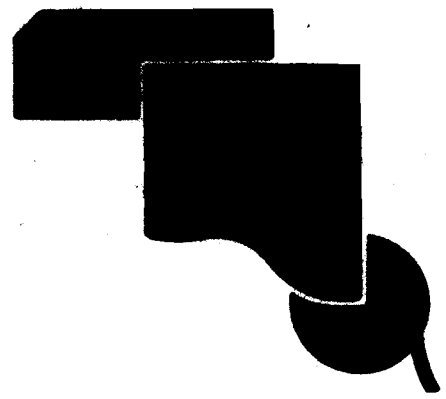
GENERAL ELECTRIC
COMPUTERS

GE-200 Series Operating Manual



GENERAL ELECTRIC

CPB-247C

GE-200 SERIES
OPERATING MANUAL

December 1962

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GENERAL ELECTRIC

INFORMATION SYSTEMS DIVISION

PREFACE

This manual has been prepared as a guide to operating the central processor for the GE-225 Information Processing system. It includes a brief description of the major components of the system, general operating practices, system startup and shutdown, and a detailed description of the controls on the operator's console and typewriter.

Part I has been revised to include descriptions and illustrations of equipment not included in the earlier editions of this manual.

The appendix includes a section on number systems, a table of powers of 2, and octal-decimal conversion tables. Much of the basic information about machine instruction repertoire and programs is necessarily brief, since this information is contained in detail in the GE-225 Programming Reference Manual (CPB-252).

This manual supersedes the former GE-225 System Operating Manual (CPB-247A). The operating information on peripheral subsystems contained in that manual is now covered in separate manuals for each subsystem. A list of these manuals appears in Appendix E.

Much of the information in this manual is also applicable to the GE-205 and GE-215 central processors which have virtually identical operating controls and procedures.

In this revised edition, changes in technical content from the previous edition are identified with a bar in the margin opposite the change.

Suggestions and criticisms relative to form, content, or use of this manual are invited. Comments may be sent on the Document Review Sheet in the back of this manual or may be addressed directly to Document Standards and Publications, B-84, Computer Equipment Department, General Electric Company, 13430 North Black Canyon Highway, Phoenix, Arizona 85029.

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I INTRODUCTION

The role of the operator of the GE-225 Information Processing System is discussed in this manual. Information is provided about the equipment, procedures for operating the system, and related operator duties such as record keeping and care of input and output media. The operator plays a most important role in the use of the computer system, as will be seen in chapters which follow.

A TYPICAL COMPUTER CENTER

A computer center is usually located in a main building of the organization which it serves. The function of the center is to assist in the performance of one or more of the clerical, industrial, management, and/or scientific jobs of the organization. For example, a center might handle a company's billing, its payroll, its inventory, and solve certain scientific problems on a routine basis.

When a center is first established, programs have to be debugged and operators have to be trained. During this stage of initial organization, a General Electric application engineer will be on hand to assist the setting up of operations which will soon become more or less routine. After the initial stage, the operator will use most of the same computer programs over and over, some on a daily basis and others at weekly or monthly intervals. The center usually operates under the supervision of the computer center manager.

Of immediate interest to the operator is the main computer room where he spends most of his working hours operating the GE-225 System. He may work under the immediate supervision of a shift supervisor who controls the flow of work into and out of the center; or at a large installation, the operator may work under the direction of a machine-room supervisor who works under the shift supervisor.

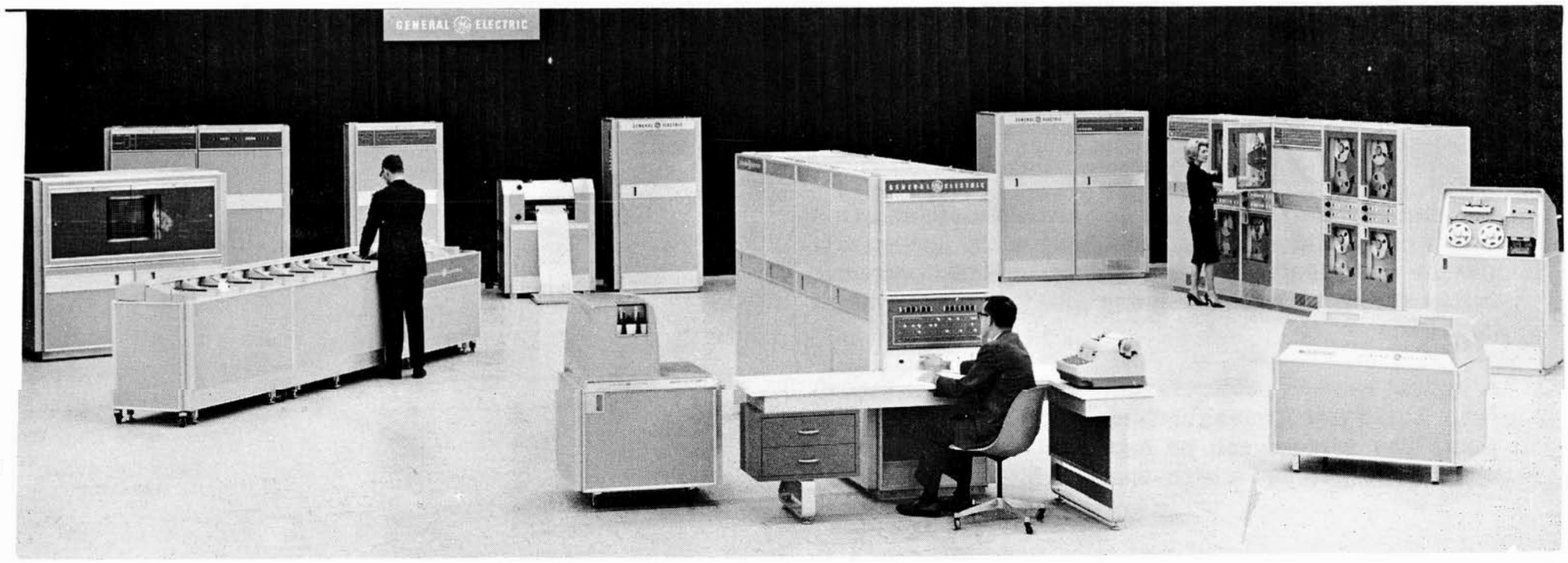


Figure I-1. The GE-225 Information Processing System

Adjacent to or located very close to the main computing room will be an area where service engineering personnel have their office and shop headquarters. Service engineering personnel maintain the GE-225 System and are either on hand or on call at all times.

Other areas of immediate interest to the operator are the tape library, the supply and storage area, and the office of the machine-room supervisor. At a large center, the tape library is usually in a separate room and is managed by a tape librarian. (Section II describes the duties of a tape librarian.) At a small computer center, a single room might serve as the tape library, the storage area, and the office.

A programming staff room may or may not be located in the immediate vicinity of the computer center. However, the operator should know how to contact a programmer for each of the center's major programs to obtain information, if necessary, when difficulty is encountered in the program's execution.

THE GE-225 INFORMATION PROCESSING SYSTEM

The GE-225 Information Processing System, illustrated in Figure I-1, is a medium-sized system which utilizes transistor and magnetic-core components. It consists of a central processor, control console, and a complete line of input-output equipment. The system is adaptable to a wide range of business and scientific applications.

SYSTEM CONFIGURATION

The number and type of input-output devices associated with a particular system depends upon the application and the end results desired. This means that operator duties vary somewhat depending upon the type of system installed.

A typical system configuration is illustrated in Figure I-2. This system uses punched cards for input and output. The system can be expanded by the addition of magnetic tapes and a high-speed printer.

The system which uses paper tape for input and output is illustrated in Figure I-3. Here again, the paper tape reader and punch are sufficient for input and output, but the magnetic tape can be added to enlarge the system's capability. This configuration is particularly suitable for scientific computation, for research and development, and for data reduction.

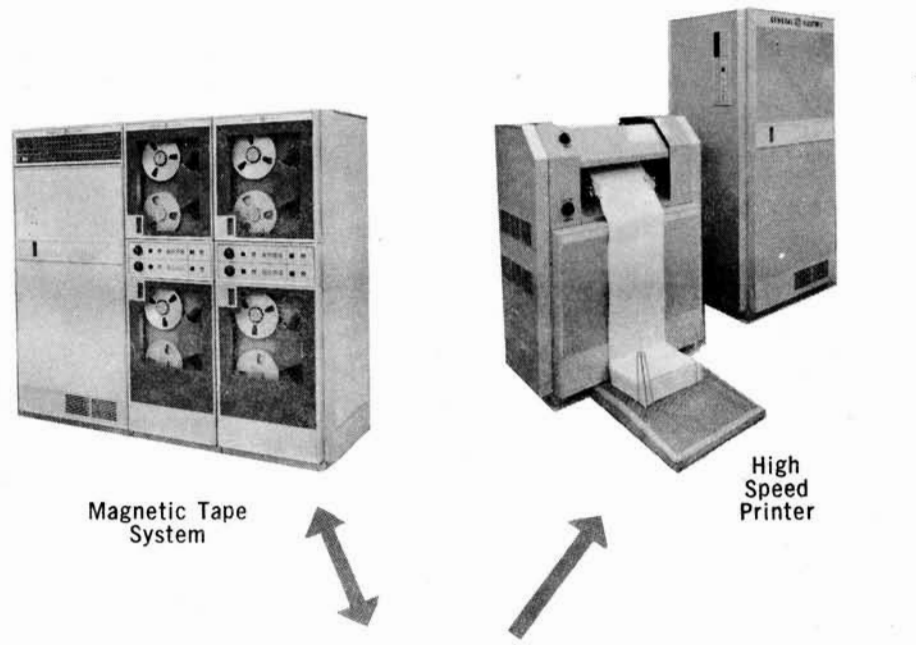


Figure I-2. The GE-225 System Using Punched Card Input and Output

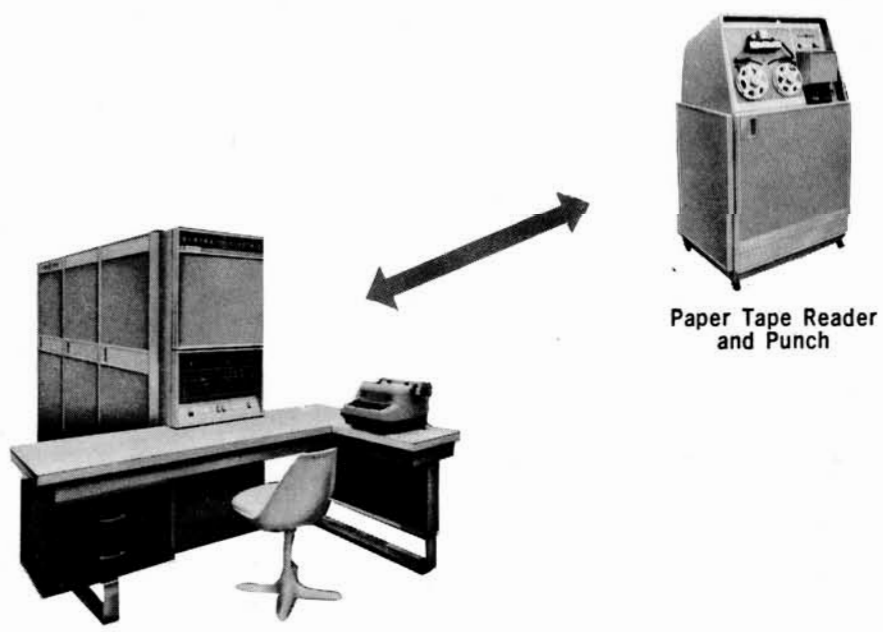


Figure I-3. The GE-225 System Using Paper Tape Input and Output

THE CENTRAL PROCESSOR

The central processor (Figure I-4) contains arithmetic, memory, and control sections. Its primary function is to store and execute programs. It also controls the various input-output operations such as reading and writing magnetic tape, reading cards, and printing. The central processor is available with three memory sizes: 4,096; 8,192; and 16,384 words.

The control console, with its indicator lights and control buttons, permits a certain degree of manual control over operation of the system. The operator spends a great deal of his time at this console. Here, he initially loads a program into memory, monitors its progress from messages on the console typewriter, and, when required, stops the run for checking or other purposes.

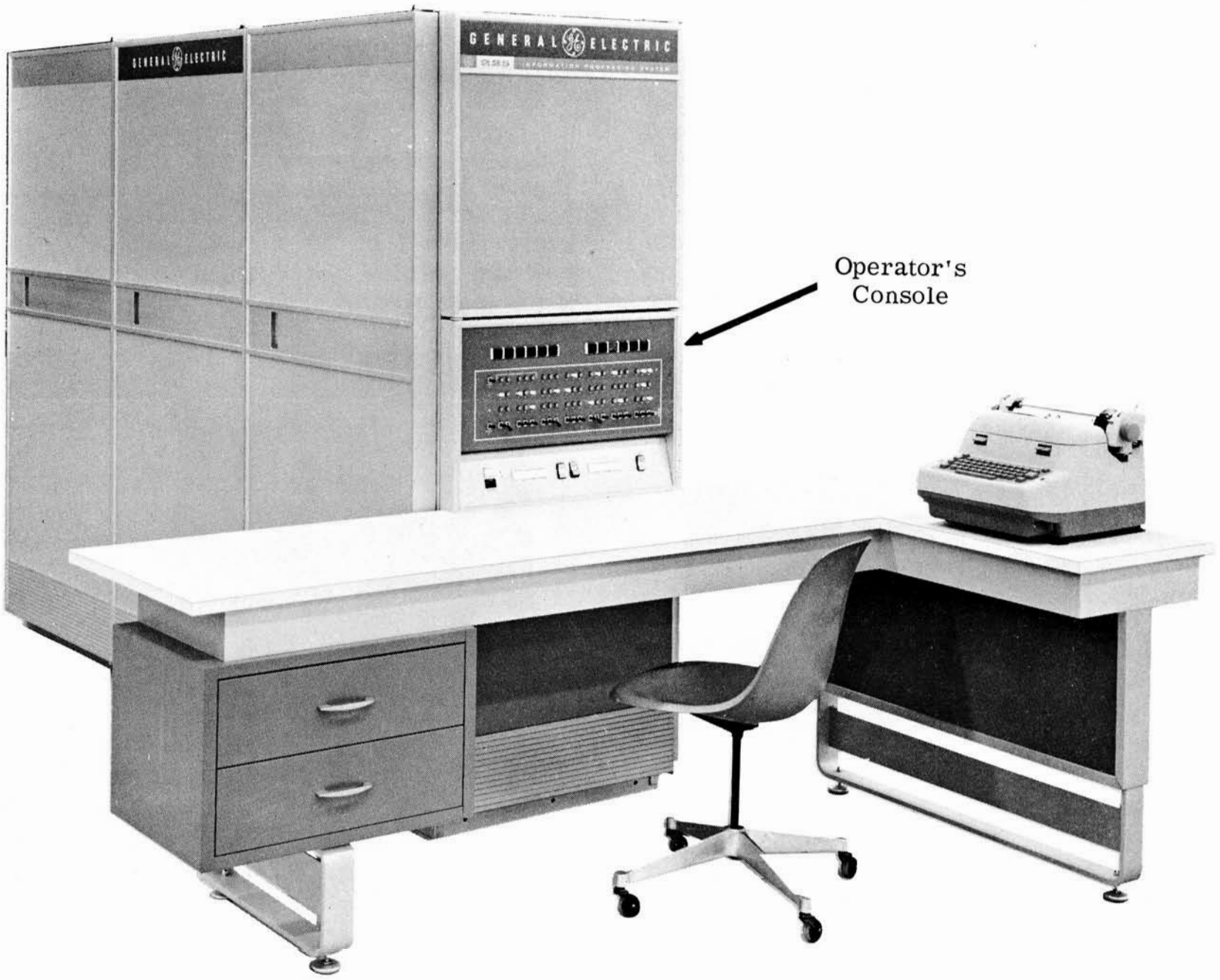


Figure I-4. The Central Processor

INPUT-OUTPUT DEVICES

Each of the various input/output devices used in the GE-225 system is described briefly on the following pages. Separate manuals containing complete programming and operating information for all subsystems are listed in the Appendix.

Card Readers

A card reader enables information (such as business transactions or computer programs) punched on cards in either binary or Hollerith codes to be fed directly into computer memory for processing.

Either of two types of card readers can be used with the GE-225 system. The 400-card-per-minute (cpm) reader is illustrated in Figure I-5. The high speed card reader (1000 cpm) is illustrated in Figure I-6.

The same programs can be written for use with either card reader. In addition to using the card reader to enter program and/or data cards, the operator maintains a file of software programs on cards which he uses over and over again for routine types of operations.

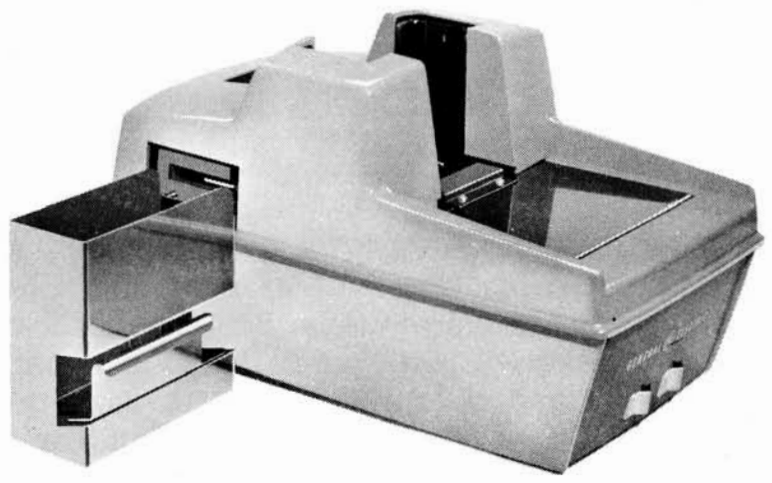


Figure I-5. The 400 Card-Per-Minute Reader

Card Punches

Either of two types of card punches can be used with the GE-225 system.

The 100 card-per-minute card punch, illustrated in Figure I-7, permits output information from the computer to be recorded directly on punched cards under control of the stored program. The punch can also be used for duplication (gang punching) of cards in an off-line mode.

