket 150304 and tie bracket 153321. Retainer rings 119652 may be used as spacers. The rings may be inserted without complete removal of the screws.

(b) Minor changes in code bar to function tine alignment can be obtained by the positioning of side brackets 152627 and 152626 on the stunt box assembly. The side brackets can be moved about the mounting screws 151657 after the screws are loosened. The loose fit of the side brackets allows rotational play about the screws. Raising the front part of the side bracket lowers the function tines. The screws must be tightened at the proper position of the side brackets to retain the desired adjustment.

(c) Testing. Code Bar and Transfer Lever Selections. Tape can be prepared to operate the M-28 printer code bars and transfer levers at slow speed, which will materially aid in the diagnosis of intermittent trouble by observing the travel and frequency of the selected functions. Punch a test tape with the following group of characters:

5 CR,	5 blank spaces	(5 times).
5 E's	5 blank spaces	(5 times).
5 T's	5 blank spaces	(5 times).
5 LF's	5 blank spaces	(5 times).
5 LTRS,	5 blank spaces	(5 times).

With the test tape in operation, observe code bar operation recalling a mark signal moves the code bars to the left and a space signal moves the code bars to the right.

71. WIRE ROPE REMOVAL AND INSTALLATION PROCEDURE.

a. Removal:

(1) With front plate mounted on printer, remove the dashpot cylinder.

(2) Position the margin indicator cam disk on the spring drum so a screwdriver may be placed through the drum to hold its position rigid. This is necessary to prevent loss of spring tension when removing the wire rope and to fix the position of the spring drum so the wire rope holding screws on the spring drum and the spacing drum are exposed.

(a) Observe and mark the location of the oscillating rail slide with respect to the oscillating rail. This is necessary so the point at which the wire rope is attached can be returned to the same position. Remove the oscillating rail slide retaining plate.

(b) Remove both wire rope holding screws on the spring drum. Caution: Do not remove the screwdriver from the spring drum or tension will be lost.

(c) Remove both wire rope holding screws on the spacing drum. Both ropes should now be free from the unit.

b. Installation: (Printer in upright position.)

(1) **Upper rope:** Make a loop in the rope and taking both ends, attach them together and mount them in the anchor hole in the spacing drum. Thread the two loop leads into their respective slots around the drum; one threaded out the back and one out the front. Place these leads in their proper pulleys and down and around the spring drum. Attach the end loop in the rope to its anchor point on the outer perimeter of the spring drum. Leave the holding screw loose enough to perform the wire rope tension adjustment at a later period in time.

(2) **Lower rope:** Installation can be accomplished by anchoring one end of the rope to its anchor point on the spacing drum. Thread the rope around the spacing drum in the front slot and along the outermost edge of the slot, assuring that the lower rope does not cross over the upper rope. Thread the rope over and into the front slot of the spring drum making sure it is positioned along the outermost edge of the slot. Anchor the end of the rope to the mounting hole on the front of the drum. Position the

lower rope in the tensioning pulley. It may be necessary to position the front, left and right rail pulley towards each other to accomplish this. Reposition the front rail pulleys to their respective positions in their elongated mounting holes.

(3) Check and adjust for equal tension on the two ropes feeding across the top of the front plate. After adjustment, tighten down the holding screw on the outer ring surface of the spring drum.

(4) Position the oscillating rail slide to the indicating mark made on the rail prior to rope removal.

(5) Install the retaining plate on the oscillating rail and slide, anchoring the wire rope to the slide.

(6) Performing associated adjustments: If the wire rope tension was the same on both leads prior to upper-rope removal it may be necessary to check and adjust the following in accordance with Teletype Bulletin 217B instructions:

(a) Left margin.

(b) Right margin.

(c) Print carriage position.

(d) Margin indicator cam disk.

c. Performance Checks: After the screwdriver is removed from the spring drum, manually position the print carriage from the left to the right extreme of its travel and visually check the action of the upper and lower wire rope.

72–85. RESERVED.

Section 2. BDIS EQUIPMENT

86. GENERAL.

The continuous and reliable operation of BDIS equipment is directly dependent upon uniform adjustments and measuring procedures. The procedures outlined herein are those which should be used by the technician in adjusting and maintaining the BDIS equipment to the standards prescribed in chapter 4. It is imperative that the technican be thoroughly familiar with the test equipment and techniques involved, to avoid damage to the test equipment or to the equipment comprising the system. Conditions such as damaged or deteriorated parts, unauthorized modifications, loose connections, defective wiring or non-standard replacements detract from the normal efficiency and reliability of the system. The presence of such deficiencies constitutes an unsatisfactory condition demanding that prompt and effective corrective action be taken.

87. ADJUSTMENTS.

The adjustments and procedures set forth in the manufacturer's bulletins and specifications have proven adequate for the various electromechanical equipments utilized in the BDIS facility and are listed in tables 1 and 2 for convenient reference.

Table 1

Equipment	*Bulletin, specification, or paragraph*
Automatic Program Unit, High Speed Monitor (APUHS)	277B
Stepping Switches	Pages 4/51–4/56
High Speed Reperforator (DRPE)	50167S
High Speed Tape Reader (CX)	267B
Line Relay (RY33)	259B
Low Speed Non-Typing Reperforator (LRPE)	256B
Low Speed Transmitter-Distributor (LBXD) .	243B
Synchronous Motor (LMU)	243B
Tape Handling Stand (LTHS)	248B
Tape Splicer (LTS)	257B

The electronic adjustments for the BDIS facility as found in Teletype Corporation's bulletin 277B, Volume 2, and various specification publications are listed in tabular form for convenient reference.

Table 2

Adjustment	*Module*	*EC Card Position*	*Bulletin 277B Page No. or *Spec.*
Bit Timer	HISRED	Z1330	4–38
Bit Timer	HISTRAD	Z1403	4–27, 4–28
Character Sample Delay	Access II	Z2908	4–74
Feed-Out Timer	Access II	Z2921	4–71
Feed-Out Oscillator	Access II	Z2923	4–72
Gated Oscillator	MULSRED	Z5723	4–59
Idle Line Timer	Access II	Z2922	4–70
Inhibit Current	COPS	R2201 thru R2248	*60224S
Oscillator Control	MULSRED	Z5719	4–62
Output, −12 volt	MVPS II		4–7
Output, +6 volt	MVPS II		4–8
Output, +1.5 volt	MVPS II		4–8
Output, +1.5 volt	MVPS III		4–15
Punch Control	HISPUC II B	Subassemblies I & II, R5400, R5401, & R5402	4–17
Reset Delay	HISRED	Z1329	4–38
Sample Delay	HISTRAD	Z1412	4–26
Sequence Period Timer	CODCON I	Z2401	*60224S
Stop Inserter	HISRED	Z1324	4–36
Start Sample Delay	HISRED	Z1325	4–37
Stop Timer	HISTRAD	Z1414	4–25
Transfer Prime Delay	Access II	Z2928	4–73
Unijunction Bit Timer	MULSRED	Z5720	4–60 or 4–61
Unijunction Bit Timer	MULSTRAD	Z5821	4–65 or 4–66

88. REPAIRS TO TRANSISTORIZED EQUIPMENT.

The repair procedure for transistorized equipment differs from conventional repair practices. Transistors can be permanently damaged if handled improperly. When soldering or unsoldering transistor leads, it is important to prevent excessive heat from reaching the transistor. Use long-nose pliers to grasp the transistor leads between the soldered connection and the body of the transistor; thus, the pliers act as a heat sink

and prevent damage to the transistor. The use of a low wattage (25 or 37½ watts) soldering pencil is recommended when making transistor connections. Also of importance is the use of the soldering iron at its correct operating temperature and the application of heat only long enough to establish a good solder joint. Solder having a low melting point is recommended. Solder for printed circuit repair, having a content of 3% silver, 61.5% tin and 35.5% lead, is available from normal supply sources. When replacing parts other than transistors on the EC Cards, exercise care that adjacent transistors are not overheated. Occasionally it will be necessary to remove an adjacent transistor in order to replace another part. Extreme care should be exercised when soldering directly to the foil of an EC Card, as the foil is easily damaged. If space permits use of the leads of the old part in connecting a new part, this method is recommended (clip off leads of old part as close as possible to the body of the faulty unit, twist leads of old and new parts together, trim excess wire, and solder). Breaks in the foil circuitry may be repaired temporarily by soldering in a length of wire as a jumper to re-establish continuity.