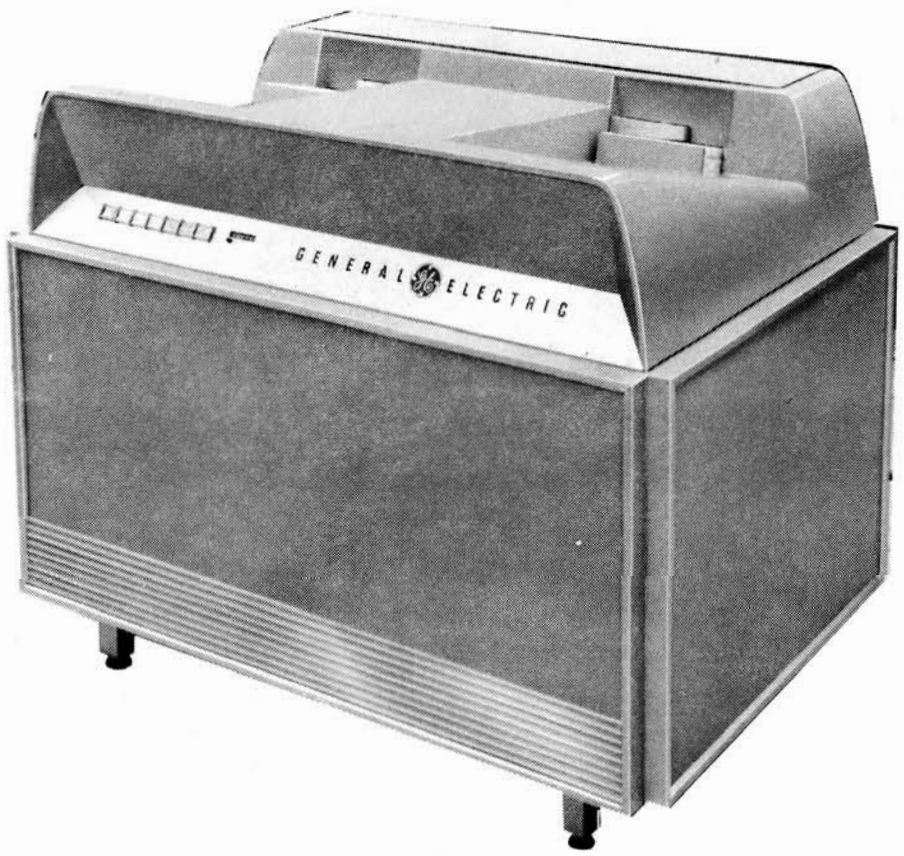


Figure I-6. The High Speed Card Reader (1000 cpm)

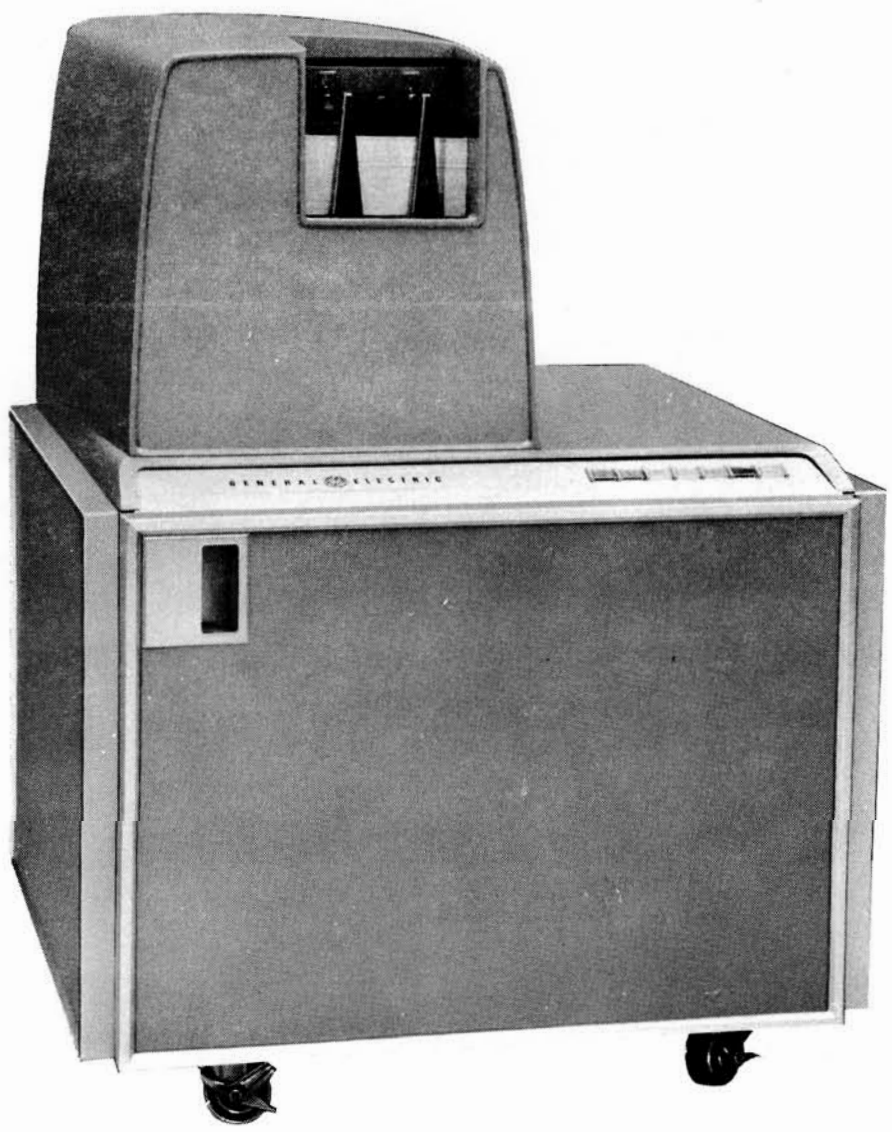


Figure I-7. The 100 Card-Per-Minute Card Punch

The freestanding card punch shown in Figure I-8 operates on-line at the rate of 300 cards per minute. It does not function off-line except for product testing operations. It has an input hopper with a capacity of 3500 cards, and the output stacker can contain a maximum of 3000 cards. Both the input hopper and the output stacker can be easily loaded and unloaded during operation. Card fields can be arranged by program control.

For maximum operating efficiency, this punch is designed so that it goes from an operate, or normal, status to a standby status (having motors off but power on) if not called upon to punch cards within a specified period of time. The operate status is automatically reinstated as soon as another punch instruction is received.

When the instruction is given to begin card punching, the bottom card of the deck is pushed from the input hopper, through a feed mechanism, into the proper position for punching. Cards are punched one row at a time, starting with the 12-row, by 80 punching dies. After the card is punched, it is moved to the reading station where 80 read brushes sense the presence or absence of holes and relay this information to the controller for verification. The card then goes into the output stacker.

Figure I-8. The 300 Card-Per-Minute Card Punch

ASA Seven-Track Magnetic Tape Controller

The magnetic tape controller is housed in a single rack and contains a matrix, interface, common control logic, operator panel, blower assemblies, service/ maintenance panel, power supply, and device address panel.

This single controller can be used with up to eight magnetic tape units and is capable of reading and writing magnetic tapes at rates of up to 60,000 frames per second, operating with seven-track tape units.

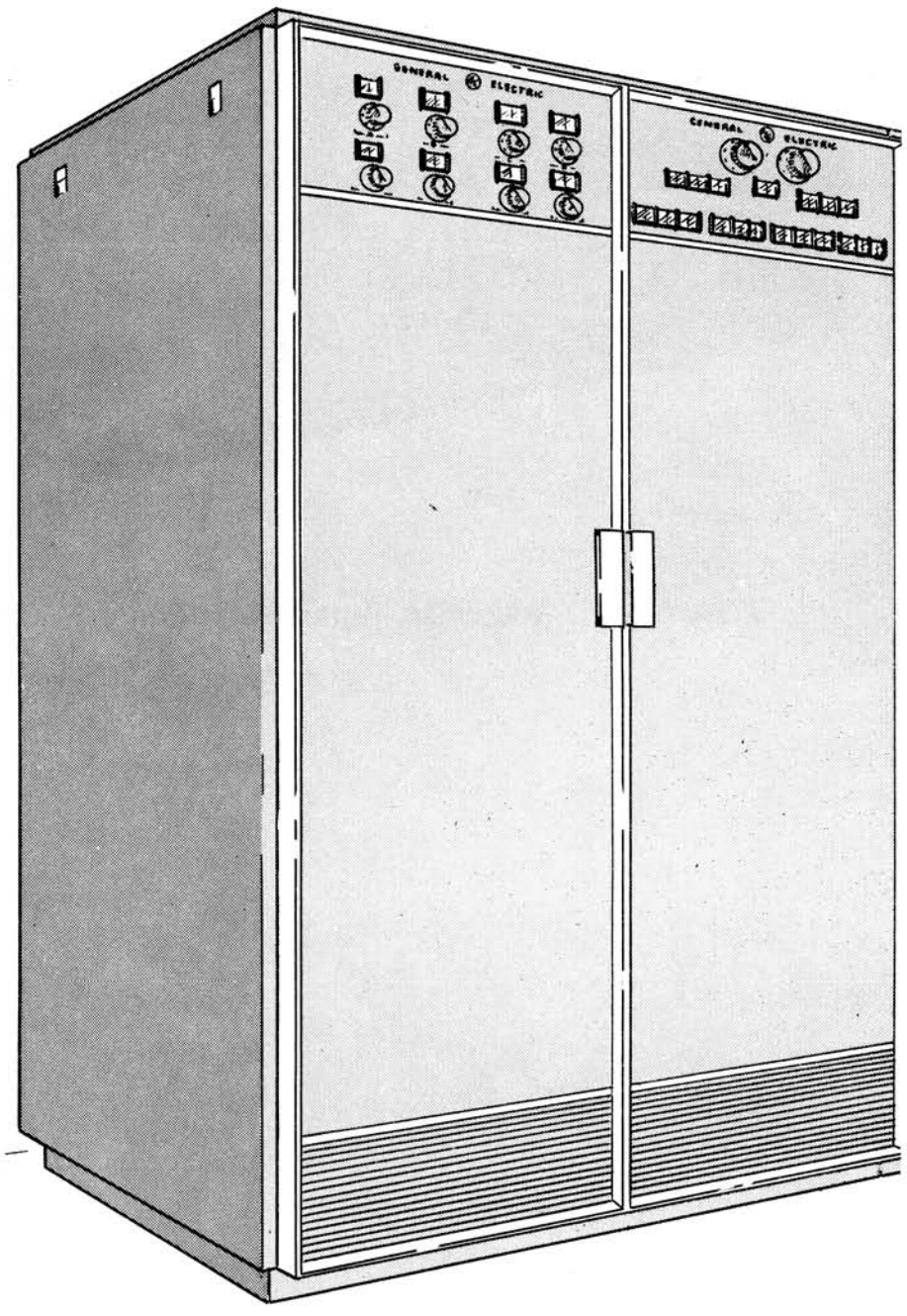


Figure I-9. ASA Seven-Track Magnetic Tape Controller

Magnetic Tape Subsystem

The magnetic tape subsystem illustrated in Figure I-10 is used for both input and output to the central processor. Each subsystem contains a magnetic tape controller and from one to eight magnetic tape handlers. The subsystem contains a handler mechanism which transfers information at the rate of 15,000 characters per second; other handlers with faster transfer rates are available. A good operator is one whose dexterity permits him to make rapid changes of tape reels, for time is of the essence in computer operations.

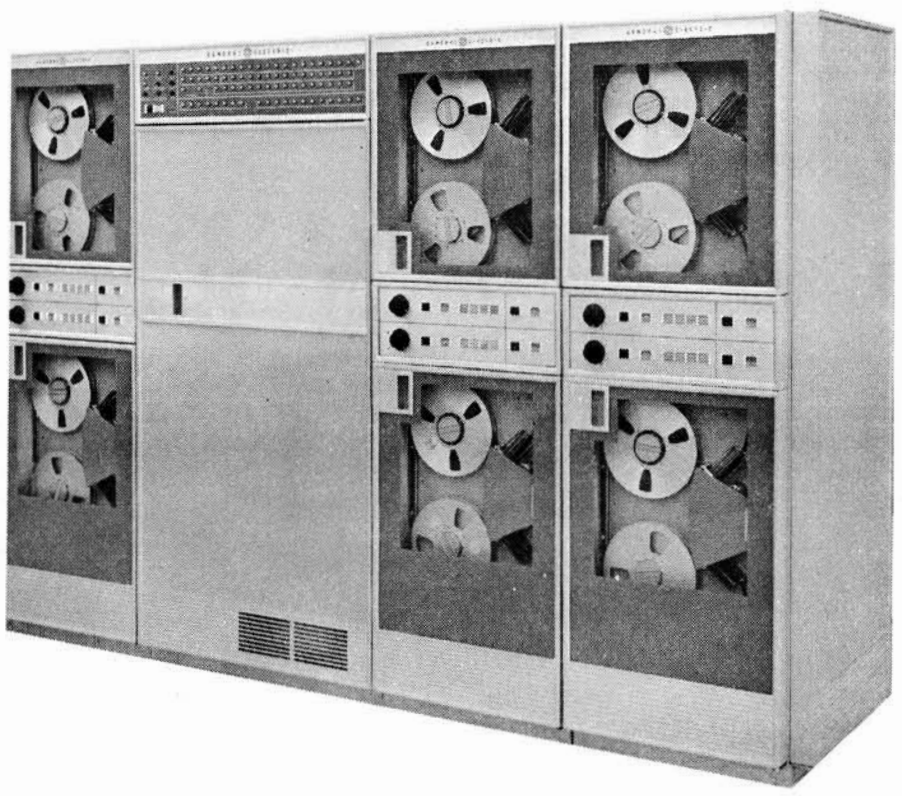


Figure I-10. Magnetic Tape Subsystem

GE-225 On/Off Line Printer

This On/Off Line device produces a printed output for the Information Processing System of 120 columns, at speeds of up to 900 lpm. The A1 and A2 units contain low density (15KC) tape decks; the B2 unit contains a low/high density (15/42KC) tape deck.

Figure I-11. GE-225 On/Off Line Printer

High-Speed Printer

The high-speed printer illustrated in Figure I-12 permits rapid printing of reports under control of the stored program. It is used in applications where large amounts of output information from the computer must be transformed into a permanent visual record, such as tabulated listings. Nine hundred lines of alpha-numeric information (as many as 120 characters per line) can be printed in one minute.

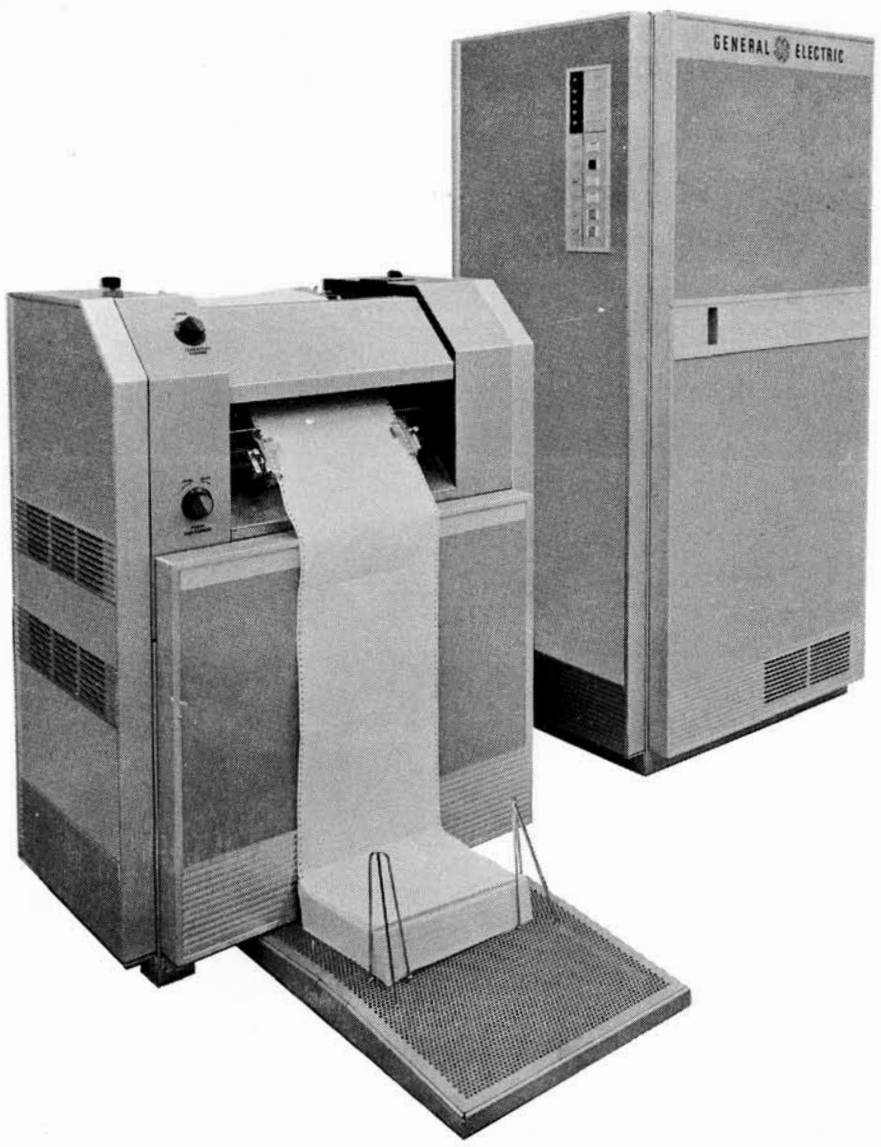


Figure I-12. High-Speed Printer

Paper Tape Reader and Punch

The paper tape reader and punch illustrated in Figure I-13 provides still another means for entering information into the memory of the GE-225 System and for recording its output. The paper tape reader reads information represented as punched holes in the paper tape and transmits it directly to the computer memory. Output information from the computer is punched on paper tape by means of the paper tape punch.

Figure I-13. The Paper Tape Reader and Punch

AUXILIARY COMPONENTS

Auxiliary Arithmetic Unit (AAU)

The addition of the General Electric Auxiliary Arithmetic Unit, shown in Figure I-14, extends the arithmetic capability of the GE-225 System. This unit is particularly useful in scientific and engineering applications where numerous floating point or double-word calculations are required. Binary arithmetic is described in Appendix A, which contains a summary of number systems.

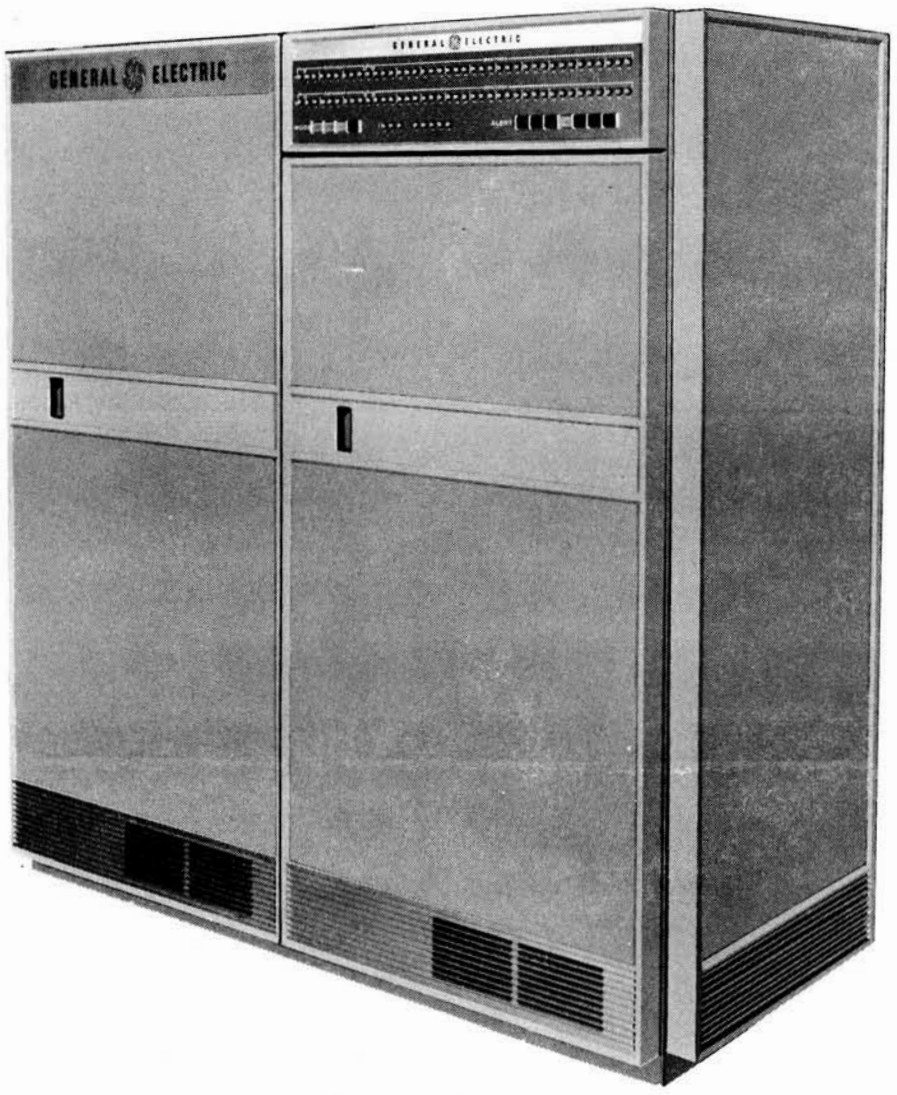


Figure I-14. The Auxiliary Arithmetic Unit

Mass Random Access Data Storage Unit

Another variation in system design is the extension of the memory capability of the central processor itself by the addition of one or more mass random access data storage (MRADS) units, illustrated in Figure I-15. This unit is extremely valuable in applications where large volumes of information must be stored and retrieved periodically with a minimum of delay. One of the chief advantages of the MRADS unit is that information stored does not have to be in any sequence, hence no sorting is required.