89. TROUBLESHOOTING.

The individual equipment instruction books should be used for troubleshooting the particular equipment, and applicable diagrams should be utilized for troubleshooting the system. The diagrams available for use with the BDIS facility are of four distinct types: timing diagrams, schematic diagrams, actual wiring diagrams, and individual circuit board (EC Card) schematic diagrams. Applicable timing diagrams for individual pieces of electro-mechanical equipment incorporated into the BDIS facility will be found in the manufacturer's instruction bulletins pertaining to the specific equipment (listed in table 1). Timing diagrams for electronic units of the BDIS facility are located in Teletype Corporation Bulletin 277B. Schematic and actual wiring diagrams are contained in Teletype Corporation specification 50115S. EC Card actual and schematic diagrams are found in Teletype Corporation specification 50114S. Specification 50113S, Installation and Checkout Procedures should be referred to as required. Certain oscilloscope waveforms are illustrated on the diagrams in Bulletin 277B, volumes I and II; these are output voltage waveforms and are located adjacent to the output terminals of the symbolic block. Use an oscilloscope to follow the signal flow from inputs to outputs of the various stages to determine the presence or absence of correct voltage levels. Use of the schematic diagram of the particular module involved will aid in determining the signal flow. Where an incorrect signal is present, a check of the voltage supply is advisable. When no signal is transferred through an EC Card, it is necessary to check and replace individual faulty components or to substitute an equivalent EC Card known to perform satisfactorily. The urgency of restoring the equipment to service and the availability of spare EC Cards will govern the course of action which the technician must follow. When a relay does not transfer a signal, check the continuity of the coil and the condition of the contacts through which the signal normally flows.

90. SAFETY PRECAUTIONS.

In addition to the safety observances of chapter 1, paragraph 8, it is advisable to always be mindful that certain modules contain high voltages of sufficient intensity to be lethal. Careful use of test equipment probes may avoid extensive damage to the transistorized circuitry under test. Exercise caution when cleaning electromechanical equipment to avoid distorting delicate springs, thus reducing their tension.

91–105. RESERVED.

Section 3. RESERVED

106–115. RESERVED.

Chapter 4. STANDARDS AND TOLERANCES

116. GENERAL.

a. The standards and tolerances prescribed herein are based on system requirements, specifications under which the equipments were manufactured, use of standard test equipment, standard procedures, and the results of field experience. Systems standards and tolerances are applicable to the system taken as a whole. Equipment standards may in certain special instances be listed; however, in general, equipment standards should be found in individual instruction books or modification instructions. Where the standards and tolerances shown in equipment instruction books and other material are in conflict with those contained herein, the criteria contained herein shall apply.

b. Equipment Standards vs Monitor Standards. Where a facility utilizes monitor alarm equipment, the equipment operating standards and tolerances are seldom the same. Equipment operating standards and tolerances are considered limits beyond which safety may be jeopardized.

c. Definitions of standard, initial tolerance and operating tolerance for the purpose of this handbook are as follows:

(1) Standard: The optimum value assigned to an essential parameter of the system.

(2) Initial Tolerance: The maximum deviation, from the *standard* value of the parameter, which is permissible at the time of initial tune-up or a major readjustment.

(3) Operating Tolerance: The maximum deviation, from the *standard* value of the parameter, beyond which remedial action by maintenance personnel is mandatory.

d. Explanation of Terminology. Each essential equipment parameter has been assigned a standard value, which, by definition, is the optimum value from a systems engineering viewpoint. These standard values are compatible with the system as a whole and the design capability of the equipment involved. In addition, each parameter (standard value) has been assigned an "initial" and operating" tolerance expressed in terms of permissible deviation from the standard or in absolute maximum and/or minimum performance levels as appropriate to meet the needs of maintenance personnel. The initial tolerances are those limits within which an equipment must operate in order to be accepted for use in the National Airspace System at the time of initial commissioning or after a major overhaul, modification or modernization. The operating tolerances are those acceptable limits which meet the system requirements, and within which an equipment may continue to operate on a commissioned basis without adjustment or corrective maintenance although the terms "standard," "initial tolerance" and "operating tolerance" differ from the terms previously used (that is; normal, initial and operating), the intended application and the effective values are the same.

e. The standard value of each equipment adjustment parameter is contained in the manufacturer's instruction books or applicable Agency Directives.

f. Standard Interface. The criteria established in MIL STD 188B section 3.2.4, Digital Transmission Reference System, shall be the standard for the FAA.

g. Long Lines Signal Distortion. The tariff under which the teletypewriter or teleprinter service is provided does not establish a maximum distortion figure for the received signal. The distortion on telegraph loops will vary from loop to loop depending upon several parameters. Line length, equipment, circuit speed and types of transmission media are some of the factors determining the amount of distortion that may be present at the receiving equipment. Bell System serving companies refer to the characteristics of the telegraph loop as a coefficient. The coefficient is measured in performance units indicative

of long time performance of circuit parts. For testing and local evaluation purposes of Bell System telegraph circuits, the coefficient may be obtained from the local test board, converted to approximate distortion value and compared to distortion readings taken from the lines by the use of FAA telegraph test equipments. The Western Union Company, however, records the distortion percentage for which the telegraph circuit has been engineered. For testing and local evaluation purposes this value may be obtained directly from Western Union testboards. It is to be remembered that the serving companies, under the tariff, guarantee good copy even though there is no set figure for the allowable distortion on the line.

117. TABLE 3, STANDARDS AND TOLERANCES, GENERAL TELETYPEWRITER EQUIPMENT

Item	Reference paragraph	Standard	Initial tolerance	Operating tolerance
a. Receiving Equipment				
(1) Marking and spacing bias tolerance	127, a,b	Not less than 40%	Same as standard	Same as standard
(2) Marking and spacing end distortion tolerance	127	Not less than 40%	Same as standard	Same as standard
(3) Marking and spacing internal bias distortion	127	Not to exceed 5%	Same as standard	Same as standard
b. Transmitting Equipment				
Transmitter-distributor distortion	129	Not to exceed 4%	Same as standard	Same as standard
c. Auxiliary Equipment				
Busy-Line (BL) relay release time	68, e, (7)	Not to exceed 500 msec	Same as standard	Same as standard
d. Interface				
(1) Low level (polar operation)	MIL-STD-188B 3.2.4.1.1.1	Balanced mark and space voltage levels; (+6 volts and −6 volts)	±0.6 volts	±0.6 volts
(2) High level (neutral operation)	MIL-STD-188B 3.4.1.1.1.8.1., 3.2.41.3.2	20 ma or 60 ma steady marking current levels	±0.6 ma or +1.8 ma	±0.6 ma or +1.8 ma
e. Test Equipment				
(1) Word generator				
(a) Indicated speed (WPM)	Inst. book	Indicated value	Within ±1%	Within ±1%
(b) Indicated distortion (%)	Inst. book	Indicated value	Within ±2%	Within ±2%
(2) Distortion analyzer				
(a) Speed	Inst. book	Indicated value	Within ±1%	Within ±1%
(b) Distortion	Inst. book	Indicated value	Within ±2%	Within ±2%

118. STANDARDS AND TOLERANCES, BDIS EQUIPMENT.

The standards and tolerances are listed in the manufacturer's specification 50113S, "Installation and Check-Out Procedures for FAA Service B Data Interchange System (BDIS)." The operating tolerances for the BDIS facility are set forth in the various instruction books supplied by the manufacturer and listed in Table 2. The operating tolerances for the individual equipments comprising the BDIS facility are contained in the manufacturer's instruction books applicable to the individual equipments listed in Table 1.