The use of two random access controllers, each having four disk units, adds a storage capacity sufficient to hold 275,200,000 decimal digits.

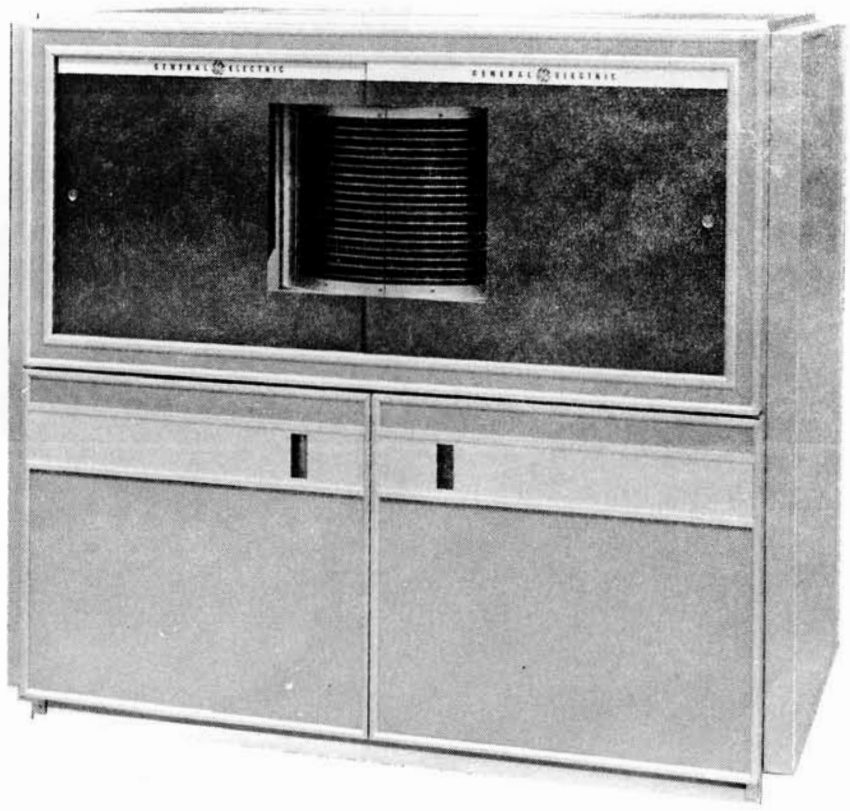


Figure I-15. The Mass Random Access Data Storage Unit

Data Transmission Controller

The General Electric DATANET-15 Data Transmission Controller shown in Figure I-16 is a special-purpose buffer-converter unit that provides remote stations with on-line access to the GE-225 Information Processing System.

The DATANET-15 accommodates up to 15 channels which may be connected to remote input/output stations via 2-wire cables, toll telephone, or telegraph quality channels. The DATANET-15 serves the multiple unit stations while the GE-225 is operating simultaneously with other peripheral equipment by employment of the automatic priority interrupt feature of the GE-225. (See Optional GE-225 System Features.) It accepts 5, 6, 7, or 8-level codes.

The DATANET-15 operates under control of the GE-225 program, and normally requires no media conversion or manual intervention. It accepts incoming messages from the transmission line for direct on-line entry into the GE-225 Central Processor. It receives messages from the central processor and prepares them for instant release over the transmission lines.

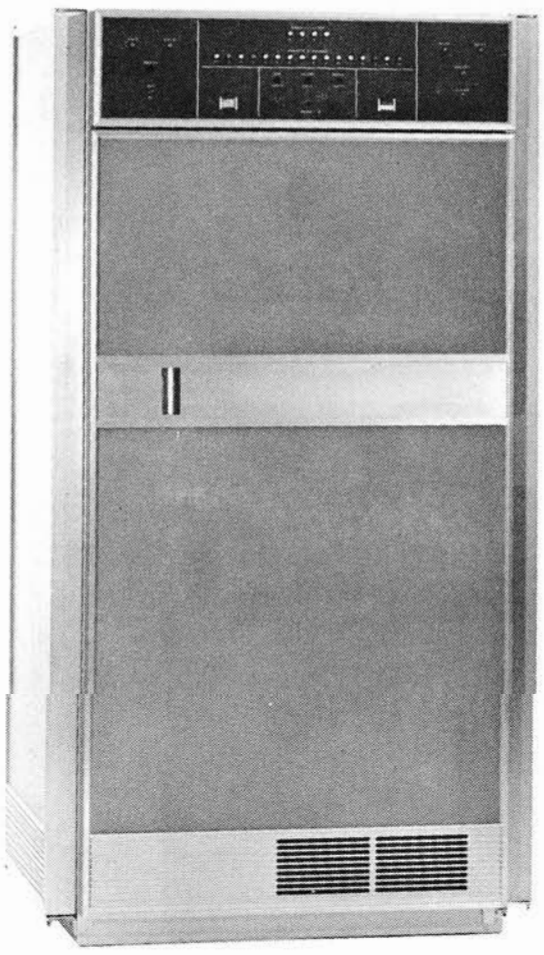


Figure I-16. DATANET-15

Manual Peripheral Switch Control Unit

The manual peripheral switch control unit illustrated in Figure I-17 is an optional feature which makes possible the switching of up to eight peripheral controllers between two GE-225 systems. This switching capability permits optimum utilization of both GE-225 systems during normal operation and also permits convenient equipment substitution for maintenance purposes. Any peripheral device normally connected to the controller selector may be switched by this unit.

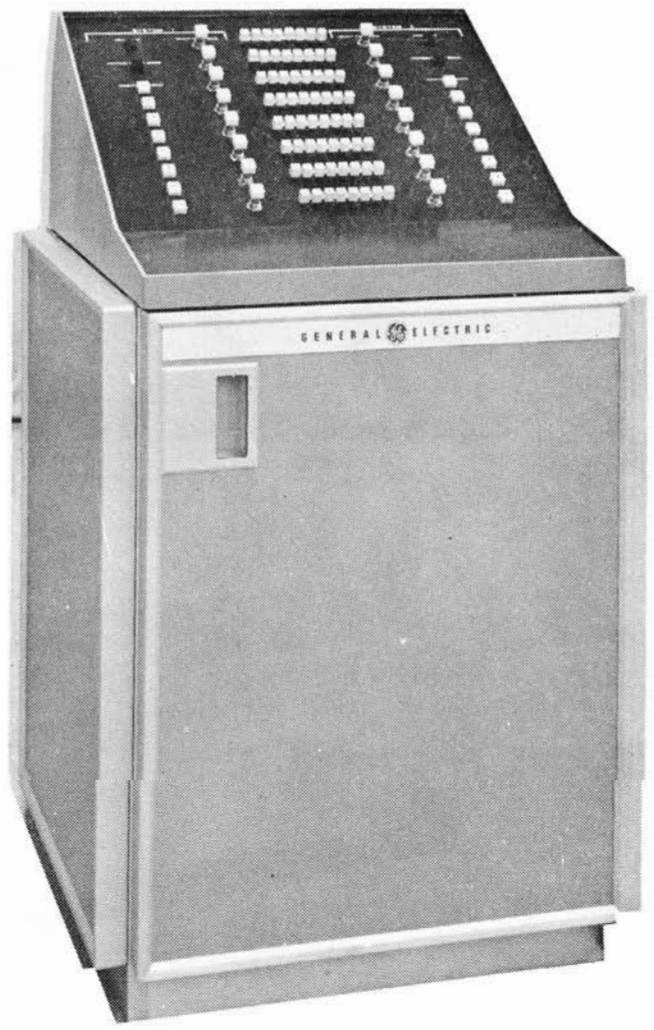


Figure I-17. Manual Peripheral Switch Control Unit

Document Handlers

The GE 12-pocket document handler is an optional input device which accepts random-size documents encoded with a special font of magnetic ink characters. It reads the magnetically encoded information directly into the memory of the computer and sorts the documents into any or all of its 12 pockets in a predetermined order.

Two models of 12-pocket document handlers are available for use in the GE-225 system. One, which reads documents at the rate of 1200 documents per minute, is illustrated in Figure I-18, and the other, which reads documents at the rate of 750 words per minute, is illustrated in Figure I-19.

In addition to the MICR font of magnetic ink characters which can be read by this equipment, COC-5 characters can also be read. A COC-5 Optical Reader option kit is available for use on the document handler, using the special five-bar COC-5 character font developed by General Electric. This permits the computer to print and re-enter computer information on deposit slips, bills, stubs, and other records without the need for special additional peripherals and with the advantage of higher speed.

The system can be used as a separate unit to sort documents (off-line mode) or it can be connected to the computer, with sorting controlled by the stored program (on-line mode). Although initially designed for processing bank checks, the document handler can be used to great advantage in any application where paper with magnetic ink characters provides input to the computer.

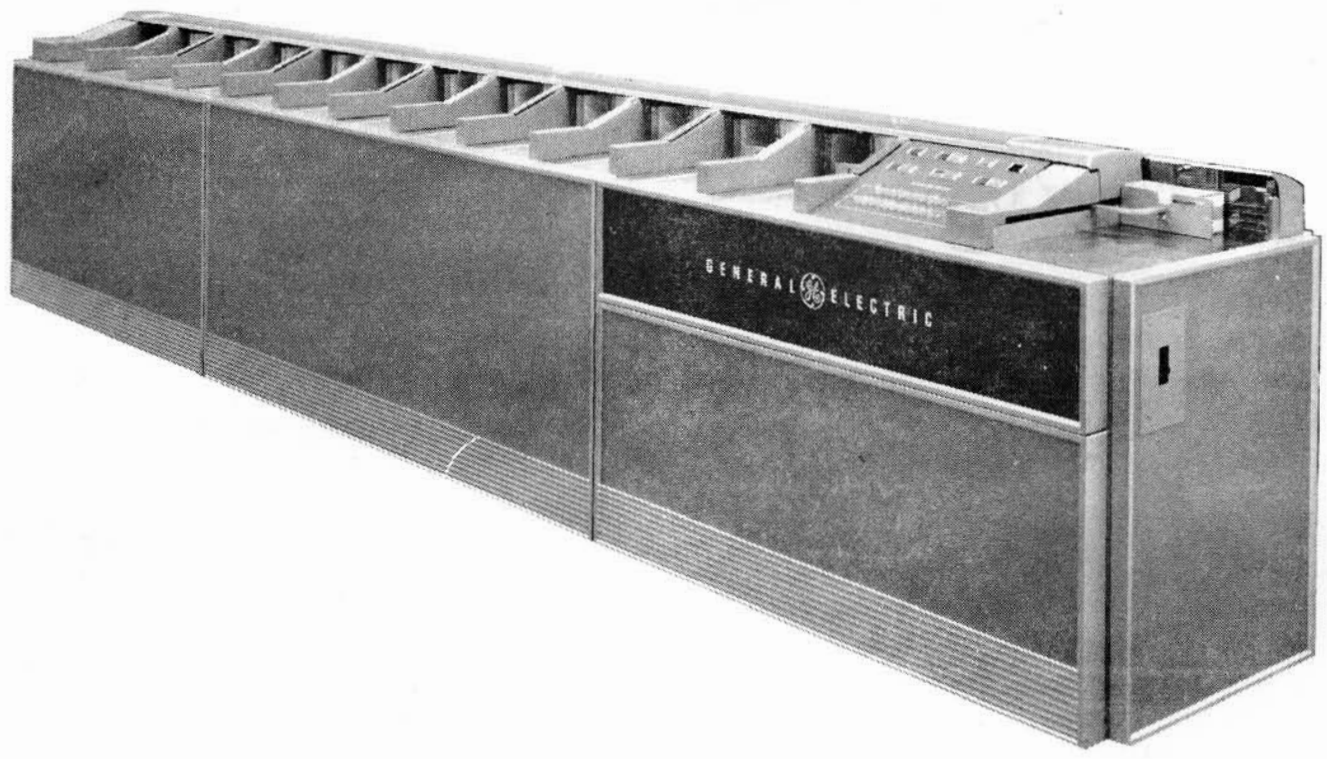


Figure I-18. The GE 12-Pocket Document Handler (1200 Documents/Minute)

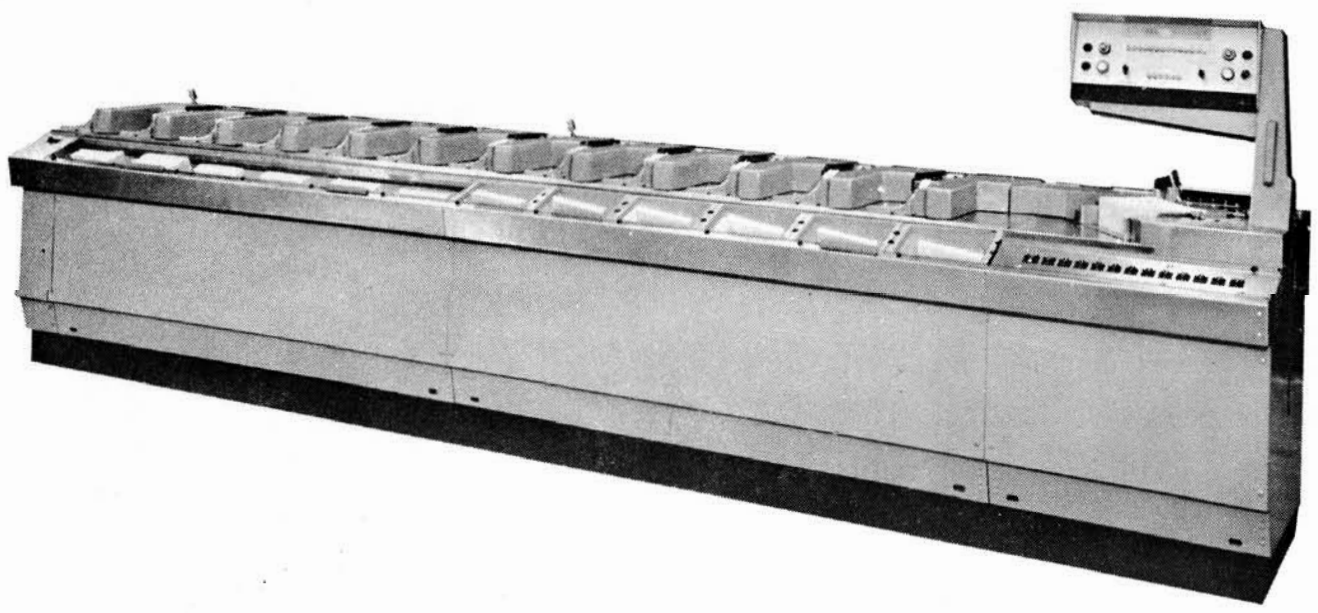


Figure I-19. The 12-Pocket Document Handler (750 Documents/Minute)

PRIORITY CONTROL

All the peripheral equipment just described, or any combination of them, can operate simultaneously in the GE-225 System. This is possible because each major GE-225 input-output peripheral device controls itself and executes its own commands; also because access to main memory is time-shared by all peripherals. A priority system in which each unit is assigned a priority number permits each peripheral to access main memory whenever necessary, without conflicting with any other peripheral.

All peripherals which do not access memory directly access it through a common control and data transfer channel known as the controller selector. The controller selector establishes communication between memory and the peripheral controller and allocates priority control to the various units.

The connections of the peripherals and the central processor are described in Section IV. By use of plug-in connectors, peripheral units can be connected in varying configurations and interchanged according to the user's requirements. Figure I-20 gives a schematic diagram which illustrates access of peripheral units to main memory via the central processor p. ority control.

OPERATOR'S USE OF EQUIPMENT

As a general rule, the operator uses only controls and indicators located on the exterior of the equipment. This manual specifies which operations may be performed by the operator and mentions others that must be performed by field engineers. Only where this operating manual specifies that the operator open doors or remove covers, should he do so. The reason for this is that most of the internal parts of the equipment have exposed electrical wiring; such areas should be accessed only by personnel who have electrical and electronic training and who are familiar with the equipment. It is in the interest of safety that the operator stay away from parts of equipment out of his jurisdiction.

GE-225 INSTRUCTIONS

It is necessary that the operator learn to identify the octal (binary) configuration of the various programming instructions, particularly those pertaining to the peripheral equipment. The operator reads the octal representation of instructions from the A and I register lights of the console, and he enters instructions in octal from the console's option switches. For a complete description of the more than 150 instructions, the operator should refer to the GE-225 Programming Reference Manual (CPB-252A).

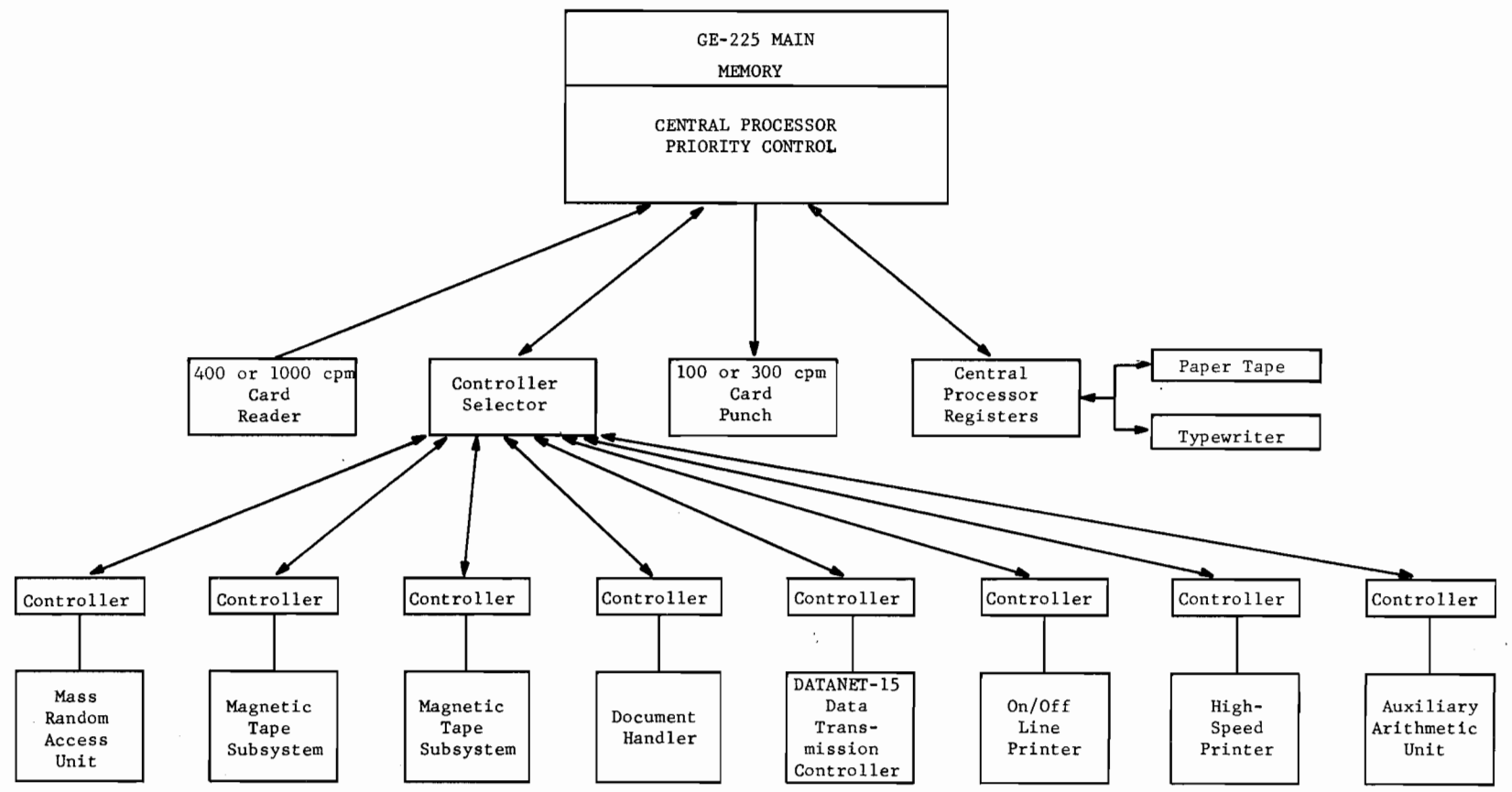


Figure I-20. Diagram of the GE-225 System

II. OPERATOR DUTIES

INTRODUCTION

The most important duty of the GE-225 System operator is the actual operation of the central procesor and the system's peripheral equipment. His knowledge of the equipment and its operating procedures and his cautious application of this knowledge can make considerable difference in whether the equipment operates at 100 per cent or at some unreasonably low figure such as 60 per cent. To a certain extent, the operator shares equipment responsibility with the service engineers, and a congenial, cooperative relationship between operators and service engineers can go a long way toward improving actual system performance.

In addition to the equipment responsibilities, the operator is responsible for monitoring and logging operations, assisting programmers, correcting transitory errors, and caring for input and output media. Here again, the results obtained from system operation will depend largely upon the skill and understanding of the operator. This manual will attempt to include necessary information for operator performance in these areas.

Equipment and Operation Responsibility

At some sites, the service engineer turns on the equipment, cleans working parts, and does any necessary maintenance before turning the system over to the operator. Each day such items as cleaning read heads with solvent, emptying the chip box on the paper tape punch, replacing worn ribbons on type-out machines may be done by maintenance personnel, but should be checked by the operator. In cases where there is heavy use of the equipment, it may be necessary for the operator to perform these duties at the beginning of each shift or even more often. There is a definite procedure for turning the equipment on and off; it is covered in Section III of this manual. The operator should know how to do this, even though it may be done by the service engineer. The operator will usually be responsible for shutting down the system at the end of the day.

During operation, the operator must service peripherals for individual runs; handle input and output; control the execution of the program; and, when the computer stops during an operation, locate the errors if possible and restart the program. From available instructions such as those in the run book or on the instruction card, the operator will load magnetic tape handlers, set switches, and make sure that the correct controller-selector plug is connected for each peripheral. He will load punched paper tape, load punched cards, including necessary loader cards and routines called for, and in general take care of and properly label all input/output media. Setting up peripherals takes time, but extra care here is time well invested.

A good operator is more than a button pusher. Intelligence and ingenuity are needed if the computer is to be efficiently utilized. The operator should examine output and compare it to examples in the run book. If the output does not look right, the operator may need to call on the programmer for help in determining correct procedures for running the program. Until a program becomes routine, most programmers are anxiously watching the output as it is being printed.

ACTION UNDER EMERGENCY CONDITIONS

Because the computer is an extremely expensive piece of equipment and because the operator may be solely in charge of it during much of its operating time, he must be thoroughly familiar with the procedures for handling emergency conditions. Besides preventing unnecessary damage to equipment, the correct action on the operator's part may also prevent harm to personnel. All operators and service engineers in the computer area at the time of an emergency condition should share responsibility for action.

Exact procedures of shutting down the entire system will depend on the urgency of the situation; that is, whether the emergency is predicted, about to occur,

is occurring, or has already occurred. For instance, a flood may be predicted; a fire may be approaching the system room; a peripheral may be shorting out; or a main power supply may have failed. In each case, the operator should weigh the importance of saving data against the amount of time he feels he has before he must get main power off to the system. In each case of doubt, throw the main power switches and worry about saving or retrieving data after the emergency is over.

Fire

Most fires can be avoided if matches, cigarettes, ashes, etc., are not thrown into wastepaper baskets. If a fire starts in the computer room, regardless of its cause, take the following action:

1. Immediately shut power off with the master circuit breaker on the main power panel.
2. Release the fire alarm warning signal.
3. Evacuate personnel from the area as quickly as possible.
4. Notify plant guards of the location of the fire.
5. Notify service engineering personnel of the emergency condition.
6. Use carbon dioxide extinguishers on the electrical equipment. (Never use water or any other kind of extinguisher on an electrical fire.)

Flood

If water gets into the computer room or in a computer wiring area such as under a false floor, take the following steps:

1. Shut power off. If flooding appears to be slight and gradual, follow normal shutdown procedure. If flooding is extensive and fast, shut power off with the master circuit breaker on the main power panel.
2. Notify building maintenance personnel and plant guards.
3. Notify service engineering personnel.
4. Evacuate personnel as necessary.

Power Failure

If external power should fail, take the following steps:

1. Immediately shut power off at the master circuit breaker on the main power panel. (This is necessary to avoid damage to the equipment.)
2. Notify the service engineer of the power failure.

Air Conditioning Failure

When air conditioning fails from any cause, room temperature will rise to a point which endangers computer operation. Temperatures above 80 degrees Fahrenheit are considered dangerous. When air conditioning fails, take the following action:

1. Follow normal shutdown procedures to remove power from the central processor and peripheral equipment.
2. Notify service engineering personnel.
3. Notify building maintenance personnel.

Injury to Personnel

Emergency phone numbers of medical personnel should be posted at the control panel or in a conspicuous place in the computer area. If there is an injury to personnel, take the following action:

1. Do not move the injured person unless his position would cause further injury.
2. Notify the designated medical personnel.
3. If medical personnel are not on duty in the plant, contact any building security personnel who will assist with first aid and/or ambulance service.
4. If conditions indicate a delay in continued computer operations, follow normal shutdown procedures to remove power from the central processor and peripheral equipment.

Safety Considerations

To avoid serious injury, operating personnel

should adhere to basic safety practices. Operator functions have been specified with a view to permitting the operator to handle equipment only to the degree that it is safe, both for himself and for the equipment. The following list specifies safety considerations which are of importance to all operators.

1. Do not remove covers to any equipment unless specifically instructed to do so by this operating manual and confirmed by the service engineer.

2. Do not attempt to remove a jam from any machine while it is running.

3. Do not operate a machine with covers off.

4. Do not use power extension cords in the operating area.

GENERAL SITE OPERATING PROCEDURES

Each site must develop methods of scheduling machine time, of keeping logs of machine performance, of recording information about programs run, and of operating a tape and card library. There are, of course, numerous ways to do this, and some locations may have individual problems which make one method better than another. One or more methods will be suggested here, and the sample forms included may be used without change, or may be used as a basis for designing forms to better suit a particular operation.

Schedule of Computer Operation

A sample schedule of operation is shown in Figure II-1. Such a form is useful for precise scheduling. Although scheduling of computer time is a management problem, the operator should be aware of how scheduling is done. There are two methods of scheduling computer time, block scheduling and individual scheduling. In block scheduling, blocks of time are assigned to an organization or a customer to use as needed. In individual scheduling, the name of the person involved is entered on the scheduling form. In Figure II-1, a combination of the two methods has been used. The first two columns show block scheduling, and the third column shows individual scheduling.

If a programmer does not show up at the appointed time, his name can be shifted to the bottom of the block or used as a fill-in later in the day. The operator should encourage programmers to show up early, in case the previous run is completed ahead of schedule. It is important that computer time be scheduled so the system is never idle; the time is too valuable to ever be wasted.

Instructions to the Operator

There are numerous ways in which the operator can be given the specific instructions needed to run a program. These may vary from verbal instructions to a whole book on the operation of a single program. Of course, the more standardized instructions become, the easier it is for all concerned. Completed production programs have Programmer's Run Books which should contain all the information an operator would ever need to run a program. At many locations, operations are so standardized that there are run books for every program and the same programs are used day in and day out. Where a program has not reached its final stage of completion, the programmer has probably not finished writing the run book. In such cases, the programmer will either be on hand to direct the running (usually debugging) of the program or provide written operating instructions for each particular operation. Several instruction forms will be described and illustrated.

Programmer's Run Book. This book is actually a procedures manual; its purpose is to provide a written record of everything pertinent to a run. It is identified by the title of the run and usually gives the name of the programmer. Some of the information is written specifically for the operator. Even portions of the manual which are not directed to the operator will be of interest to him, for they will assist him in understanding what the program is about.

Under the section heading of 'Operator Instructions,' the following types of information are found:

1. Error procedures, rerun and restart instructions, and average run time. A list of program halts, their meaning, and specified operator action.

2. Initial setup for tape input and output, including tape labels and controller plug numbers; disposition of tapes.

3. Printer controller plug number, paper form number, setup of print position, VFU tape name, line number, punch number, and length.

4. Card description for use with card punch, including form number of card and color code, if any.

5. Document handler controller plug number, description of or number of plugboard, if used.

Schedule of Operation

225 Machine No. 1
Date 4-12-62

6 AM	AM	PM	PM	PM
6:05	9:05 ENGR'G	12:05 SYSTEMS	3:05 SMALL	6:05 PR + D
6:10	9:10	12:10 DEVEL.	3:10	6:10
6:15	9:15	12:15	3:15	6:15
6:20	9:20	12:20	3:20	6:20
6:25	9:25	12:25	3:25 PRODUCT	6:25
6:30	9:30	12:30	3:30 RESEARCH	6:30
6:35 PR + D	9:35	12:35 Richards	3:35	6:35
6:40	9:40	12:40	3:40	6:40
6:45	9:45	12:45	3:45	6:45
6:50	9:50	12:50 SAMUELS	3:50	6:50
6:55	9:55	12:55	3:55	6:55
7:AM	10 AM	1 PM	4 PM	7 PM
7:05	10:05 1ST. NAT'L.	1:05	4:05	7:05
7:10	10:10 BANK	1:10	4:10	7:10
7:15	10:15	1:15	4:15	7:15
7:20	10:20	1:20 WHITE	4:20	7:20
7:25	10:25	1:25	4:25	7:25
7:30	10:30	1:30	4:30	7:30
7:35	10:35	1:35	4:35	7:35
7:40	10:40	1:40 PAULSON	4:40	7:40
7:45	10:45	1:45	4:45	7:45
7:50	10:50	1:50	4:50	7:50
7:55	10:55	1:55	4:55	7:55
8 AM	11 AM	2 PM	5 PM	8 PM
8:05	11:05	2:05	5:05	8:05
8:10	11:10	2:10 DAVIDSON	5:10	8:10
8:15	11:15	2:15	5:15	8:15
8:20	11:20 NATURAL	2:20	5:20	8:20
8:25	11:25 GAS CO.	2:25	5:25	8:25
8:30	11:30	2:30	5:30	8:30
8:35 ACCOUNTING	11:35	2:35 SMITH	5:35 SPECIAL	8:35
8:40	11:40	2:40	5:40 SYSTEMS	8:40
8:45	11:45	2:45	5:45	8:45
8:50	11:50	2:50	5:50	8:50
8:55	11:55	2:55	5:55	8:55
9 AM	12 NOON	3 PM	6 PM	9 PM

Figure II-1. Sample Schedule of Operation

6. Typewriter tab settings, if non-standard. Description of typeouts which could include a dictionary of informative typeouts and corresponding operator action.

7. Order of card placement in card reader, including program cards, data cards, loader cards, transfer cards, blank cards, and any others used.

8. All instructions for setup of the control console, such as option switch settings.

9. Memory dump requirements and instructions for the dumps.

10. Take-down procedure, which covers information such as disassembly of the program and data decks of cards, labeling of punched cards, identification of reports from the printer, rewinding and labeling of all tapes. It specifies disposition of all cards, tapes and reports.

Areas of information in a run book which are not written directly for the operator, but which should nevertheless be of interest and assistance to him are:

1. General run description. This is a narrative description of the scope and purpose of the program. It usually states the system components required for the program's operation.

2. A general (top level) flow chart. This usually shows the source and disposition of all input/output. It indicates the input/output tapes, paper tape, cards, printer etc., and specifies tape unit numbers, plugs, and labels.

3. Input and output specifications. This covers card and tape formats and descriptions of each field. Printer formats and field descriptions are also given.

4. Detailed flow charts. These indicate all of the major programming steps.

5. Memory allocation chart. This lists the areas of the program in memory and shows locations of input, output, constants, working storage, and available memory. It also shows locations of major subroutines.

Operator Instruction Sheet. This form, illustrated in Figure II-2, was developed for use in run books, but it has been found useful in giving instructions for nonproductive types of runs and during debugging stages of runs which would later have their own run books.

Operator Instruction Cards. Cards can be used to provide a compact form of instructions to the operator, as illustrated in Figure II-3. Here, all necessary information is written on a card the size of a tab card. It should be noted that on each of these cards there is a space for the operator to write his initials, the date, the running time of the program, as well as any special remarks about the operation of the run.

Operator Manual. Frequently, a site will make up a manual consisting of exerpts of the operating portions of run books and other pertinent operating instructions, such as those for utility routines, assembly, and compiler manuals. Depending on the scope of the instructions and the familiarity of the operator with the various programs, the manual may be used instead of the more lengthy run books or other manuals on specific programs.

Error and Operator Corrective Action

Specific errors and operator corrective action are described in the individual sections on each peripheral and in the section on the console. However, a few generalized remarks on these procedures can be made here.

When a program stops, the operator must determine whether the error condition was an operator error, program error, or an equipment error. This determination is often a matter of judgement on the operator's part. The more simple of each of these types of errors can often be corrected on the spot and the program can be continued. Often a second pass at the program will be successful. If the error is found to be caused by the operator or by the program, the operator should make a note of it in the operator's log book for future use.

Operator errors. It is obvious that for this type of error, the operator either made a mistake in the order of procedure or, for example, in the actual setting of switches, placing of tapes on tape handlers, or method of feeding input cards or paper tape. The solution is to review the instructions for the particular operation, then check everything that was done to see if an error was made. In checking peripheral equipment, the operator will soon learn which are the most common mistakes. Each peripheral in use will have to be examined to be sure it is properly set up and in a ready condition.

GE 225 OPERATOR INSTRUCTION SHEET

CK 64

RUN _____
SYSTEM _____

PROGRAMMER John S James
DATE 6/20/62

TAPE UNIT	PLUG NBR	TAPE REEL	DATA IDENTIFICATION	DATE CREATED	DISPOSITION
0					
1	1	234	Old Master File	6/12/62	Save
2	1	361	New Master Pay File	6/20/62	Save
3	1	Blank			
4	1	Blank			
5					
6					
7					

OTHER PERIPHERAL UNITS USED	DATA IDENTIFICATION
CARD READER	Changes to master file
CARD PUNCH	
HIGH SPEED PRINTER	Listing of New Master Pay File
MRAF	

WHEN THIS OCCURS:	DO THIS:
Halt at 2164	Restart the program
Halt at 2168	Toggle Switch # 3

SET SWITCHES	
#	FUNCTION
3	Reject pay card

RERUN INSTRUCTIONS:

Figure II-2. Sample Operator Instruction Sheet

SYSTEM [illegible] | TIME ESTIMATE [illegible] | NAME [illegible] | JOB NO. [illegible] | EXT. [illegible]

INSTRUCTIONS TO OPERATOR:

Dump tapes 3 and 4 in octal and BCD

Take memory dump at end of run.

OPERATOR COMMENTS:

[illegible]

OPERATOR INITIAL DATE & TIME COMPLETED [illegible] 6-30-62 [illegible] | TIME USED [illegible]

INPUT						OUTPUT						
PAPER TAPE		CARDS		MAG TAPE		CARDS		MAG TAPE		PRINTER		
YES	NO	(YES)	NO	TU	REEL #	YES	NO	TU	REEL #	FORMAT	No. Copies	Save
				1	72[illegible]							
				2	241							
				3	Blank			3			2	✓
				4	Blank			4			2	✓

NAME George Hobbs JOB # 421 EST. TIME 30 min. CALL X EXT. 3101 SYSTEM 2

DEBUG X PRODUCTION

PRIORITY PLUGS IF NON STANDARD
AAU HSP SORT. ADP TAPE CTRL. 1 2

GECOM ☐ GAP 412 ☐
GAP ☐ WIZ ☐
CPM ☐ L.P. ☐

SWITCHES	1 2	3 4	5 6	7 8	9 10	11 12	13 14	15 16	17 18	19
TAPES	(1)	(2)	(3)	(4)	5	6	7	8	9	0
REEL # (INPUT)	133									
RING OUT	X									
SAVE	X									

PRINTER X # PARTS 2 | LOOP Stand. | FORM

SPECIAL INST:

Save and return typewriter messages.

NORMAL STOP IS	2040
DUMP CORE	X
DUMP TAPES	4
DATE IN	8-15-62
DATE RUN	8-15-62
RUNNING TIME	28 min.
OPERATOR	[illegible]
SYSTEM USED	2
DATE OUT	8-16-62

Figure II-3. Two Types of Operator Instruction Cards

Program Errors. The operator will want to make sure his equipment and operating procedures are in order before blaming the program for the halt. A persistent repetition of halts in the same area of the program is apt to be an indication of a program error or, if there has been a series of halts known to be due to programming errors, the operator may save time by checking first for another program error. During the running of a program in the debugging stage, and when the programmer is not present, the operator must have a definite understanding about whether he is to make any program changes or corrections on his own. When a program is past the debugging stage, the operator should consult the run book for any applicable instructions, but in no case should he make changes in the program.

A review of the section of this manual on console operations will explain procedures of program changing. The first thing for the operator to notice is the information in the I Register which tells him what instruction is not yet executed, and the information in the P Register which is the location of the I Register's instruction. The information in the A Register is only meaningful to one who has a knowledge of the program at that point.