119–125. RESERVED.

Chapter 5. PERFORMANCE CHECKS

Section 1. GENERAL TELETYPEWRITER EQUIPMENT

126. GENERAL.

The following performance measurements and observations shall be used to determine that teletypewriter equipments are operating within prescribed tolerances. The approved telegraph distortion generators and analyzers listed in 6200.4 shall be used in determining transmitting and receiving equipment performance under the following general conditions:

a. Connect the equipment being evaluated to the local test circuit (spare equipment on the regular circuits).

b. Use a "QUICK BROWN FOX" tape whenever transmissions are required for evaluation purposes.

c. Adjust the distortion generator for 35% distortion.

d. Record the range arm setting (RAS) before making adjustments.

e. Adjust test loop current to 60 ma.

127. RECEIVING EQUIPMENT DISTORTION TOLERANCE TEST.

The following four measurements are made to determine how much distortion the teletypewriter receiving equipment will tolerate, while still producing accurate copy. With the generator transmitting, proceed as follows:

a. High RAS Marking Bias.

(1) Place the distortion generator switch in the "Marking Bias" position.

(2) Find the highest range arm setting on the receiving equipment which will produce one error-free line of copy. Note reading.

b. Low RAS, Spacing Bias.

(1) Place the distortion generator selector switch in the "Spacing Bias" position.

(2) Find the lowest range arm setting on the receiving equipment which will produce one error-free line of copy. Note reading.

c. High RAS, Spacing End Distortion.

(1) Place the distortion generator selector switch in the "Spacing End Distortion" position.

(2) Find the highest range arm setting on the receiving equipment which will produce one error-free line of copy. Note reading.

d. Low RAS, Marking End Distortion.

(1) Place the distortion generator switch in the "Marking End Distortion" position.

(2) Find the lowest range arm setting on the receiving equipment which will produce one error-free line of copy. Note reading. The following calculations, using the information obtained in the preceding tests, can be made to determine the extent to which the receiving equipment is capable of interpreting distorted signals:

A=High RAS for marking bias
B=Low RAS for spacing bias
C=High RAS for spacing end distortion
D=Low RAS for marking end distortion
E=Optimum RAS for bias
F=Optimum RAS for end distortion
G=Bias tolerance
H=End distortion tolerance
I=Internal bias

(a) Calculate the Optimum RAS for End Distortion (F) utilizing the formula

$$F = \frac{C + D}{2}$$

(b) Calculate the Optimum RAS for Bias (E) utilizing the formula

$$E = \frac{A + B}{2}$$

(c) Calculate the Bias Tolerance (G) utilizing the formula

$$G = \frac{A - B}{2} + 35$$

(d) Calculate the End Distortion Tolerance (H) utilizing the formula

$$H = \frac{C - D}{2} + 35$$

(e). Calculate the Internal Bias (I) utilizing the formula

$$I = F - E$$

128. TRANSMITTER DISTORTION TEST.

This measurement is made to determine the percentage of distortion on the signals transmitted by the transmitter-distributor equipment.

a. Patch the TD to be evaluated into the test circuit with the distortion analyzer.

b. Transmit the test tape on the TD under test.

c. Observe the percentage of distortion indicated by the distortion analyzer.

129–135. RESERVED.

Section 2. BDIS EQUIPMENT

136. GENERAL.

Prior to evaluating the "B" Service Data Interchange System, prepare test tapes using a condition code, a station identifier, a short test message and an end-of-message code (<<↓ABC↓<=RYRYRYRYRYRYRY=<↓) for every identifier programmed into the low speed address selector (ADSEL) of the Rejector associated with each circuit served by the BDIS facility.

137. SYSTEM PERFORMANCE.

a. Set up a complete test circuit. Place one of these previously prepared test tapes, containing the programmed identifiers for a particular circuit, into the transmitter-distributor (LBXD) of the Automatic Send-Receive Set (ASR) in the maintenance test position (ascertaining that the rejector corresponding to the programmed identifiers of the test tape is patched to the test circuit. When the Automatic Program Unit Low Speed (APULS) associated with this particular circuit calls the local transmitter-distributor (LBXD), or when the start button of the Automatic Send-Receive Set (ASR) is depressed (in case and APULS is not located at the facility), this test tape will be transmitted to the local circuit. The rejector associated with the circuit will recognize each identifier as being a local call programmed in the local low speed address selector (ADSEL) for the local circuit, thus refusing to pass the ensuing message to the high speed line; therefore, the low speed reperforator (LRPE) will not copy any of these messages, with the result that no count-up will be registered by the Differential Message Counter (DIMCO).

b. Insert into the same transmitter-distributor a tape that was previously prepared for another circuit which does not contain local circuit identifiers programmed in the address selector (ADSEL) for this particular circuit. When the Automatic Program Unit Low Speed (APULS) associated with this particular circuit or the start button on the Automatic Send-Receive Set (ASR) is depressed, the local transmitter-distributor (LBXD) will transmit this test tape to the local circuit. The rejector associated with the circuit will not recognize these identifiers as calls programmed on the local circuit, thus enabling the low speed reperforator (LRPE) to copy each message as it is transmitted. A count-up of the messages will be registered by the Differential Message Counter (DIMCO) as end of message (EOM) codes are detected. Simultaneously with the first message being counted and recorded, the traffic available light will come on (remaining lighted until the transmission to the high speed line of the last message is completed), a motor start signal will be initiated and the High Speed Tape Reader (CX) motors will start. When a registration of eight (8) messages has been recorded as shown by the light display of the Differential Message Counter (DIMCO), a visual alarm indication will be initiated; this alarm indication may be stopped without changing the message count registered by depressing the alarm reset button located on the front of the Differential Message Counter Module (DIMCO).

c. After the message transmission has been completed, the count-up registered by the lighted display of the Differential Message Counter (DIMCO) may be verified with the number of messages having end of message (EOM) codes as indicated on the tape just transmitted. For BDIS facilities having Automatic Program Units High Speed (APUHS) power is now applied to the unit. Since traffic is available, indicated by a light on the High Speed Reader Control and Alarm Module (HISRAAC), and a request to send has been sent to the Data Set which returns a clear-to-send signal, the Automatic Program Unit High Speed (APUHS) begins to scan the BDIS facilities, the motor start light, on the Motor Start Line Request (MOSLR) module, will be extinguished and a scan-in-progress indicator, on the Automatic Program Unit High Speed-2 (APUHS–2) module, will light and remain lighted during the entire high speed polling program.

d. At the BDIS facilities where no Automatic Program Unit High Speed (APUHS) is located, the Test Accessories Module (TAM) simulates the functions normally supplied by the Automatic Program Unit High Speed (APUHS) when the transmitting and receiving circuits are

patched onto the test circuit. By either method used, the High Speed Tape Reader (CX) will transmit to the high speed line, the send indicator on the Special Electronics Accessories Low to High (SEA L/H) will light during the time the High Speed Tape Reader (CX) is transmitting all messages stored on tape (the distributor cycling indicator on the High Speed Transmitter-Distributor (HISTRAD) module and the distributor cycling indicator on the High Speed Receiving (HISRED) module will be lighted during the entire transmitting period). As these messages are transmitted, the count-up of messages displayed by the Differential Message Counter (DIMCO) will be decreased each time a message transmission is completed, provided an end of message (EOM) code is detected.

e. **The messages transmitted** by the High Speed Tape Reader (CX) and circulated on the high speed circuit, they are available for copying by the High Speed Reperforator (DRPE). When a message circulating on the high speed circuit has an identifier that is properly conditioned which is programmed in the High Speed Address Selector (ADSEL), the High Speed Reperforator (DRPE) will be enabled and the ensuing message will be copied. A slack tape condition will now exist between the High Speed Reperforator (DRPE) and the Low Speed Transmitter-Distributor (LBXD) so that when the BDIS call "QS" is transmitted by the Automatic Program Unit Low Speed (APULS) or when the LBXD start switch of the Test Accessories Module (TAM) is depressed, the low speed transmitter-distributor (LBXD) may transmit to the local circuit the message stored on the tape. These messages being transmitted to the low speed circuit will not be copied by the low speed reperforator (LRPE) associated with the circuit since the low speed reperforator (LRPE) is inhibited to the transmissions of the BDIS transmitter-distributor (LBXD) associated with the same circuit.

138. HIGH SPEED CIRCUIT PERFORMANCE.

Using a Telegraph Signal Analyzer, Model DT-603-2, or a Digital Pattern Analyzer, Model FA-5648, the following checks of the high speed line should be made in accordance with the instructions contained in the manufacturer's bulletin of operations for the test equipment:

a. Bias distortion.
b. End distortion.
c. Speed error.

139–145. RESERVED.

Section 3. RESERVED

146–150. RESERVED.

Chapter 6. PREVENTIVE MAINTENANCE

151. MAINTENANCE SCHEDULES.

The following schedules list the key performance checks and maintenance tasks and the maximum permissible intervals between successive accomplishments to ensure that the performance of the facility is reliable and within the designated tolerances. The regions may shorten the time intervals specified, but may not lengthen them except on a test basis at a limited number of locations. A copy of each regionally authorized increase in the established time intervals, complete with justification, shall be forwarded to Systems Maintenance Service, Washington, D.C. not later than the time of issuance to the field. The periodicity of all maintenance tasks not listed below shall be established by the regions.

a. General Teletypewriter Equipment. This schedule applies to all M28 and associated equipment.

(1) Monthly.

(a) Lubricate in accordance with manufacturer's instruction books.

(b) Clean type pallets as required.

(2) Bimonthly.

(a) Test the transmitting and receiving equipment for compliance with standards and tolerances. Take corrective action as required.

(b) Check signal line current.

(c) Check signal line distortion.

(3) Quarterly.

(a) Clean, lubricate, and adjust all distortion test sets such as CA–406, DXD, etc.

(b) Clean and check all switching units and cabinets.

(4) Semiannual. Service and test rectifiers.

(5) Biennial.

(a) Accomplish overhaul of the teletypewriters equipments.

(b) Overhaul consists of complete disassembly of unit; cleaning of all metal parts in an approved solvent (the selector coils; wiring and any parts constructed of plastic or rubber shall not be immersed in the solvent but shall be wiped clean); inspection of all parts for suitability of reuse; replacement of those parts, not deemed reusable; *all* bearings, felts, springs and lockwashers shall be replaced; reassembly of unit; complete adjustment of unit; lubrication in accordance with the manufacturer's instructions; final testing of the unit and returning it to normal service status.

b. BDIS Equipment.

(1) Weekly. Interchange the main and standbly equipments on the circuit. (In the case of Converter Units, designate a standby unit on a rotational basis.)

(2) Biweekly. High Speed non-typing Reperforator (DRPE). Clean, inspect and lubricate per Teletype Corporation specification 50167S.

(3) Monthly.

(a) High Speed Tape Reader (CX). Clean, inspect and lubricate per Teletype Corporation Bulletin 267B.

(b) Converter Cabinets (LCAC 291). Vacuum interiors and wash glass doors.

(4) Bimonthly.

(a) Low Speed non-typing Reperforator (LRPE). Clean, inspect and lubricate per Teletype Corporation Bulletin 256B.

(b) Tape Handling Stand (LTHS). Clean, inspect and lubricate per Teletype Corporation Bulletin 248B.

(c) Low Speed Transmitter-Distributor (LBXD). Clean, inspect and lubricate per Teletype Corporation Bulletin 243B.

(d) Low Speed Typing Reperforator (LPR). Clean, inspect and lubricate per Teletype Corporation Bulletin 247B.

(e) Automatic Send-Receive Set (ASR). Clean, inspect and lubricate per Teletype Corporation Bulletins 217B, 243B or 250B.

(f) Test the receiving and transmitting equipments and all lines (Low Speed and High

Speed) associated with the BDIS for compliance with standards and tolerances. Take corrective action as required.

(5) Quarterly.

(a) Automatic Program Unit High Speed (APUHS). Stepping Switches shall be cleaned, inspected, adjusted and lubricated per Teletype Corporation Bulletin 277B.

(b) Cabinet (Control, LCAC 295; Transceiver, LCAC 292; Rejector, LCAC 293). Clean and inspect interiors.

(c) Cabinets (Converter, LCAC 291). Clean or replace filters; lubricate muffin fans per manufacturer's instructions on specification sheet.

(d) Multi-Voltage Power Supplies (MVPS II and MVPS III). Check and adjust the variable output voltages.

(e) Rectifiers, 48 volt and 110 volt. Check ac Ripple output.

(f) Electronic adjustments shall be checked and adjusted as necessary (see chapter 3, Table 2).

(6) Annually.—Perform a complete overhaul of the following Automatic Send-Receive Set (ASR) equipment:

(a) Cabinet (LAAC).

(b) Keyboard-Base (LAK).

(c) Typing Unit (LP).

(d) Perforator (LPE).

(e) Reperforator (LPR), if installed.

(7) Biennial.

(a) Accomplish an overhaul of the following equipment:

1. Tape Handling Stand (LTHS).
2. Low Speed Reperforator (LRPE).
3. Low Speed Transmitter-Distributor (LBXD).
4. High Speed Tape Reader (CX).
5. High Speed Reperforator (DRPE).
6. Motors (LMU).

(b) Overhaul consists of complete disassembly of the unit; cleaning of all metal parts in an approved solvent (the selector coils; wiring and any parts constructed of plastic or rubber shall not be immersed in the solvent but shall be wiped clean); inspection of all parts of suitability of reuse; replacement of those parts not deemed reusable; all bearings, felts, springs and lockwashers shall be replaced; reassembly of unit; complete adjustment of unit; lubrication in accordance with the manufacturer's instructions; final testing of the unit and returning it to normal service status.

152. MAINTENANCE OF TEST EQUIPMENT.

Schedules have not been provided in this chapter for maintenance of test equipment. Reference shall be made to manufacturer's instruction books for more comprehensive information on test equipment performance checks and calibration instructions.

153. TEST EQUIPMENT LIST.

The test equipment authorized by FAA for this type of facility is listed in 6200.4, Standard Allowance of Test Equipment.

154. HOUSEKEEPING.

For information relative to housekeeping functions and similar general information refer to AF P 6030.5, Maintenance of Electronic Equipment.

155–160. RESERVED.

Chapter 7. MISCELLANEOUS

161. AUTHORIZED EQUIPMENT MODIFICATIONS.

The authorized modifications applicable to the teletypewriter equipment will be found in AF P 6620.1.

162. LOW LEVEL TELETYPEWRITER OPERATION.

A standard FAA communications teletypewriter is being designed for use on the AUTODIN circuits. This teletypewriter will include the requirements of printing 12 characters per inch, 80 characters per line in addition to interfacing with the Mode V control equipment at low level. The low level standard, ±6 volts polar, as contained in MIL STD 188 B (3.2.4.1.1.1) necessitates the electrical modification of the keyers, selector magnet drivers and wiring changes.