Equipment Errors. If an error condition cannot be pinpointed at the time as an operator or a programming error, the operator should call the service engineer for help. Until the service engineer arrives, the operator can save valuable time by making a careful record of all console indicators, switch settings, and peripheral indicators so he can give it to the engineer the moment he arrives.

Another type of error is that related to input/output media. The trouble can be a bad card, a bad spot on the magnetic tape, or a worn or torn portion of paper tape. Most card jams can be cleared by the operator. Magnetic and paper tape flaws can usually be seen upon inspection. Procedures to follow in correcting or replacing faulty input/output media are described in the sections of this manual which apply to individual peripherals.

Reporting forms for Equipment Failure. At some locations it has been found helpful to use a special form for reporting equipment difficulties and corrective action by service engineering personnel. Figure II-4 is an example of such a form.

Computer Utilization Logs

It is necessary that complete and accurate logs be kept of all machine time. The operator can see how important these logs are when he realizes that each minute of time is a vital cost consideration, and it is mainly from his logs that the time utilization breakdown is made. Charge numbers may be required by the accounting office for each type of time. The information is used by management in scheduling computer time and in determining whether the system is being used effectively. The programming supervisor can use the information to determine how much time is used for certain approaches to programming and in determining the efficiency of his programmers (that is, the amount of time required for debugging). The log is also used by maintenance personnel in learning the details of difficulties experienced during operation and in determining the efficiency of maintenance procedures.

The exact form of the log should depend upon the cost accounting of the particular site. However, there is emough similarity between activities to make the following two examples of logs quite typical of the kind of log an operator would use. The log must account for all time during which the computer is turned on. Besides designating the time used as good production time and debugging time, the log must account for scheduled and nonscheduled maintenance time. Because both the operators and service engineering personnel are responsible for computer time, they usually use the same log. Here again, the operator must build a cooperative working arrangement with service engineers to avoid misunderstandings over the use of the log.

Figure II-5 is a daily computer log used by one site. Figure II-6 is a more general type of log which by means of a code, gives the user a choice of 16 types of time classifications. The log must be kept at the control console for use at the time of actual operation.

Systems which have a time clock supplement and verify the information on their logs by use of a time card (Figure II-7). The card is a regular tabulator card designed for use with key punch equipment. It should be noticed that there is a space to indicate unused time, so a record can be kept of all the time during which the computer is on. The user fills out the card, and gives it to the operator to put into the time clock. The time clock is made especially for installation under the edge of the console desk where it can be easily reached by the operator. When the time card is pushed into the clock, it prints the start time. When the card is pushed in a second time, it prints the stop time. Time is recorded in hours (24 hours to the day) and in hundredths of hours.

Although the operator is not usually responsible for scheduling of computer time, he can do much to insure efficient use of the time. He can make known (through his supervisor) any irregularities in use of computer time. He can also make it a custom to see that miscellaneous but necessary programs are always available to run when computer time unexpectedly becomes available.

INFORMATION PROCESSING CENTER
RECORD OF PRODUCT SERVICE

DATE: 5-17-62 TIME: 0200	DATE: 5-17-62 TIME: 1850
TROUBLE Two lights are burned out on the console. They are A→I and light "0" in the I register.	P.S. ACTION Replaced A→I and Io.
OPERATOR: R. James	PRODUCT SERVICE: J. Kinder
DATE: 5-18-62 TIME: 1420	DATE: 5-18-62 TIME: 2000
TROUBLE Printer slewing extra pages.	P.S. ACTION Examined vertical slew tape and recommended installing a new one--the one now in use is scotch taped and bumpy and probably causes the extra slews.
OPERATOR: M. L. Johnson	PRODUCT SERVICE: Dave Feeney
DATE: 5-20-62 TIME: 1000	DATE: 5-20-62 TIME: 1040
TROUBLE Read errors on Tape handler "C".	P.S. ACTION Adjusted read preamps on this and all other handlers. Cleared many problems.
OPERATOR: M. L. Johnson	PRODUCT SERVICE: Dave Feeney

INSTRUCTION: OPERATOR RECORD DATE, TIME AND DIAGNOSED TROUBLE THEN SIGN.
PRODUCT SERVICE RECORD DATE, TIME AND ACTION THEN SIGN.

Figure II-4. Sample Reporting Form for Equipment Repair

DAILY COMPUTER LOG

Shift *First* | Date *Aug. 20, 1962* | Operator *G. Harris*

1. Record all times
2. Fill out Hang-up sheet and Dump memory at all abnormal stops.
3. Explain all error time in remarks.

RUN DESCRIPTION	Programmer	Run Number	TIME RECORD			UTILIZATION			RERUN				MAINTENANCE			Remarks (Explain all Errors and Reruns)
			Start	Stop	Elapsed	Production	Debug	Idle	Program Error	Operator Error	Machine Error	Misc. Error	Scheduled	Unsched.	Facility Failure	
				8:03	3			3								
Posting	Roach	2010	8:03	8:33	30	30										
			8:33	9:03	30					30						Switch 3 was down
			TOTALS		63	30		3		30						
							TOTAL RERUN		30			TOTAL MAINT.				

Figure II-5.

Sample Daily Computer Log

CONSOLE LOG

JOB NO.	START SET-UP	START PROCESSING	END PROCESSING	TOTAL TIME	EQUIPMENT USED	CODE	OPERATOR NAME	CUSTOMER REMARKS	PRODUCT SERVICE REPORTS

1. Normal Routine
2. Program Error
3. Operator Error
4. Machine Error
5. Input Error
6. Debugging
7. Overhead
8. Training
9. Utility Failure
10. Demonstration
11. Unused
12. Facility Failure
13. Scheduled Maintenance
14. Unscheduled Maintenance
15. System Checkout
16. Power-On Time

Figure II-6.

Sample Operator and Maintenance Log

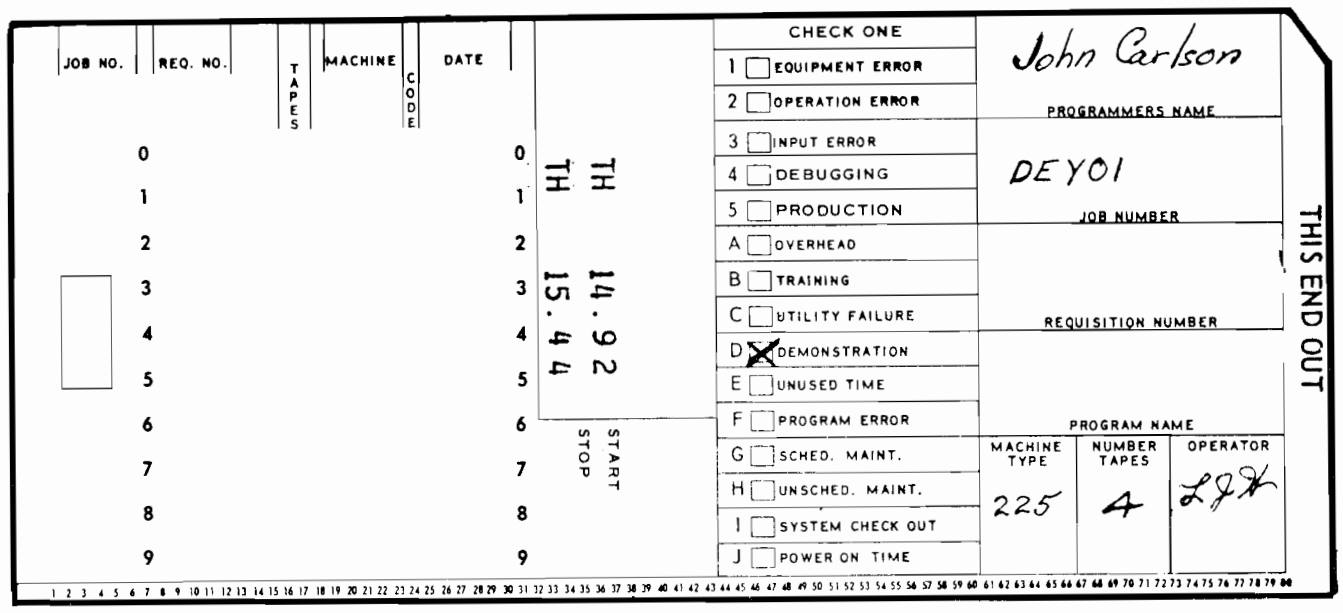


Figure II-7. Sample Time Card

Log Terminology. It is important that there be complete understanding of log terminology by both those who make the logs and those who use them. If there is any doubt about the meaning of any of the terms, the operator should insist that each term be defined in writing. The following partial list of terms may or may not provide the exact meaning necessary to understand the log terminology of a particular site, but it should provide some familiarity with the terms.

Machine Error. Lost time caused by machine malfunction.

Operator Error. Lost time caused from operator error.

Input Error. Time lost because of faulty input data.

Debugging. Applies to all work in program checkout stage.

Production. This code is used for all work that is checked out and known to be working properly.

Overhead. Time charged to computer operations, such as tape edit and tape cleaning.

Training. Time when a training group is using the computer, such as product service training, computer operations training, and other internal groups.

Utility Failure. Time lost through power failure.

Unused. Time when the machine is idle.

Facility Failure. Time when failure is caused by air conditioning, humidity control, etc.

Program Error. Lost time due to program error.

Scheduled Maintenance. This is used when service engineering personnel are on the machine during the normal maintenance time.

Unscheduled Maintenance. This is used when it is necessary for service engineering personnel to work on the machine during normal center operation; but it does not necessarily halt operations on equipment other than that being repaired.

System Checkout. This category will be used if operator is having machine trouble and decides to run some diagnostics to determine trouble areas.

Power-on-time. Time starting when power is turned on at the beginning of each day and ending when power is turned off at the end of the day.

Total available time. Includes all time that the equipment has power on, less preventative maintenance.

Library Storage and Reference Files

A regular library storage and handling procedure should be established for both tapes and cards. Some sites may be large enough to have a librarian to control the storage and use, while at other locations, the operators have this responsibility.

Magnetic Tapes. Either a librarian or the senior operator should establish procedures for storage, checkout, and use of master tapes, save tapes, and scratch tapes. Master tapes are those which contain a master file of permanent or semi-permanent information. The information on the tapes is updated

rather than replaced. Save tapes are those which contain information which must be saved for a short period of time. Scratch tapes are those which have information which is of no further use and may be destroyed.

Tapes should be identified by numbers painted on their reels. A tape control form such as the one illustrated in Figure II-8 can be used for record purposes.

the controller, and the manager of the computer center before a change may be made.

An example of tape library procedure is described in the following paragraphs. This example explains the procedure used by an activity which has a librarian and keeps a tabulator card record of the use and storage of every tape in its library. Like the other examples in this manual, it may either be copied or used as a basis for designing procedures to more

TAPE CONTROL FORM

Customers Name: Johnson

Program Code: King and Allen Tape

Charge No.: 1461

Tape Unit: E-1

COMMENTS:

OPERATOR:

REEL NO. 473 | OF

PROGRAMMERS NAME: Johnson

JOB NO. 1461 | UNIT E-1

TITLE

FROM JOB | STEP

TO JOB | STEP

SEQ. NO. 1 of 1 | OPER.

DATE SAVED 7-16-62

Figure II-8. Sample Tape Control Form

The left portion of this form is made in triplicate, and the first copy has an adhesive back. The right portion of the form is in duplicate. When a programmer checks out a tape for use, he fills out the form and fastens the adhesive backed portion to the reel itself. He keeps one copy of the form, and gives one copy to the librarian (or operator). Activities which have a sizable and active tape library use the information from these forms to punch tabulator cards which can be sorted and used to give various printouts of tape library information. A log of tape use may be kept on a form like the one in Figure II-9.

Because of the importance of master program tapes, special precautions are taken with these. A duplicate of a master tape is usually kept for use in case some of the information is destroyed and needs to be retrieved. As an added safety precaution, duplicates of master tapes are stored in a different location and often in a different building to eliminate loss of information, for example, in case of a fire. Duplicates can easily be made by use of the tape copy routine. At most locations, no change may be made in a master program tape without special authorization. Figure II-10 is an example of a form used by an activity which requires the signature of the assigned programmer, aptly fit a particular situation.

1. Two source logs of tapes are kept for each 24-hour period. One log is at the console where tape reels to be saved are listed. The other is in the tape library and lists save tapes released for use.

2. The release of save tapes (to become scratch tapes) is the responsibility of the programmer. Release may be made either by a retention schedule or by initialed entry of the library's tape log.

3. At the beginning of each working day the librarian performs the following functions:

   a. Collects the tape logs.

   b. Updates the tape file (of tab cards on each save-tape reel) as to retention schedule or entries from the logs.

   c. Updates cards by key punching information about scratch tapes that have changed to save tapes.

TAPE RECORD LOG — TAPE HISTORY

REEL NO.	RUN NAME OR NO.	FILE NO.	NO. OF REELS	REEL STATUS DATE	HANDLER NO.	TRANS-ACTION DATE	RESPONSIBLE PROGRAMMER	REMARKS	DATE CLEANED	DATE RECEIVED
495	Posting	2030	1/1	3 days	D	Aug. 1	Mary Roach		5/15/62	6/1/62

Figure II-9. Sample Log of Tape Use

d. Removes cards that represent save tapes changed to scratch tapes, and places them in the history file.

e. Makes a new scratch-tape card for the tape released in step d.

f. Files newly made cards for save tapes by file number and date, with the latest date first in the files.

g. Files updated scratch cards behind remainder of scratch cards in the file to provide rotation of tapes.

h. Preselects all tapes for the console operator for all shifts and places these cards in an in-use section of the file. Scratch tapes to be used are taken to correspond to the first cards in the scratch file (this permits tape rotation).

i. Places cards corresponding to the scratch tapes used the previous day in the back of the scratch-tape file.

4. If the librarian is absent, the senior operator selects scratch-tape reels corresponding to the cards in the front of the scratch-tape card file and places the cards in the in-use section of the file.

5. After the card file is completely updated for the day, a complete listing is made of the cards including the in-use file.

The retention schedule mentioned in step 3b above is a schedule used with production-run tapes. The schedule lists data numbers which identify a reel as containing a certain kind of data. Depending on the kind of data, the reel must be kept a specified number of days after the save tape was originated.

Cards. There should be a working card file and a duplicate card file of all frequently used routines such as sorts, loaders, and dumps. The duplicate file is necessary to permit reproduction of the card in case the card in the working file is damaged or lost. Each time cards are removed from the duplicate file, the cards must be reproduced and replaced so as to keep a complete file at all times.

See Section VI of this manual for additional information on card handling and storage.

MASTER PROGRAM TAPE CHANGE REQUEST

Name or RUN # 435

Date 8/2/62 Requestor Bill Mann

1. Problem Encountered:

2. Specifications of Change:

a) Does this change specifications of run [X] No [ ] Yes How?

George Roe
Comptroller

3. Description of how change corrects problem:

Provides for punching of cards

John Hobbs 8/2/62
Assigned Programmer Date

Reviewed by: R.L. Brooks Date 8/3/62

Comments: (Include planned date of completion)

Must be completed 8 4 62

Reviewed by: Avon Harris Date 8/3 62
Mgr. Computer Center

Comments:

Return To Howard Johnson

Before this Date 8/5/62
Suspense Date

Change Made: Date 8/4/62

Old Master Inst. Tape Jan. 20, 1962 # 241
Date & Reel # of Old Master

New Master Inst. Tape Aug 4, 1962 636
Date & Reel #

Senior Opr. on duty Doug Powell

Figure II-10. Sample Master Program Change Request

ASSISTANCE TO THE PROGRAMMER

The operator is an essential member of the team that uses and operates a GE-225 System. The programmer is also essential, and the wise operator will learn to cooperate and get along with each individual programmer. It helps if the programmer knows something about the operation of the computer. Since the programmer uses the GAP language or some other pseudo coding technique, he may or may not be completely familiar with the actual machine language. With a new system, programmers will all be anxious to try new programs as soon as possible and they will be interested in learning all they can about the computer. The programmer who devises a run will often be present when the program is debugged and during initial production runs.

Debugging

The term debugging refers to the process of determining the correctness of a computer routine, locating errors in it, and correcting them. The term is also used, mainly by service personnel, in reference to detecting and correcting malfunctions of the computer equipment. Each new program must go through a stage of debugging, for it is inconceivable that a program which contains, for example, 10,000 instructions, would not have errors in it. There are many ways in which crippling mistakes can be made in a program, and it is mandatory that each mistake be found. Console debugging such as stepping through a portion of a program on the computer, is frowned upon because it is a waste of time for all concerned as well as a waste of computer time. The best procedure (after operator and equipment errors have been ruled out) is to note the error indicator lights and the contents of the I, A, and Q registers and of the P counter; take a complete memory dump; and remove the program so that the next run can be started. Some installations use a 'Hang-up Sheet' as illustrated in Figure II-11. This form permits the operator to quickly indicate the exact conditions at the time the program stopped.

Some installations use a 'Debug Instruction Sheet' such as the one illustrated in Figure II-12. This permits the programmer to designate specifically, without being present, what is to be done. The operator may or may not know when an error is encountered in the program. The program may 'hang up' when it comes upon an error which means it will stop unintentionally (at a place where it was not programmed to stop). The program may also 'hang in a loop' when it comes upon an error, which means it will repeat a loop indefinitely and never get out of it. The operator should be able to identify programmed loops by referring to the run book which specifies these loops. The operator, in some cases, may not recognize that the program is hung in a loop until he notices that the time limit for the program has been exceeded. A rule is sometimes made that a program should be stopped when it has exceeded its known time length by ten per cent. However, when peripheral equipment has stopped all visible operation and the central processor continues to operate, the operator can very well suspect that the program is in a loop. If, after checking the run book, the operator is still uncertain of the computer's operation, he can set the AUTO/MANUAL switch on the console to MANUAL and step through the program to determine exactly what is going on. (See Section IV for directions on manually stepping through the program). In some cases, the program may continue with whatever processing it is supposed to be doing, but produce faulty results, for example, it may punch cards with incorrect information on them. In these cases, the operator will never identify an error condition, but it is still important that he provide the programmer with a memory dump and any other information so that the programmer can then analyze the program.

Relationship Between Operator & Service Engineer

The operator must learn to recognize when any malfunction needs the service engineer's assistance. He will learn that better cooperation is obtained from the engineers if he does not call them unnecessarily and; if when the engineer's services are necessary, he can provide him with a complete description of what went wrong, supplying all necessary information from panel indicators at the time of equipment stoppage. This manual tries to spell out in detail the division of authority and responsibility between operators and service personnel; but it must be remembered that there is leeway for operating sites to alter this relationship to best fit the schedules, equipment, and personnel of the individual location.

Operator Behavior and Appearance

The operator should maintain proper decorum and appearance in the operating room. Computer installations are always more or less show places where important visitors are brought by company executives. The operator, by his behavior and appearance, can add or detract from the favorable impression that should be made. As a skilled individual, the operator should seek to maintain status in that respect.

HANG-UP SHEET

Posting Run — NAME OR RUN #

DATE 7/18/62

E. C. Jones — PROGRAMMER

TIME 1430

Caution: Be sure all information has been recorded before taking memory dump.