163. MERCURY WETTED KEYING RELAYS.

a. A program has been underway to evaluate the operation of mercury wetted relays in teletypewriter equipments. The Clare type HGSX5066 and Western Electric 314A relays are direct replacements for the RY33 type relay. Testing has shown that their performance is entirely satisfactory with the additional benefits of no maintenance required and the reduction of radiated noise. These relays operate in either a vertical or horizontal position. The use of these relays is recommended where excessive maintenance time is being spent on alignment of 33RY type relays and/or where radio receivers located in close proximity to teletypewriter equipments are experiencing noise from the line relay operation.

b. The Clare type HGS5106 mercury wetted relay has been used successfully as the keying relay of the APULS unit. It has the disadvantage of not functioning correctly when the APULS unit is inverted for service. However, when operated normally in the vertical position satisfactory results have been obtained. Where excessive maintenance of the present relay is encountered the Clare HGS5106 should be considered.

164. GUIDEPLATE WEAR.

Teletype Corporation has designed a steel strip, part No. 195109 to compensate for part No. 153322 "guide plate" wear. This wear is evidenced by an indentation (approximately 1/64″) at the point of contact between the guide plate and function levers (Part Nos. 152121, 152641, 154647, 157207, etc.). The steel strip may be ordered from the FAA Depot listing the part number (195109) and the Federal Stock Number 5815–055–6988, on the requisition. The steel plate should be installed on the top of the guide plate so that it will stop the forward movement of function levers in lieu of the guide plate.

165. FACTORS AFFECTING PRINTER MARK-SPACE CURRENTS.

Reports have been received indicating excessive variation in marking and spacing currents. Where this situation exists, a check should be made to determine that the 2750 ohm resistor in series with the marking contact of the 33RY relay is actually shorted out by a jumper as shown in the standard drawings. Another possibility of wiring error is the center tapped 3500/2000 ohm resistors being mounted and wired in reverse (end for end). Refer to DWG 3434–Wd, line relay mounting assembly, station "J". Bulletins 216B, and 246B, Description and Theory of M–28 Printer and Typing Reperforator, figure 11 show that the typing unit selector magnets current is 30 ma. for FAA systems, therefore, the magnets should be connected in series.

166. LINE SWITCHING UNIT CA–1696.

The following maintenance instructions apply to all CA–1696 Teletypewriter Line Switching Units:

a. KS–7471 grease may be used in place of

the instruction book specified lubricant for the push button assemblies. Lubricate per instructions in Section 6, Preventive Maintenance and per instructions in paragraph 1.3 in Section 7, Corrective Maintenance of the instruction book. Refer to section 5 and 6 of the instruction book for detailed lubrication instructions.

b. Metal filings are produced by the rotation of panel mounting screws during removal of switching units. The metal filings fall into the switch units that may have been loosened and partly withdrawn.

(1) Loosen and remove, every switch from the rack.

(2) Lubricate the switch units using KS–7471 grease between the panel mounting screw and washer, between the True Arc ring and panel, and on the threads of each mounting screw. If the washer is not stuck to the paint, lubricate between washer and the panel. Lubricate the top of the slides.

(3) The insulation spacer between the actuating arm and the #1 contact leaf of the S–3 switch pileups should be inspected periodically for wear or flattening. This could expose the rivet holding the spacer to the contact leaf, thus allowing the rivet to make contact with the actuating arm. This causes a ground or intermittent ground on the signal line. Added insulation can be provided by cutting a 3/8" by 3/8" square of "Scotch" No. 33 (or equivalent) electrical tape. Using long nose pliers, carefully apply one piece of tape on the actuating arm of each line switch and on the bottom actuating arm of the access switch. The tape is applied to the actuating arm directly under the insulating spacer riveted to the 1t and 1b contact spring.

167–178. RESERVED.

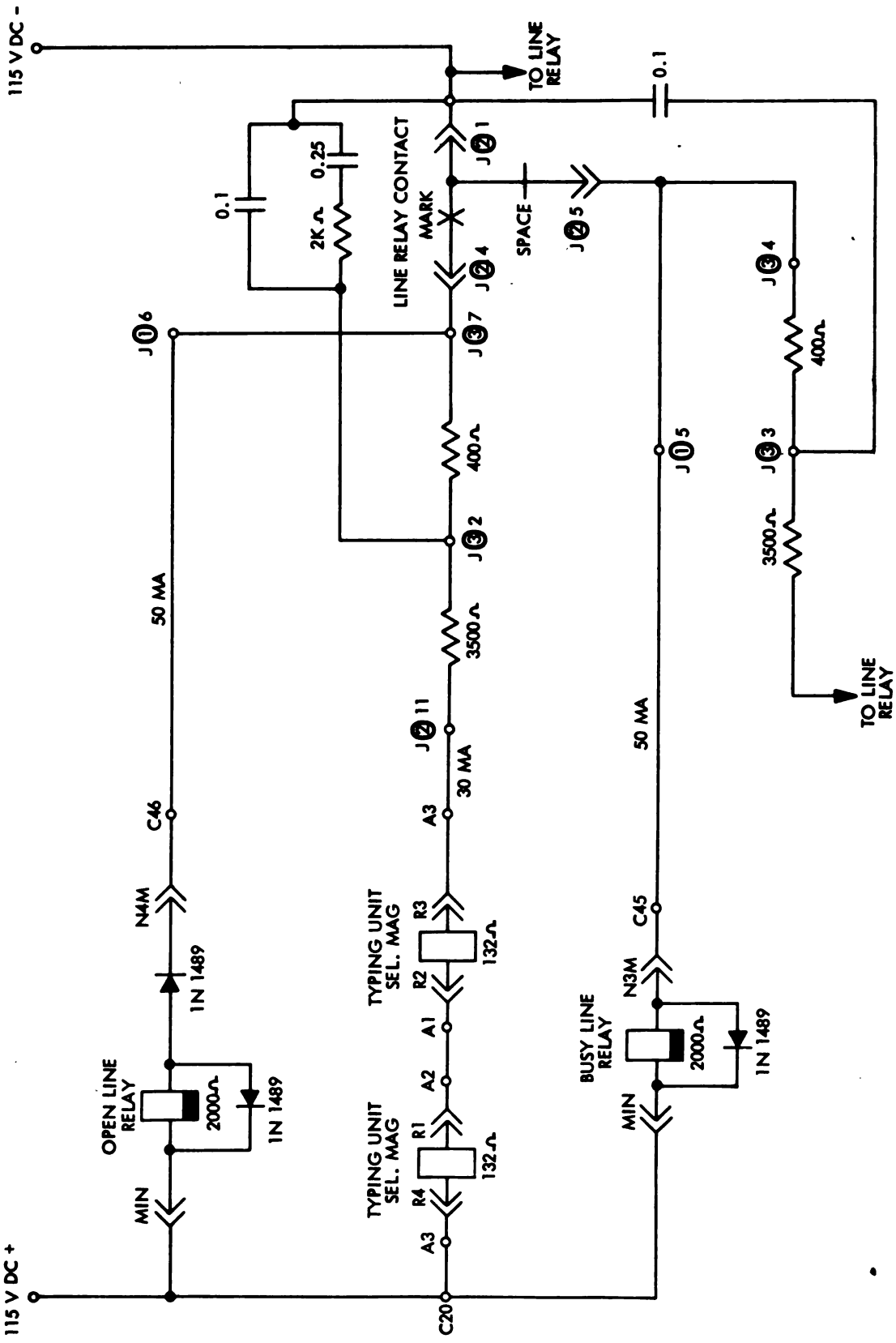


FIGURE 11. FAA Standard Relay Control Group Schematic Diagram.

Chapter 8. RESERVED

179–180. RESERVED.

Chapter 9. PERIODIC INSPECTIONS AND EVALUATIONS

181. PURPOSE.

This chapter identifies key performance parameters which shall be investigated by personnel performing periodic inspections and technical evaluations on the equipment covered in the previous chapter.

182. INTRODUCTION.

Periodic inspections and technical evaluations, objectively conducted, are an important part of the overall maintenance evaluation system. They are one of the more effective management controls for assuring the required quality level of maintenance work, and of equipment and facility performance.

a. Regular Inspections. Technicians and others engaged in regular maintenance activities, as well as their immediate supervisors, are expected to inspect equipment and system performance as part of their normal routine duties. They should refer to the preceding chapters for detailed technical guidance.

b. Formal Periodic Inspections and Evaluations. This chapter is intended to provide guidance for those performing formal periodic inspections and technical evaluations. These will normally be accomplished on a systematic basis by staff personnel or line supervisors who are one or more steps higher in the chain of command than members of the organizational unit responsible for daily maintenance of equipments and facilities.

183. POLICY GUIDANCE.

Facility inspections and evaluations shall be conducted in accordance with basic policies and objectives published in regional and Agency directives.

184. SCOPE AND DEPTH OF FORMAL INSPECTIONS.

Verification of proper equipment adjustment, examination of technical condition and investigation of operational performance shall be carried out to whatever degree is required to assure that equipment is being operated within its design capabilities and maintained in accordance with established technical standards and tolerances. Particular emphasis should be placed on the performance of monitoring and transfer equipment to ascertain that it will accurately and reliably perform its assigned functions.

185. KEY PERFORMANCE PARAMETERS.

The items listed in figure 13 are the key performance parameters for the equipment. Determination of the extent of measurements made to establish whether the equipment is performing its intended function and is being properly maintained, rests upon the judgment and competence of the inspector. If an examination of the key performance parameters, or a review of other factors noted, indicates a possible equipment malfunction or maladjustment, the inspector should perform whatever additional analysis is necessary to arrive at a definite conclusion.

186. REPORTS.

Personnnel reporting the results of facility inspections and evaluations shall comply with regional and Agency instructions covering such matters as report format, usage of forms, report distributions, and responsibility for follow-up and initiating corrective or remedial action.

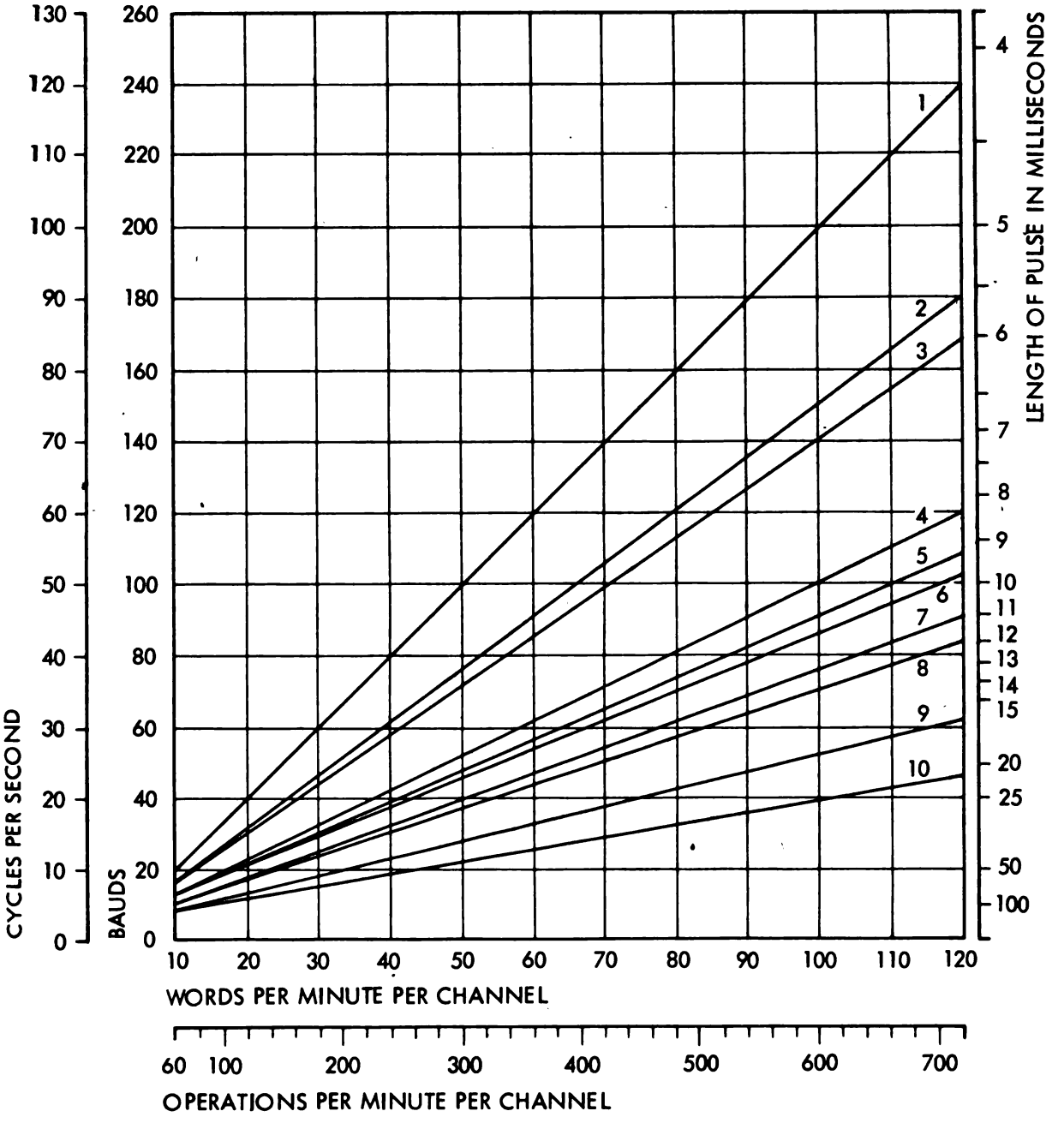
187. SECURITY.

Personnel performing and reporting the results of technical inspections and evaluatons must conform to applicable security regulations and instructions in those cases where classified facilities are involved.

188–190. RESERVED.

Performance parameter	Reference paragraphs	
	Standards and tolerances	Measurement procedures
a. General Teletypewriter Equipment		
Marking and Spacing Bias Tolerance	117, a, (1)	127
Marking and Spacing End Distortion Tolerance	117, a, (2)	127
Transmitter Distributor Distortion	117, b	129
BL Relay Release Time	117, c	68, e, (7)
b. BDIS Equipment		
Diversion of properly coded messages for remote circuits	118	137
Rejection of properly coded messages for local circuits	118	137
Distortion of High Speed Lines	118	138
Distortion of Low Speed Lines	118	139
Fidelity of Transmissions	118	139
Fidelity of Reperforations	118	137
Traffic Available Indication	118	137
Correctness of Message Count-up or Count-Down	118	137
Response to Scan Calls either by Transmission or Answer Back	118	137
Correctness of Alarms Indications	118	137