☒ ALERT HALT

☐ BRANCH HALT

☒ LOOP (Try to give the Branches)

Remarks:

TAPE CONTROLLER

(ⓧ LIGHT ON)

◯ Ready	◯ End of File	⊗ Alert
◯ N Reg	⊗ Alert Last Record	◯ Memory Alert
⊗ Lateral Parity	◯ Horizontal Parity	MOD ◯ Alert

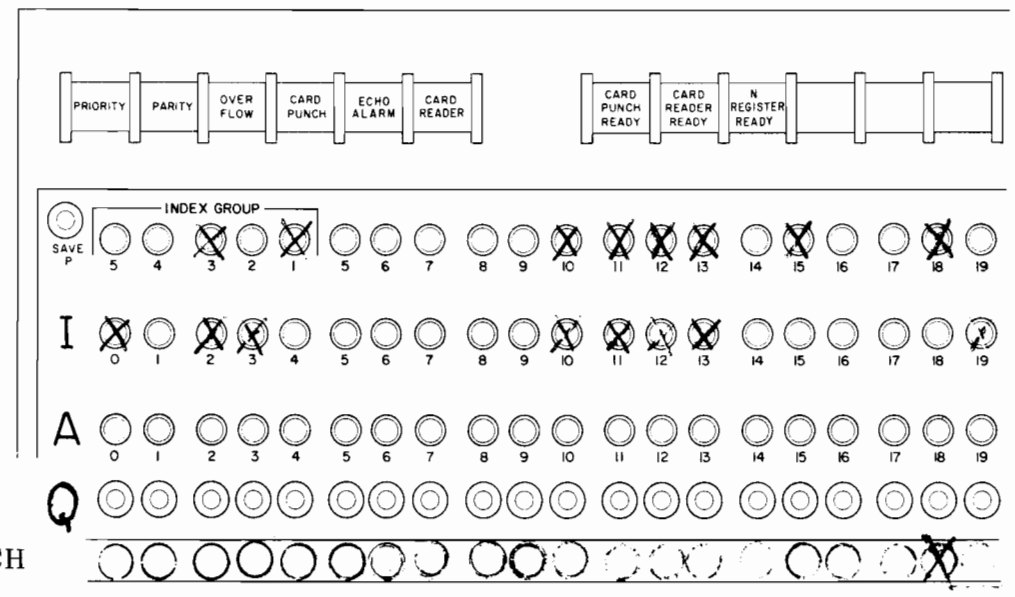
CONSOLE

BCD MODE

On Off

☐ ☒

ⓧ LIGHT ON



☐ X For Switch Down — SENSE SWITCH

RUNNING TIME 30 min.

OPERATOR Dave Rogers

Figure II-11. Sample Hang-up Sheet

DEBUG INSTRUCTION SHEET

Program Name Posting Run Date 8/19/62
Programmer Tom Smith Scheduled Time 2200

I. GAP

☐ Switch Options 18 Down (See General Instructions)

☒ Card Output ☒ Binary
☐ Octal (Binary Tape T.U. 6)

☒ Tapes Plug #1. [Input - GAP Master T.U. 1
Output - Blank Tapes on 3, 4 and 5, T.U. 6 optional

II. Debug

1. General Instructions (include console switch settings, special loading instructions, etc.)

2. Peripheral

☒ Card Reader ☐ Sorters (☐ 1, ☐ 2)
☒ Card Punch ☐ Printer (# Copies 1 ; Form #14")

☐ Tapes Plug # 1

T.U.	0	1	2	3	4	5	6	7
IN								
OUT								
Print								

(Indicate Tapes to be Saved)

3. Normal Stops (include type-outs)

Normal Stops (include type-outs)	Action to be Taken
Reference GAP Operating Instructions Manual	*Fill out Hang-up Sheet and Dump Memory (octal)

4. Abnormal Stops

☒ a. Fill out Hang-Up Sheet
☐ b. Dump Memory
☐ c. Dump Tapes octal _____ ; BCD _____
☐ d. Save Tapes _____

Date Run 8/20/62
Time Used 30 min.

Operator Dave Rogers

Figure II-12. Sample Debug Instruction Sheet

III. SYSTEM STARTUP AND SHUTDOWN

GENERAL

The GE 225 System is turned on at the beginning of a shift; the entire system is then normally left on while any part of the system is being used. Power is turned off under three circumstances: (1) When operators go off duty at sites which do not operate continuously; (2) During regular or unscheduled maintenance by the service engineer; and (3) During emergencies. The system should never be left unattended when power is on.

Power Sources

The operator will be aware of four stages of power supply: the substation, main power panel, the AC circuit breakers in individual equipment, and the DC power supplies to individual equipment.

1. Power is controlled, transformed, and regulated by the substation which supplies electric power to the system. This is of no immediate concern to the operator.

2. Power enters the room of the system through the main power panel, usually a wall panel, where power is distributed through individual circuit breakers labelled for each piece of equipment in the system.

3. AC circuit breakers are installed in the central processor and in peripheral controllers. In addition to turning blowers on and off, the breakers allow current to pass to the DC power supplies that run the processor, controllers, and peripherals. These blowers are contained in each controller and in the central processor and force air through the equipment in which installed. AC circuit breakers are normally left on by the service engineer. They must not be touched by the operator, for they are inside of cabinets which are to be entered only by service personnel.

4. DC power supplies for the paper tape reader/punch, and the card punch are contained in the cabinets of the individual equipment concerned. DC power for the 400 card per minute reader and console typewriter is supplied by the central processor. Each peripheral controller contains the DC power supply for that controller and attached peripherals.

Responsibility

The service engineer is primarily responsible for turning on and shutting off power to the system. However, the operator is usually given some freedom in this area and may be allowed to handle this duty. If the service engineer is not on duty when a normal shutdown is required, the operator must then turn power off. The operator will always be responsible for emergency shutdown when the service engineer is not immediately available.

STARTUP PROCEDURES

The principle of turning on power to the GE-225 System is to start with the main power, then proceed through the central processor, to individual controllers, and then to peripheral equipment. Startup procedures include the following steps:

1. Turn on each switch or circuit breaker at the main power panel, starting with the switch for the central processor.

2. At the central processor:

   a. Set INSTR/WORD switch to the WORD position.

   b. Set AUTO/MANUAL switch to the MANUAL position.

   c. Be sure blowers are operating, then press the PWR ON switch. If blowers

are not heard and it is verified that the wall switch is on, notify the service engineer.

3. For each peripheral that does not have a controller, turn power on at the peripheral in any order desired. These peripherals and their power controls are:

   a. Typewriter: Set the switch underneath the right side to the on position (white will show in the viewing window).

   b. 400 card per minute reader: Set the power switch to the ON position and the STOP/ENABLE switch to the ENABLE position.

   c. 1000 card per minute reader:

      1. Set the AUTO/MANUAL switch on the computer console to the MANUAL position.

      2. Depress the power ON switch on the card reader's control and indicator panel (will glow amber).

      3. If the READ ERROR indicator on the control and indicator panel is lit, depress the READ ERROR switch.

   d. Card punch: Depress the POWER ON switch on the control and indicator panel. (will glow green).

   e. Paper tape reader/punch:

      1. Depress the POWER ON switch on the control and indicator panel (will glow red).

      2. Depress the OPERABLE switch on the control and indicator panel (will glow white).

4. For each peripheral that has a controller, insure that the blower is operating in the controller cabinet; turn on power to controller, then to the peripheral (if it has separate power switch). These peripherals and their power sources are:

   a. Magnetic tape subsystem:

      1. Depress the POWER ON switch on the controller (will glow red).

      2. Depress the POWER ON switch on the tape handler (will glow red).

   b. High Speed printer:

      1. Depress the POWER ON switch on controller panel, then quickly proceed to step 2.

      2. Depress the MANUAL CLEAR switch to prevent a runaway printer. This switch will turn off any alert lights that came on abnormally.

   c. Mass random access data storage: (It is assumed that the circuit breakers in each of the three units are on.)

      1. Depress the POWER ON pushbutton on the electronic unit's control and indicator panel (will glow green).

      2. Depress the PWR ON pushbutton on the controller's control and indicator panel (glows white).

      3. Notice whether the discs in the disc file unit are turning.

      4. Wait for the OPERABLE light on the electronic unit's control and indicator panel to be lit (glows green). This takes about 6 minutes. (The DISC ALARM indicator light goes off when the OPERABLE light comes on.)

   d. Auxiliary arithmetic unit:

      1. Depress the DC ON pushbutton on the AAU maintenance panel.

      2. If a red ALERT light is on, depress CLEAR ALERTS on the control and indicator panel.

   e. Document handler (1200 documents per minute):

      1. For on-line operation, turn on power to the central processor. This turns on power to the document handler adapter. (Steps 2 through 6 following apply to both on-line and off-line operation).

      2. Turn the circuit breaker switch on the document handler to the on position (up).

      3. Check to see that the POWER indicator on the handler's control and indicator panel is on (will

glow green). This places the document handler's electronics in a standby condition.

4. Depress the MOTOR ON pushbutton on the control and indicator panel (will glow green).

5. Depress the ON-LINE, OFF-LINE MODE pushbutton on the control and indicator panel for the desired setting. (The ON-LINE or OFF-LINE portions of the switch light alternately each time it is depressed).

6. The document handler is not ready for use until the FEED READY light is illuminated; this occurs after a delay of about a minute following the depression of the MOTOR ON pushbutton. (step 4).

f. Document handler (750 documents per minute):

1. For on-line operation, turn on power to the central processor. This turns on power to the document handler adapter and the 'Z' rack. (Steps 2 through 6 apply to both on-line and off-line operation).

2. Turn the circuit breaker switch on the document handler to the on position (up).

3. Check to see that the MAIN CIRCUIT BREAKER indicator on the document handler's control and indicator panel is lit.

4. Depress the POWER ON pushbutton on the control and indicator panel (glows when lit).

5. Position the function switch on the control and indicator panel to PROCESS for on-line operation and to SEQUENCE for off-line operation.

6. The document handler is not ready for use until the FEED READY indicator is illuminated; this occurs after a delay of about a minute following the depression of the POWER ON pushbutton.

The operator will now be ready to set up the individual peripherals for on-line operation. Directions for loading input and output media and setting up individual peripherals are contained in sections of this manual under headings of the specific peripherals.

SHUTDOWN PROCEDURES

The procedures for turning power off and thereby shutting down the GE-225 System are the opposite of those for turning power on. Start with the switches most distant, electronically, from the main power and work toward main power. That is, turn off power to a peripheral, then to the controller, then to the central processor, and last of all, turn off the main power switches.

Peripherals may be turned off in any sequence desired. The most convenient order will depend on physical arrangement of the equipment. If paper tape and magnetic tape are to be removed and stored, the operator may wish to start with these units. The following sections describe procedures for both normal shutdown and emergency shutdown.

Normal Shutdown

The following procedures are to be followed any time operators go off duty and whenever service engineers perform routine maintenance. These procedures are designed to save data in the central processor core memory and to prevent runaway peripherals.

1. Magnetic tape system:

   a. Set the REMOTE/LOCAL switch to LOCAL.

   b. Rewind and de-thread magnetic tapes (remove and store if desired), relieve tension on tension arms, and close all dust covers and doors on tape handlers.

   c. Depress the POWER ON switch on each tape handler (light goes out).

   d. Depress the POWER OFF switch on the tape controller.

2. Paper tape reader and punch:

   a. Remove and store punched tape.

   b. Depress the OPERABLE switch on control panel if either READER ON or PUNCH ON indicators are on.

   c. Depress the POWER ON switch (light goes off).

3. High speed printer:

   a. Depress the **OFF LINE** switch on the controller.

   b. Depress the **POWER OFF** switch on the controller.

4. Card punch:

   a. Unload cards from input hopper.

   b. Depress the **MANUAL CYCLE** switch until the punch is clear of cards.

   c. Depress the **POWER OFF** switch.

5. 400 Card per minute reader: **Set** the Power switch to the **OFF** position and the STOP/ENABLE switch to the **STOP** position.

6. Typewriter: Put the power switch under right side to **OFF** position (white will disappear in viewing window and **OFF** will appear).

7. 1000 card per minute reader:

   a. Depress the power **OFF** switch on the card reader's control and indicator panel.

8. Mass random access data storage:

   a. Depress the **POWER OFF** pushbutton on the electronic unit's control and indicator panel.

   b. Depress the PWR OFF pushbutton on the controller's control and indicator panel.

9. Auxiliary arithmetic unit:

   a. Depress the **DC OFF** pushbutton on the AAU maintenance panel.

10. Document handler (1200 documents per minute):

    a. Depress the **MOTOR OFF** pushbutton on the control and indicator panel.

    b. Turn the circuit breaker switch to the off position (down).

11. Document handler (750 documents per minute):

    a. Depress the **POWER OFF** pushbutton on the control and indicator panel.

    b. Turn the circuit breaker switch to the off position (down).

12. Central processor: After all peripherals are turned off,

    a. Put the AUTO/MANUAL switch in the MANUAL position.

    b. Put the INSTR/WORD switch in the WORD position.

    c. Depress the PWR OFF switch on the control panel.

13. Turn off all individual circuit breakers at the main power panel. (The master circuit breaker is normally left on).

Before going off duty, the operator would normally have all output media stored or distributed to persons concerned and would remove and file all input material.

Emergency Shutdown

In emergencies, equipment is shut down for protection of both the equipment and the personnel in the system room. In grave emergencies, such as fire, flood, or a malfunctioning power system, the system is less likely to suffer heavy damage if the power is turned off at the main power panel. In minor emergencies, such as runaway tape units, jammed tape, or shorts in equipment, the operator will normally be required to turn off power only to the equipment and controller concerned. The gravity of the emergency will govern operator action. Whenever main power fails, main power switches should be turned off to prevent damage to the system when power is restored. Section II of this manual contains more specific information on operator action under various conditions of emergency.

IV. CENTRAL PROCESSOR

GENERAL DESCRIPTION

The central processor (Figure IV-1) performs the computational (arithmetic), the storage, and the control functions for the GE-225 System. The processor is housed in three equipment racks which are bolted together.

The console indicating and control panel (usually termed the control console) is mounted on the side of the first rack. Below the panel is the console desk and above it is the half-length door covering a maintenance control panel. Inside of the first rack are the main power supply for the processor, the power distribution panel, and the electronic control logic for the card reader, card punch, paper tape reader, and paper tape punch.

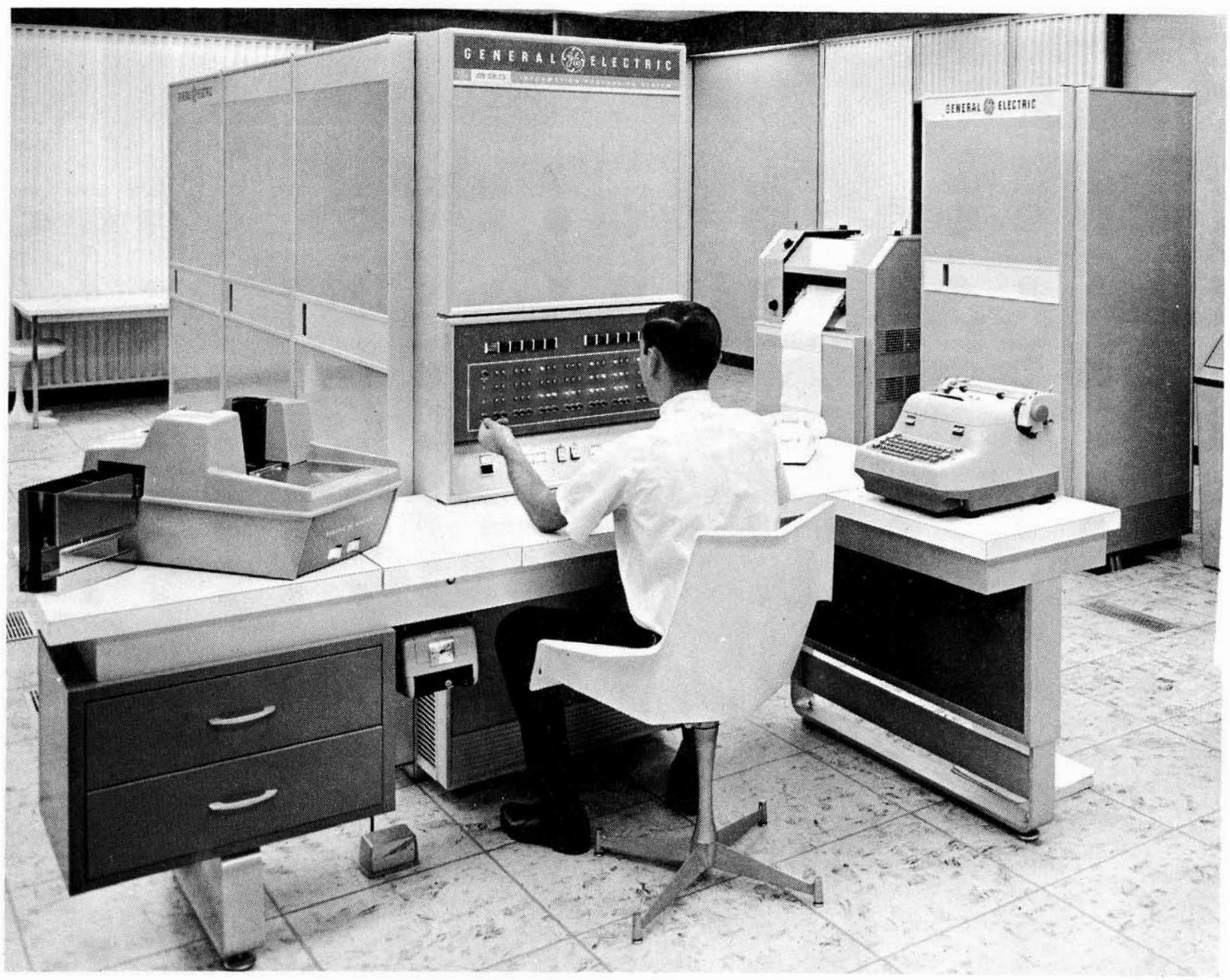


Figure IV-1. The Central Processor

The second rack contains the majority of the electronic counters, registers, timing circuits, and control logic associated with the processor.

The third rack contains the remaining registers, the magnetic core memory and its associated timing and control logic, and the logic for the controller selector.

Cable Connections

All peripherals are connected to the central processor by cables. The typewriter is connected directly by cable to the first rack of the central processor. The card reader is also connected to the first rack, but through a junction box mounted in the rear of the console desk.

The peripheral equipments which have controllers are connected to the controller selector by cables so that each peripheral controller is connected in parallel with the controller selector and in series with every other controller. Cables are connected to two plugs in the third rack of the central processor. The output cable from the central processor is connected to one plug, and leads to the input plug of the first controller. Controllers are connected to each other by cables which lead from the output of one to the input of the next. The output of the last controller leads back to the controller selector, and connects to the second of the two plugs in the third rack of the central processor.

The card punch is connected to the central processor through a plug located on the same connector panel on the third rack as the two plugs for the controller selector. The punch cable is clamped in place by means of a 'shoe' connector attached to the end of the cable.

Controls and Indicators

The GE-225 System operator constantly watches and uses the controls and indicators of the central processor. Most of the control switches and indicator lights are on the control console which provides switches for manual control, indicates the status of equipment, and displays the contents of certain registers. In addition to the control console, there is a maintenance panel which has three areas of interest and use to the operator.

A. MAINTENANCE PANEL. The maintenance panel of the central processor, illustrated in Figure IV-2, is located inside the door which is above the control console. It is used mostly by service

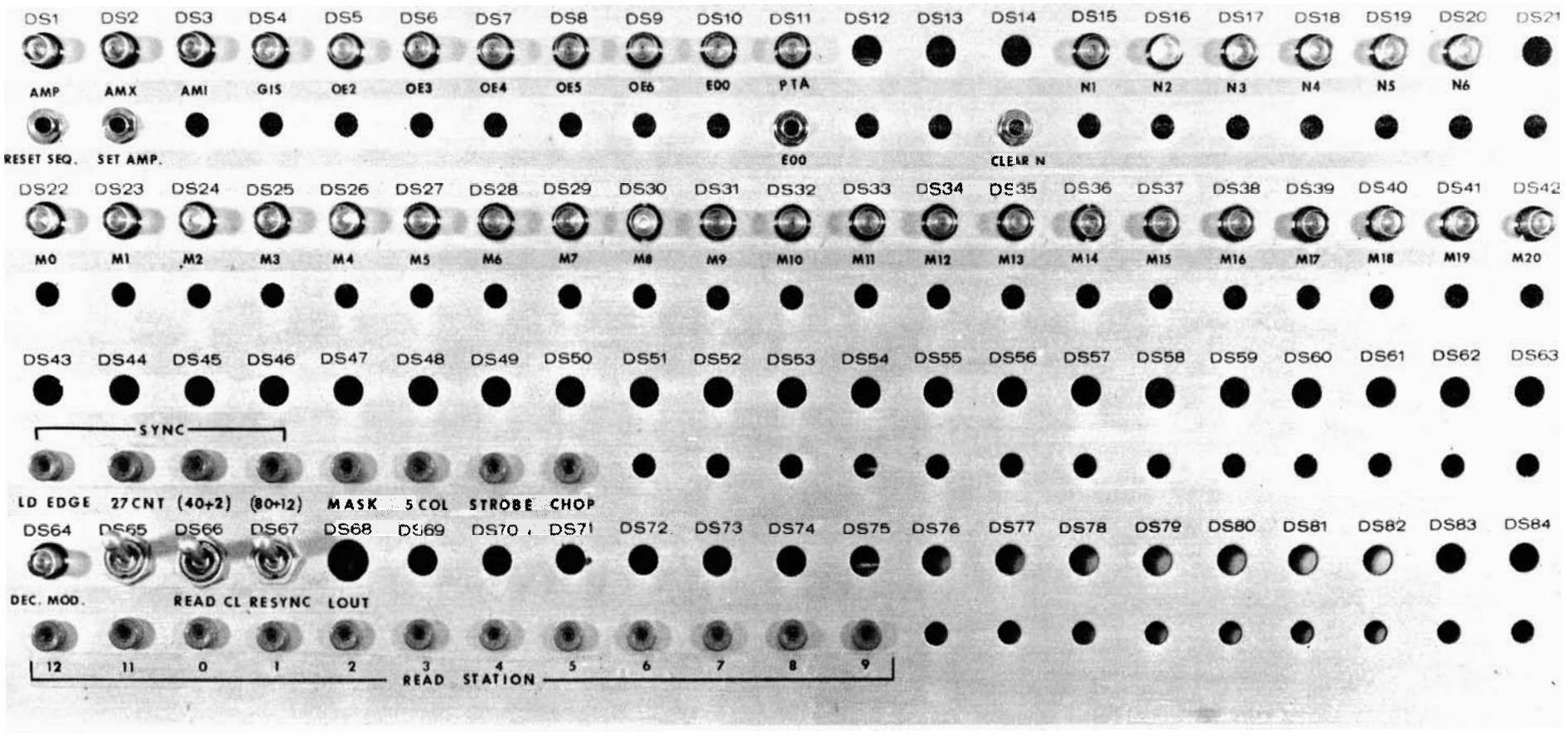


Figure IV-2. The Maintenance Panel of the Central Processor

engineers, but there are two items of concern to the operator, the N register indicators and the CLEAR N Switch.

N Register Indicators. These lights are located in the upper right corner of the maintenance panel and are labelled N1, N2, N3, N4, N5, and N6. They show the contents of the N register which is a BCD character representation of the input or output for either the paper tape reader, paper tape punch, or the typewriter.

CLEAR N Switch. This switch is to the left and slightly below the N register indicators. When depressed, it clears the contents of the N register to zero. The operator uses this switch , for example, when the typewriter is hung in a loop and depressing the space bar does not clear the N register. This could happen if someone turns off the typewriter while a program is running. Depressing the CLEAR N switch and manually entering a TON instruction will cause the typewriter to resume typing.

B. CONTROL CONSOLE. The control console (Figure IV-3) is the most important and most used panel on the GE-225. It is sometimes referred to as having both an indicator panel and a control panel, for the upper two thirds of the console contains indicator lights and the lower third contains control switches. The indicators are alarm lights, ready lights, and register display lights for the A, I, and P registers. The controls are option switches and control switches.

Alarm Indicators. The six alarm indicator lights in the upper left hand corner of the console are danger signals that indicate error conditions have occurred during system operation, and the program may be aborted. The cause can be an operator error, a programming error, or a malfunction in the system equipment. All alarm indicators except the PRIORITY alarm can be turned off by the RESET ALARM switch. However, it must be remembered that use of the RESET ALARM switch can damage the program if used when not authorized to do so by the programmer. The conditions which cause these alarms to come on are as follows:

PRIORITY Alarm. This alarm is turned on under any of the following conditions:

1. The AUTO/MANUAL switch is in the MANUAL position.
2. The STOP ON PARITY ALARM switch is engaged and a parity error is detected.
3. The central processor does not have priority (access to memory).
4. A card punch or card reader alarm condition has occurred.

PARITY Alarm. If the STOP ON PARITY ALARM switch is engaged when a parity error is detected, the central processor will halt. The PARITY alarm can be turned off by pressing the RESET ALARM switch or by programmed instructions. The PARITY alarm is turned on under any of the following conditions:

1. The memory-checking circuits of the central processor detect a parity error while the AUTO/MANUAL switch is in the AUTO position.
2. The parity checking circuits associated with the paper tape reader detect a parity error.
3. A parity error is detected as information is received from a controller through the controller selector.

OVERFLOW Alarm. The central processor does not halt on an overflow alarm. The alarm may be reset automatically several times during a normal MPY instruction. The indicator also can be turned off by depressing the RESET ALARM switch or by programmed instructions. The OVERFLOW alarm is turned on under any of the following conditions:

1. The capacity of the A register is exceeded during arithmetic operations.
2. An illegal divide is attempted.
3. A one bit is shifted out of bit position one of the A register during a shift-left operation.

CARD PUNCH Alarm. This alarm is turned on any time a WCB, WCD, or WCF instruction is attempted when the card punch is not in the ready condition. As already noted, the PRIORITY alarm also comes on, and the central processor halts. The alarm can be reset only by pressing the RESET ALARM switch.

ECHO Alarm. This alarm is turned on when the central processor makes an unsuccessful at-

tempt to select a controller through the controller selector for an input/output operation. The ECHO alarm light can be turned off only by depressing the RESET ALARM switch. The alarm indicates the following conditions:

1. The selected controller is busy (delay not programmed).
2. An erroneous address was programmed, the addressed plug is not installed.

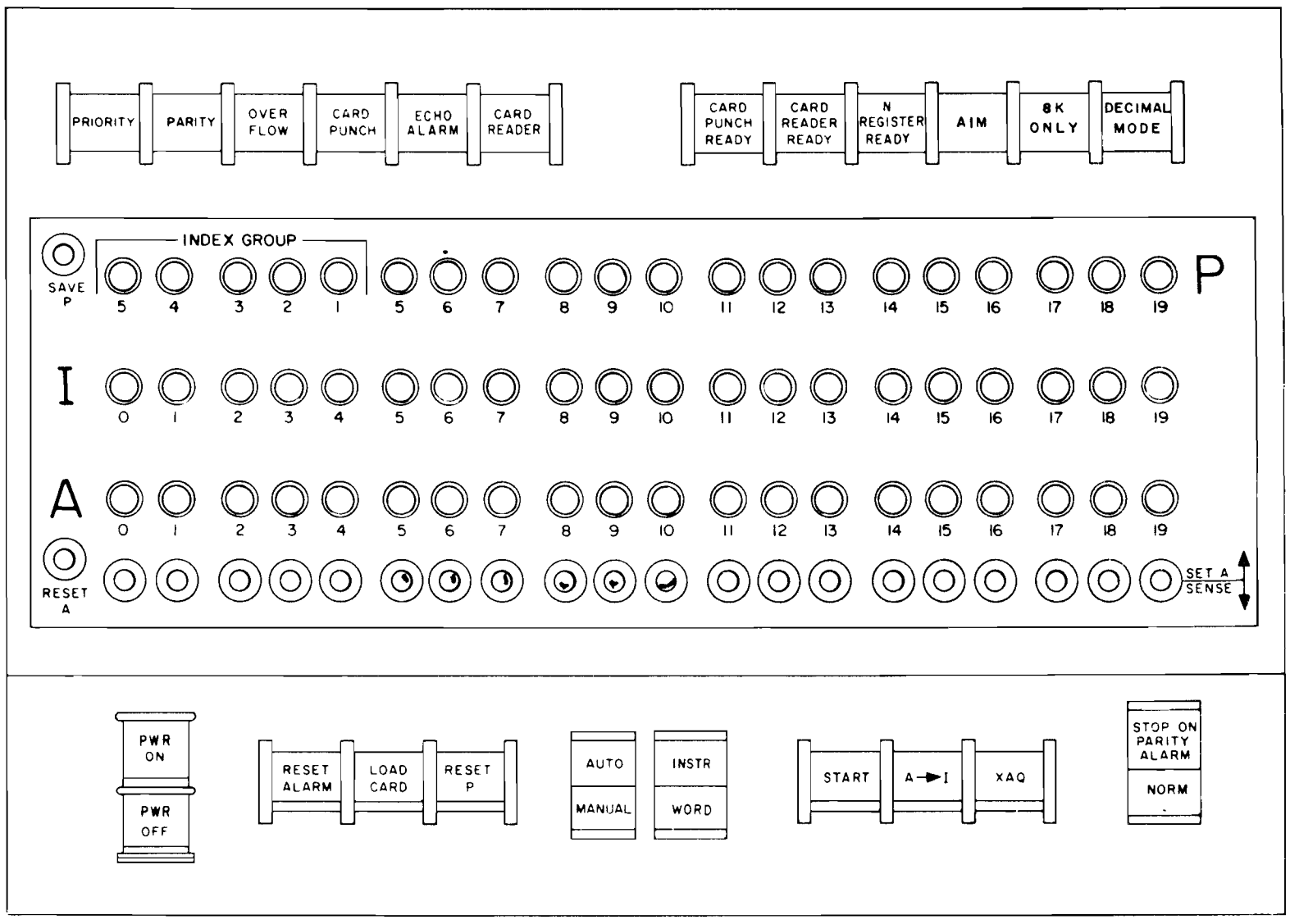


Figure IV-3. The Control Console

3. Controller is off line.

4. Power is off to controller.

5. Controller is malfunctioning.

CARD READER Alarm. This alarm is turned on when attempting to execute an RCB, RCD, or RCF instruction while the card reader is not in the ready condition. When the CARD READER alarm comes on, the PRIORITY alarm also comes on and the card reader and the central processor halt. The alarms in this combination are reset only by depressing the RESET ALARM switch. The reader can be 'not ready' for any of the following reasons:

1. Card Reader is not turned on.

2. Input hopper is empty.

3. A card is not positioned on the sensing platform.

4. Reader is busy (already reading a card).

5. A misfeed or card jam occurs.

Ready Indicators. The green ready indicator lights in the upper right corner of the control console give 'go-ahead' signals to the operator. With certain exceptions, these lights come on when the card punch and card reader are ready for use or when the N register is ready to receive information. If the equipment is not ready for operation, an attempt to use it will turn the ready light off and set an alarm indicator.

The standard ready indicators are the following:

CARD PUNCH READY. This light is turned on to indicate that, in five respects, the card punch is ready to punch cards. If the card punch is not otherwise in an operable condition when a punch instruction is attempted, the ready light will go off and the CARD PUNCH and PRIORITY alarms will come on. The five conditions of readiness which together turn on the CARD PUNCH READY light are:

1. The input hopper contains cards.

2. The stacker is not full.

3. A card is properly located at station 'one'.

4. A card is not currently being punched.

5. The chip box is properly seated.

CARD READER READY. This light is turned on to indicate that, in three respects, the card reader is ready to read cards. If the card reader is not otherwise in an operable condition when a read instruction is attempted, the ready light will go off and the CARD READER and PRIORITY alarms will come on. The three conditions of readiness which turn the CARD READER READY light on are:

1. The input hopper contains enough cards (or weight) to depress the hopper-empty switch.

2. A card is not currently being read.

3. No misfeed or card jam is detected.

N REGISTER READY. This light comes on to indicate that the N register is ready to receive input or output information. Specifically, it means that the register is not currently being used by the typewriter, paper tape reader, or paper tape punch. If an illegal code is placed in the N Register and a TYP command given, the N REGISTER READY light goes out and stays out until a space key is struck.

There are three more indicators to the right of the ready indicators. These are:

AIM. The automatic interrupt mode permits the simultaneous operation of two or more programs. When a program puts the computer in the interrupt mode, the green AIM light comes on at the time of the first interrupt and remains on until turned off under program control or is turned off by the operator. The operator can turn the AIM indicator off by procedures described later in this section.

8K ONLY. On a computer which has only an 8K memory, this indicator is on all the time. A computer which has a 16K memory can be set by the service engineer to operate either with the complete (16K) memory or with only half of it (8K). The 8K ONLY indicator is lit when the computer is set to operate only with 8K; it is off when the computer is set to operate with 16K.

DECIMAL MODE. This indicator is lit when the central processor is in the decimal mode. When the indicator is not lit, the processor is in the binary mode.

Index Group Indicators. The five INDEX GROUP display lights are located below the alarm lights and to the left of the P counter display lights. The lights are numbered one through five from right to left. These five lights, read as binary digits, indicate

the index group that has been selected by the program (Groups 0 through 31). Each group has four registers, 0 through 3. When all lights are off, group zero is available without special selection. Only index group zero is standard on the GE-225 System; additional groups are optional. Any time a light is on in the index group, the operator knows that an index group other than zero has been selected.

P Counter Lights. The fifteen display lights for the P counter are located to the right of the INDEX GROUP indicators. They are numbered, left to right, from 5 through 19, and are arranged in groups of three to facilitate reading the binary numbers in their octal representation. By reading these groups, the operator can know the location of the instruction which appears in the I register. The P counter is useful when debugging a program and when checking for correct operation after a manual branch command to a particular program location.

SAVE P Switch. This switch permits the operator to return to a particular position in the program after he has interrupted it to make a correction, such as to introduce an instruction manually. The SAVE P switch in the down position prevents the P counter from incrementing. When the operator returns the SAVE P switch to the up (normal) position after manual operations, the program is ready to continue from the place of interruption. When the SAVE P switch is in the down position during the automatic mode of operation, the instruction in the I register is executed over and over again.

I Register Lights. The 20 I register display lights are located below the INDEX GROUP and P counter lights, and are number from 0 to 19. They display the contents of the instruction register. Like the other register display lights, they are read in their octal representation. The I register displays the current instruction, the instruction that has not yet been executed or has been only partly executed.

A Register Lights. The 20 A register display lights are located below the I register lights. They are numbered from 0 to 19, and display the contents of the A register. These are also read in octal. By using the XAQ switch (described later), the A register lights can be used to display the contents of the Q register. All data and instructions feed manually into the central processor go through the A register, and are entered by use of the option switches.

Option Switches. The 20 option switches just below the A register display lights are used to feed information into the A register. Each of these toggle switches enters information into the corresponding A register position. The numbers 0 through 19 below the A register lights may be thought of as also applying to the switches. When moved up, the switches are spring loaded and return automatically to the center (normal) position. When moved down, they remain in the down position until manually returned to the normal position.

When the central processor is in the manual mode of operation, moving an option switch up causes a one to be put into the corresponding position of the A register. This is indicated by an A register display light. Moving an option switch up has no effect when the central processor is in the automatic mode of operation.

Moving an option switch down when the central processor is in the automatic mode causes a one to be put into the corresponding position of the A register at the time of a programmed RCS instruction. Specified switches are left in the down position while running certain routines and while generating GAP assemblies. These and other special uses of the option switches are specified in the programmer's instructions to the operator.

RESET A Switch. This switch is to the left of the option switches. It is effective only when the central processor is in the manual mode of operation. Like the option switches, it is spring loaded in the up position but not in the down position. When moved either up or down, it clears to zero the contents of the A register, and turns off all of the A register display lights. When the operator makes a mistake while using the option switches, he can correct this

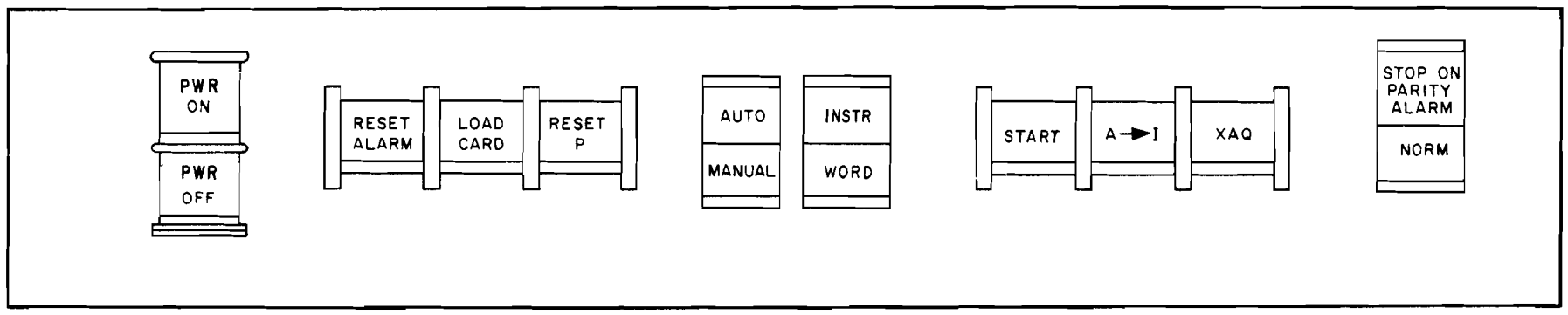


Figure IV-4. Control Switches on the Control Console

mistake by clearing the A register with the RESET A switch and then starting over.

When the computer is in the automatic mode, the operator must be very careful not to accidentally lower the RESET A switch. If he should lower it accidentally, branch commands would not operate correctly. The operator would probably not know of the error he caused until the programmer reported back to him that the run was confused.

Toggle. When referring to the toggle switches, it has become customary to use the term toggle as a verb. When used in this way, it means to move the switch either up or down and immediately return it to its original position.

Control Switches

A strip of switches along the bottom of the control console, and the SAVE P and RESET A switches just described, give the operator manual control over the central processor and certain functions of peripherals. Eight of the switches are the pushbutton type that require only to be pressed momentarily to be activated. Three double-label switches are the rocker type with two positions. For instance, the AUTO/MANUAL SWITCH is placed in the AUTO position by pressing the end that is labeled AUTO and leaving that end in the depressed position.