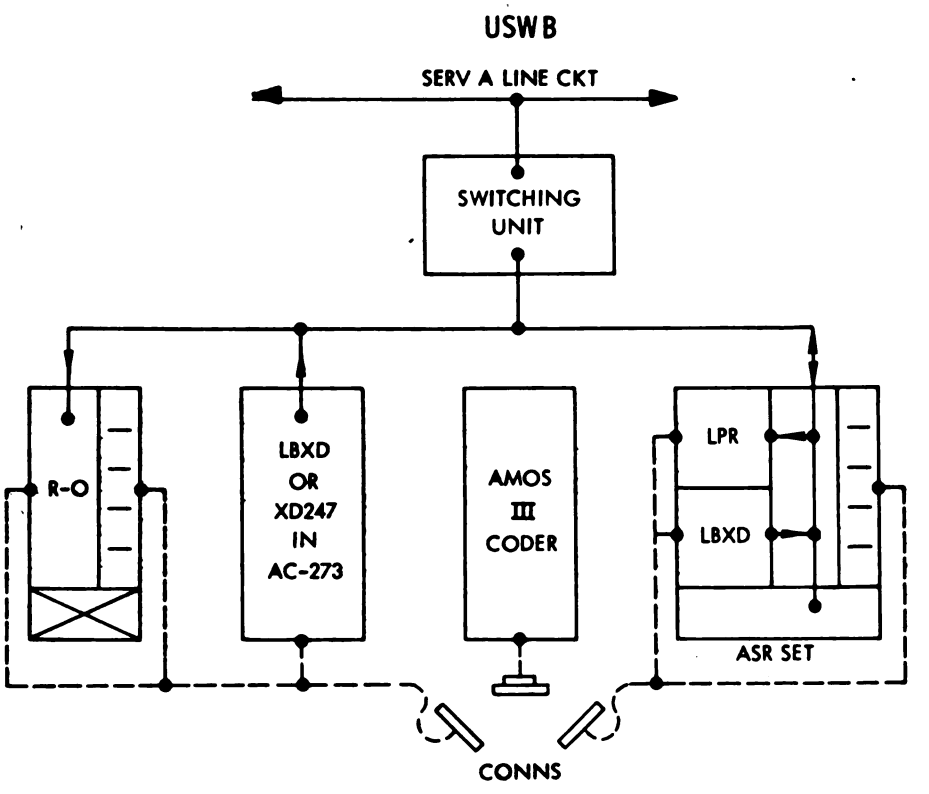
FIGURE 12. Key Performance Parameters.



* BASED ON REPETITION RATE OF SHORTEST SIGNALING ELEMENT

1. MULTIPLEX 4 CHANNELS
2. 7 1/2 - UNIT START-STOP 2 CHANNELS & MULTIPLEX 3 CHANNELS
3. 7 - UNIT START-STOP 2 CHANNELS
4. MULTIPLEX 2 CHANNELS
5. CONTINENTAL MORSE
6. AMERICAN MORSE
7. 7 1/2 - UNIT TELEPRINTER
8. 7 UNIT TELEPRINTER
9. MULTIPLEX 1 CHANNEL
10. CABLE MORSE

FIGURE 13. Signaling Speeds and Pulse Lengths.



NOTE: ATTENDED OR UNATTENDED AMOS
NO ADJACENT FSS
– – – CONTROL LINES
——— SIGNAL LINES

FIGURE 14. AMOS—Attended or Unattended AMOS No Adjacent FSS.

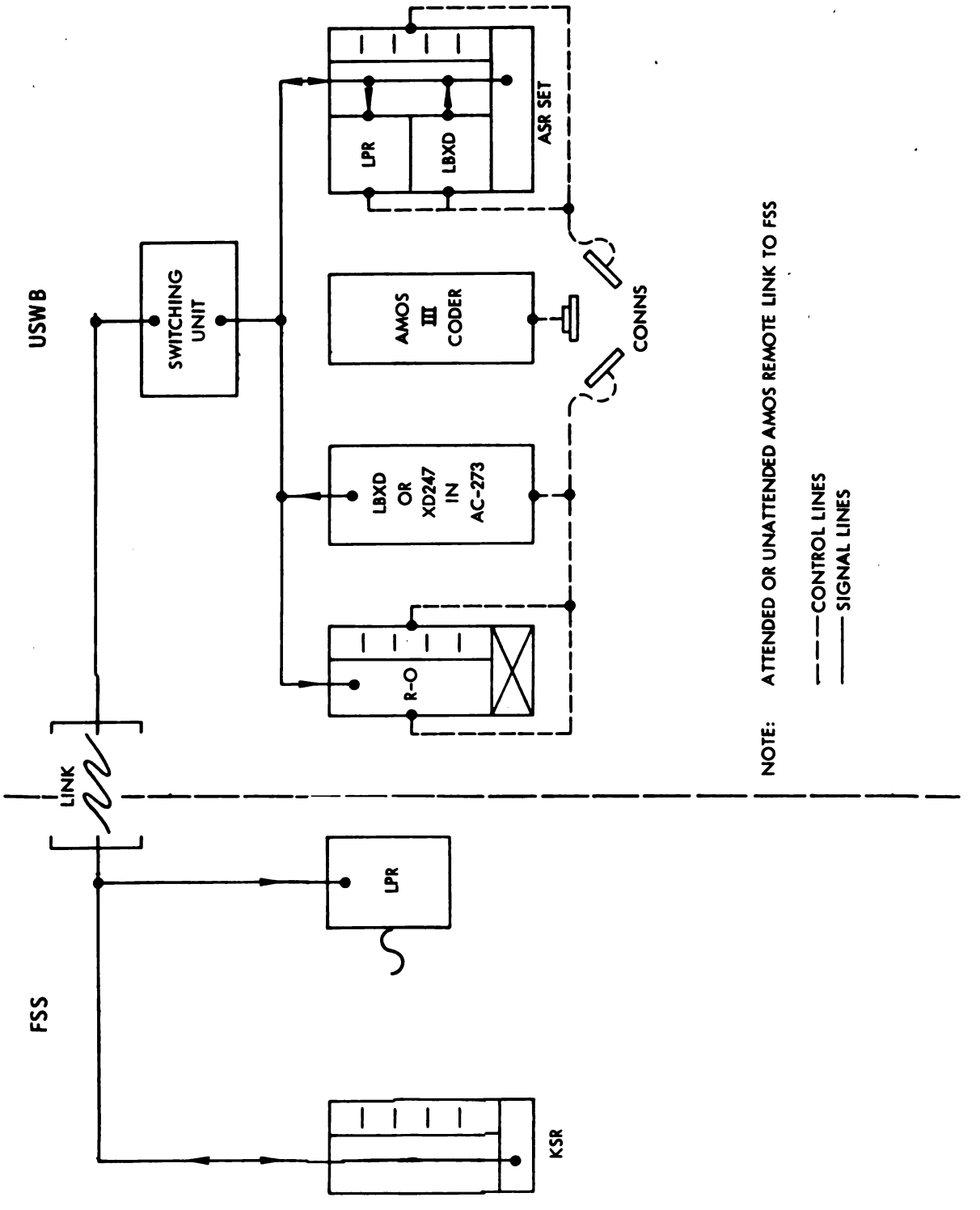


FIGURE 15. AMOS—Attended or Unattended AMOS Remote Link to FSS.

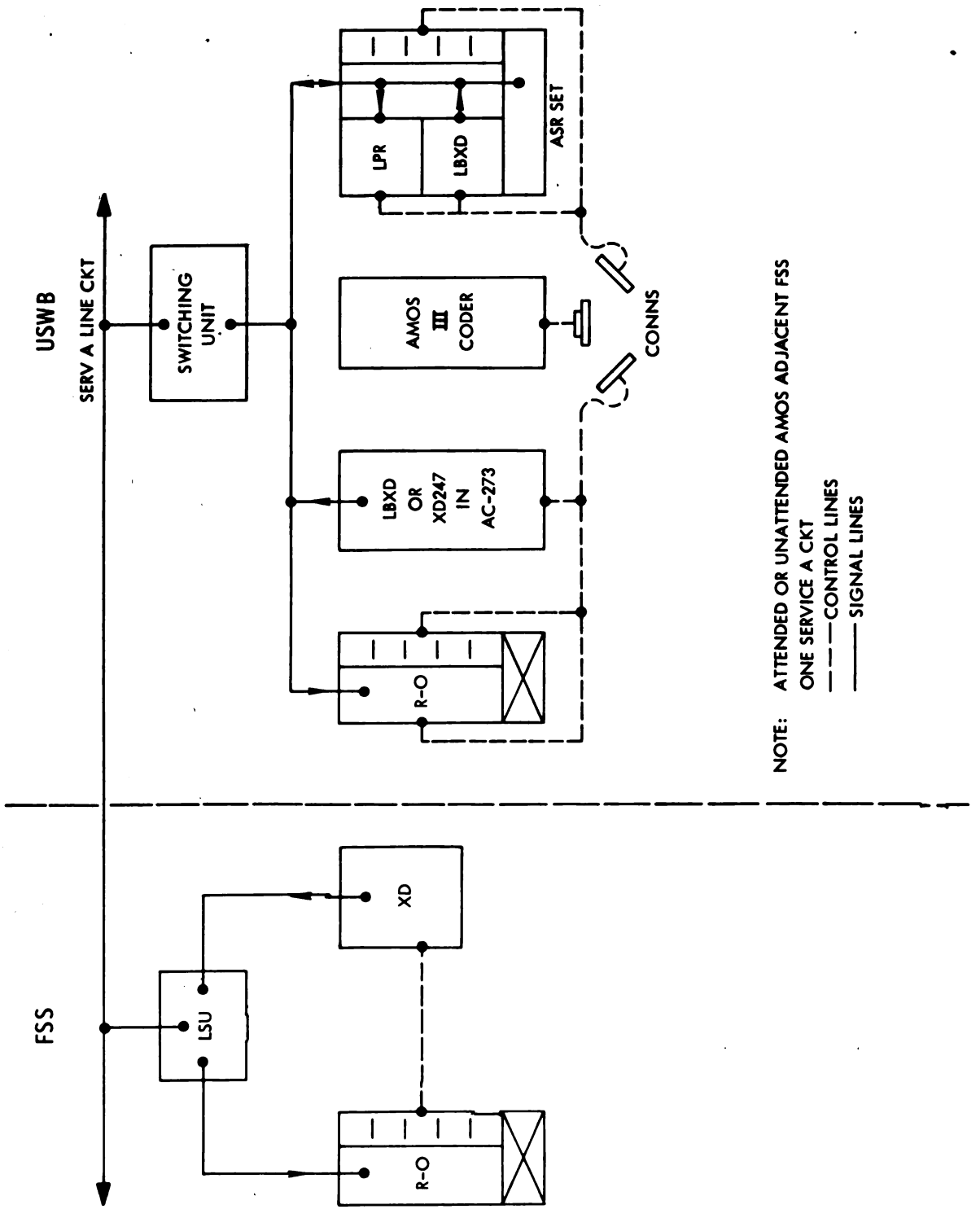


FIGURE 16. AMOS—Attended or Unattended AMOS Adjacent FSS One Service A Circuit.

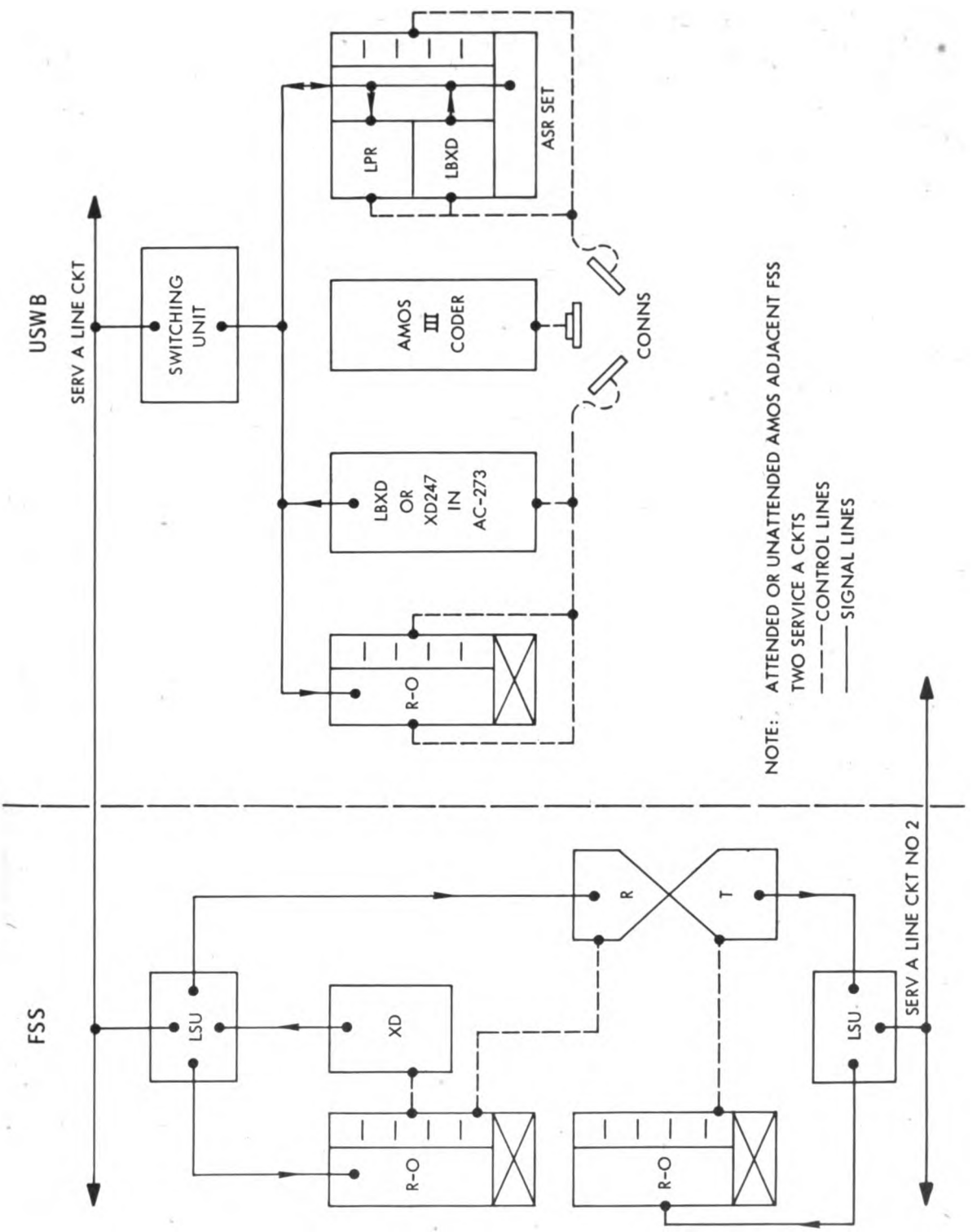
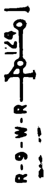


FIGURE 17. Attended or Unattended AMOS Adjacent FSS Two Service A Circuits.



CA

W-

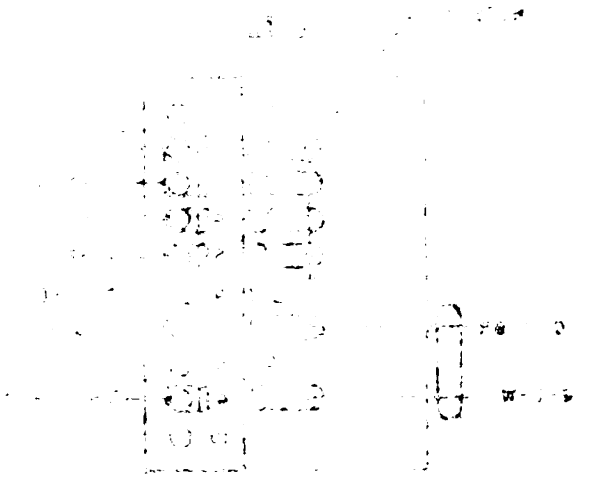
-W-

W-B

2-B

3-

4-



Index

INDEX—Continued

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W

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