These switches, illustrated in Figure IV-4, are described as follows:

PWR. ON. Depressing the PWR ON pushbutton turns on DC power to the central processor, the control console, and the 400 card per minute reader. The pushbutton is also an indicator, for it lights when power is on.

PWR. OFF. When DC power is on, depressing this pushbutton turns it off.

RESET ALARM. This switch is effective only in the manual mode of operation. Depressing the pushbutton clears any existing alarm condition. It turns off the alarm lights and resets flip-flops so the central processor can continue operation. It does not clear up the cause of the alarm.

LOAD CARD. This switch is effective only in the manual mode of operation. Depressing the pushbutton initiates card reader action and causes the reader to go through one load and read cycle. It is used most often to load the first card into memory during program startup operations. If no card was on the sensing platform, it moves one onto it. From there, the card is read into memory locations starting at 0000.

RESET P. This switch is effective only in the manual mode of operation. Depressing the pushbutton clears the P counter to all zeros. It is used most often to cause the first instruction to address memory cell zero, and is normally activated just before setting the AUTO/MANUAL switch to AUTO at the beginning of program operation.

AUTO/MANUAL. This two-position, rocker-type switch selects either the automatic or the manual mode of operation for the central processor. When the AUTO portion of the switch is depressed, the central processor is in the automatic mode, and instructions are processed in a continuous sequence under program control. When the MANUAL portion of the switch is depressed, the central processor is in the manual mode, and the program is executed only one step at a time as the START switch is depressed. Setting the AUTO/MANUAL switch to MANUAL during automatic operation causes the computer to halt operations at the end of the instruction or word being executed. The operator will recall that putting the central processor in the manual mode causes the PRIORITY alarm light to come on. The following operations can be performed only when the AUTO/MANUAL switch is set to MANUAL:

1. Clear or set information into a register with option switches.
2. Clear alarm conditions with RESET ALARM switch.
3. Reset P counter with RESET P switch.
4. Load a card manually using LOAD Card switch.
5. Transfer contents of A register to I register using A to I switch.
6. Exchange contents of A and Q registers using XAQ switch.

INST/WORD. This is also a two-position, rocker-type switch which is effective only in the manual mode of operation. It determines the length of the cycle of the central processor during manual operations. When the INST portion of the switch is depressed, the central processor executes one complete instruction each time the START switch is engaged. When the WORD portion of the switch is depressed, only one word time is executed each time the START switch is engaged. The WORD position is used by the operator during system startup and shutdown.

START. In the automatic mode of operation, depressing the START pushbutton initiates action. After the operation begins, the program runs automatically and despressing the START switch again has no effect. In the manual mode of operation, depressing the START switch causes the execution of one instruction or one word time, depending upon the setting of the INST/WORD switch.

A ⟶ I (A to I). This switch is effective only in the manual mode of operation. Depressing the A to I pushbutton transfers the contents of the A register, including the sign bit, to the I register. The contents of the A register remain unchanged, and can be cleared by toggling the RESET A switch. The A to I switch is used to manually load an instruction into the I register or to correct an instruction already there.

XAQ. This switch is effective only in the manual mode of operation. Depressing XAQ causes an exchange of information between the A and Q registers. That is, the contents of A go into Q and the contents of Q go into A. This permits the operator to observe the contents of the Q register. By using the RESET A switch and the option switches, the operator can clear and correct the contents of the Q register while saving the contents of the A register.

STOP ON PARITY ALARM/NORM. This is a two-position, rocker-type switch. It determines the response of the central processor to the detection of a parity error. When the STOP ON PARITY ALARM portion of the switch is depressed, the central processor halts each time a parity error is detected and the PARITY and PRIORITY alarm lights come on. When the NORM (normal) portion of the switch is depressed, the central processor continues operation regardless of parity errors, and the only indication of a parity error is the fact that the PARITY alarm light is turned on. The setting of the STOP ON PARITY ALARM/NORM switch is determined by the programmer. If he has included remedial action throughout the program to take care of parity errors and to reset the PARITY alarm light, he will specify the setting of the STOP ON PARITY ALARM/NORM switch to the NORM position. If he has not included remedial steps in the program, he will want the program to halt at time of a parity error, so will specify the setting of STOP ON PARITY ALARM.

Table I contains a summary of the controls and indicators of the maintenance panel and control console. It is recommended that the student operator remove the table from the manual and keep it in a handy place at the console for quick reference.

TABLE I.

FUNCTIONS OF CONTROLS AND INDICATORS

ON CENTRAL PROCESSOR

Group	Control or Indicator	Function
Alarm Indicator Lights	PRIORITY alarm light (red)	Indicates: 1. AUTO/MANUAL switch is in MANUAL position. 2. Parity alarm condition. 3. Central processor does not have priority. 4. Card punch or card reader alarm condition.
	PARITY alarm light (red)	Indicates: 1. Memory-checking circuits of processor detected parity error while processor in automatic mode. 2. Parity error connected with tape reader. 3. Parity error detected as data received from a controller through controller selector.
	OVERFLOW alarm light (red)	Indicates: 1. Capacity of the A register was exceeded. 2. Illegal divide attempted. 3. Data shifted, left out of the A register.
	CARD PUNCH alarm light (red)	Indicates card punching was attempted when card punch was not in a ready condition.
	ECHO ALARM light (red)	Indicates an unsuccessful attempt to select a controller for any of these reasons: 1. Controller busy 2. Incorrect address 3. Controller off line 4. Power off to controller 5. Malfunctioning controller.
	CARD READER alarm light (red)	Indicates card reading was attempted while the card reader was not ready (not set up, busy, misfeed, or card jam.)
Ready Indicator Lights	CARD PUNCH READY light (green)	Indicates when card punch is in 'ready' status.

Group	Control or Indicator	Function
Ready Indicator Lights (Cont.)	CARD READER READY light (green)	Indicates when card reader is in 'ready' status.
	N REGISTER READY light (green)	Indicates N register is ready to receive input/output information and no illegal or improperly programmed instruction has been given to typewriter or paper-tape reader/punch.
	AIM light (green)	Indicates that optional automatic interrupt mode is operative.
	8K ONLY Indicator (green)	Indicates, when lit, that 8,192 memory locations are available.
	DECIMAL MODE Indicator (green)	Indicates, when lit, that the central processor is in the decimal mode.
Register Display Lights and Switches	INDEX GROUP indicator lights	Indicates index group that has been selected.
	P counter display lights	Display location of instruction in I register (see text for exception).
	SAVE P switch	Prevents P counter from incrementing.
	I register display lights	Display current instruction.
	A register display lights	Display contents of the A register.
	Option Switches	Feed information into the A register while in either manual or automatic modes and run special routines such as GAP assemblies in the automatic mode.
	RESET A switch	Clears contents of A register to all zeros when manual switch is engaged.

Group	Control or Indicator	Function
Control Switches	PWR ON switch	Applies DC power to the central processor, and 400 card/minute reader.
	PWR OFF switch	Turns off DC power to the central processor, control console, and 400 card/minute reader.
	RESET ALARM switch	Clears alarm conditions (effective only when MANUAL switch is engaged).
	LOAD CARD switch	Causes card reader to execute one Read Card Binary cycle (effective only when MANUAL switch is engaged).
	RESET P switch	Resets P counter to all zeros (effective only when MANUAL switch is engaged).
	AUTO/MANUAL switch	Selects automatic or manual mode of operation of central processor; MANUAL stops processor, turns on PRIORITY alarm.
	INSTR/WORD switch	Selects length of cycle of processor during manual mode of operations (instruction or word at a time).
	START switch	Initiates execution of one cycle of operation (instruction or word); in automatic, initiates execution of program.
	A ⟶ I switch	Transfers contents of A register to I register (effective only when MANUAL switch is engaged).
	XAQ switch	Exchanges contents of A and Q registers (effective only when MANUAL switch is engaged).
	STOP ON PARITY ALARM/NORM switch	Determines whether central processor stops when a parity error is detected.

Group	Control or Indicator	Function
Maintenance Panel	N register indicators	Shows contents of N register input or output for the paper tape reader, paper tape punch, or typewriter.
	CLEAR N switch	Clears contents of N register to zero.

SETUP PROCEDURES

Setting up the central processor for operation involves only bringing power up and setting control switches. The six steps listed below are designed to save data in the core memory of the central processor. If the console was previously shut down by the normal procedure and switches have not been disturbed, steps 2 and 3 require only verification. Some operators form the habit of checking switches both visually and physically by actually pressing a switch even though it appears to be in position already. Thus, good habit patterns are formed. (EXCEPTION: Don't hit PWR ON when already on, except when performing special procedures as described later.)

1. Verify that blowers in central processor cabinets are operating. (If not, call the service engineer.)
2. Set the AUTO/MANUAL switch to the MANUAL position.
3. Set the INSTR/WORD switch to the INSTR position.
4. Depress the PWR ON switch.
5. Set the INSTR/WORD switch to the INSTR position.
6. Depress the RESET ALARM switch (this can be done either at this time or just prior to starting a program.)

The complete procedure for starting up and shutting down the central processor and the entire GE-225 System is described in Section III.

MANUAL OPERATING PROCEDURES

The option switches on the control console permit the operator to enter instructions and data manually; the register display lights permit the reading of the contents of memory and of certain registers. Thus, it is possible to feed in and execute a short program and read the results. Manual loading is used most, however, for getting a program started, correcting memory, branching, setting and clearing special modes, and reproducing damaged cards. Once an operator completes the necessary manual operations and gets a program started, control of operations is usually transferred to the central processor.

Loading an Instruction Manually

Any instruction that is intelligible to the GE-225 can be loaded manually by putting the octal equivalent of the instruction into the A register, as follows:

1. Set the AUTO/MANUAL switch to the MANUAL position.
2. Set the INSTR/WORD switch to the INSTR position.
3. Toggle the RESET A switch to clear the A register.
4. Load the octal equivalent of the instruction into the A register. (See instructions for toggling option switches in the previous section.)
5. Depress the A to I switch.
6. Toggle the RESET A switch and load any necessary data into the A register. (Not necessary for some instructions.)
7. Depress the START switch.

The central processor will then execute the instruction placed in the I-register by the operator.

The following are the most used instructions, and must be memorized as quickly as possible.

Mnemonic	Description	Octal Code
TON	Typewriter on	2500007
RON	Paper Tape Reader On	2500014
PON	Paper Tape Punch On	2500015
WCD	Write Card Decimal	250YY02
WCB	Write Card Binary	250YY03
WCF	Write Card Full	250YY17
RCD	Read Cards Decimal	250YY00
RCB	Read Cards Binary	250YY01
RCF	Read Cards Full	250YY10
BRU	Branch Unconditionally	2600000
SET DECMODE	Set Decimal Mode	2506011
SET BINMODE	Set Binary Mode	2506012
SXG Y	Select Index Group	2506YY3
STA	Store A	0300000
LDA	Load A	0000000
OFF	Input/Output Off	2500005

Loading Data Manually

When data is to be loaded into memory, the following procedure is followed:

1. Set the AUTO/MANUAL switch to the MANUAL position.
2. Set the INSTR/WORD switch to the INSTR position.

3. Toggle the RESET A switch.

4. Load an STA instruction in the A register (Store A is an octal 0300000), with the memory address where the data is to be stored replacing the 13 righthand bits of the STA instruction.

5. Depress the A to I switch.

6. Toggle the RESET A switch.

7. Load the octal equivalent of the data to be stored into the A register.

8. Depress the START switch.

Load additional words by repeating steps 3 through 8.

Manual Branching

Prior to executing a program, the operator may perform such manual operations as checking memory, feeding constants into the memory, or correcting memory. To then transfer to automatic operation, the operator must manually enter a branch instruction which contains the location of the first instruction to be executed. This is done as follows: (Power is on and the INSTR/WORD switch is in the INSTR position.)

1. Set the AUTO/MANUAL switch to the MANUAL position.

2. Toggle the RESET A switch.

3. Load a BRU instruction into the A register (octal 26 in positions 0 through 4 and the memory location of first instruction to be executed in positions 7 through 19).

4. Depress the A to I switch.

5. Set the AUTO/MANUAL switch to the AUTO position.

6. Depress the START switch.

If the operator wishes to branch and remain in manual mode, he may use the above procedure omitting Step 5 (that is, leave AUTO/MANUAL switch in MANUAL mode). If the operator branches to the first instruction of a stored program, one instruction is executed each time the START switch is pressed.

Entering and Leaving Upper Memory

In order to get into upper memory (memory locations 8192 and above), it is necessary to use a basic branch instruction modified by index register 1, 2, or 3. The index register must contain a constant of 8192 (decimal). The octal equivalent of 8192 is 0020000, which means that bit position six is turned on and all others are turned off. Thus, any time bit position six is on in the P counter indicator lights, the operator will know the central processor is in upper memory.

The following steps transfer operations to upper memory:

1. Set the AUTO/MANUAL switch to the MANUAL position. (It is assumed that the INSTR switch is engaged).

2. Set a Store A instruction into the A register. (STA is an octal 030000X, where X is 1, 2, or 3 for the index register).

3. Depress the A to I switch.

4. Toggle the RESET A switch.

5. Set an octal 0020000 into the A register.

6. Depress the START switch. (Stores constant into index register selected).

7. Toggle the RESET A switch.

8. Set into the A register a BRU to the desired memory location modified by the selected index register used in step 2, above.

9. Depress the START switch.

To transfer from upper memory to lower memory, follow the above steps, except step 5. The effect then is that step 6 (START) stores zeros into the index register being used.

Reproducing Individual Cards

In an emergency, it may be necessary to reproduce a single card. The following describes a quick method of doing this with manual instructions. It is assumed that the card punch is ready for operation and that its input hopper is loaded with blank cards.

1. Feed the card to be reproduced into the feed rollers of the card reader to position it on the sensing platform.

2. Set the AUTO/MANUAL switch to the MANUAL position.

3. By using option switches, set a read-card instruction into the A register:

a. If a binary card, use RCB, octal 250YY01.

b. If a decimal card, use RCD, octal 250YY00.

YY is the starting address where the card is to be read. The handiest address is zero; if this cannot be used, remember that the address must be a multiple of 128 and less than 2048; that is, multiples of octal 200 and less than octal 4000.

4. Depress the A to I switch.

5. Hold down the hopper-empty switch on the card reader and press the START switch on the console. (reads cards)

6. By using option switches, set a write-card instruction into the A register:

   a. If a binary card, use WCB, octal 250YY03.

   b. If a decimal card, use WCD, octal 250YY02.

7. Depress the A to I switch.

8. Depress the START switch. (punches cards)

9. Depress the MANUAL CYCLE switch on the card punch twice to clear punched card into output hopper.

If more than one copy of the card is needed, repeat steps 7 and 8 as many times as there are cards needed (the write-card instruction remains in A and can be transferred to the I register and executed as many times as necessary.)

Saving Information in A

When an operator manually enters changes to a program, it is usually necessary to save information in the A register before entering new information. It must be remembered, however, that changes should never be made by this method without instructions to do so by the programmer. The procedure for saving the information in the A register and the location of the P counter is as follows:

1. Place in a down position the option switches corresponding to the ones (the lights) of the A register. These switches are now a reminder to the operator of what was originally in A.

2. Raise the RESET A switch to clear the A register.

3. Lower the SAVE P switch to save the information in the P counter.

4. Raise the option switches corresponding to the ones of the new information to be entered into A. Return to the down position any of the switches which were in that position (as a result of step 1).

5. Move the new information now in the A register to wherever it will be used in the program, for example, move it to the I register by depressing A to I (See "Loading Data Manually").

6. Raise the RESET A switch to clear the A register.

7. Raise to the up position all of the option switches which are down (as a result of step 1). Since the switches are spring loaded, they will automatically return to the normal position. This returns the original information to the A register by entering ones into A to correspond with the down switches.

8. Raise the SAVE P switch (lowered in step 3) to restore the original information to the P counter.

Extracting Data from Memory

After a series of instructions or data has been loaded, the operator may want to check the contents of memory. The following steps can be used any time the operator wishes to know what is in any particular cell in memory. Once the information is displayed, it is a simple matter to correct it and return it to memory (see 'Loading Data Manually'). It is assumed the AUTO/MANUAL switch is set to MANUAL and the INSTR/WORD switch is set to INSTR, and no alarms lights are on.

1. If it is desired to save P, set the SAVE P switch.

2. Toggle the RESET A switch, thus leaving an LDA instruction in the A register (Load A is an octal 00).

3. Load the memory location of the information desired into bit positions 7 through 19 of the A register.

4. Depress the A to I switch.

5. Depress the START switch.

The contents of the memory location specified in step 2 now appears in the A register.

Sequencing through Programs

It is possible to manually sequence through a program, step by step, and examine each instruction by reading the instruction register. This is accomplished with the following steps. (Assume the INSTR switch is engaged):

1. Set the AUTO/MANUAL switch to MANUAL.

2. Branch to the starting location of the program to be examined:

   a. Set a BRU instruction into A register, including the address of the first instruction to be executed (BRU is octal 2600000).

   b. Depress A to I switch.

3. Press START switch once for each instruction to be executed; read the I register and P counter after each step.

Special Modes

Normally the program will set and clear out special modes, such as the decimal mode, index group select, and the automatic interrupt mode (AIM). The operator will seldom need to set these conditions, but may occasionally have to clear them manually. For instance, a program being debugged may be aborted, and the special options are left on.

The procedure for clearing AIM, index group select, and decimal mode are described in the following paragraphs. If these procedures fail, more elaborate procedures are given in the sections immediately following.

Clearing with PWR ON. A quick way to turn off the automatic interrupt mode, clear out index group select, and change from the decimal mode to binary is to use the PWR ON switch, following these steps (assume power is on to central processor):

1. Set the AUTO/MANUAL switch to MANUAL.

2. Set the INSTR/WORD switch to WORD.

3. Depress PWR ON switch.

4. Make visual checks to see if goal is accomplished.

5. Set the INSTR/WORD switch to INSTR.

At step 4, note that the DECIMAL MODE light on the console will go out AIM light on control console will go out (if on), and index group lights will go out.

If these procedures fail the operator can follow the procedures of the following section.

Setting and Clearing Decimal Mode. Normally, the program will set and clear the decimal mode. If for any reason the operator finds it necessary to do this manually, the following procedures may be used. As previously mentioned, the DECIMAL MODE light on the console will be on when the central processor is in the decimal mode.

A. TO SET THE DECIMAL MODE:

1. Set the AUTO/MANUAL switch to MANUAL.

2. Toggle the RESET A switch.

3. Put the Set Dec Mode instruction (octal 2506011) into the A register.

4. Depress the A to I switch.

5. Depress the START switch.

6. Check to be sure the DECIMAL MODE light came on.

B. TO CLEAR DECIMAL MODE (SET BINARY MODE):

1. Set the AUTO/MANUAL switch to MANUAL.

2. Toggle the RESET A switch.

3. Put the Set Binmode instruction (octal 2506012) into the A register.

4. Depress the A to I switch.

5. Depress the START switch.

6. Be sure the DECIMAL MODE light went off.

Automatic Interrupt Mode. The Automatic Interrupt Mode, which is present as an optional feature on some GE-225 Systems, is usually turned on and off by program control. Occasionally, however, it may be desired to turn this mode of operation on or off manually as follows:

A. MANUAL AIM TURN-ON PROCEDURE

1. Set the AUTO/MANUAL switch to the MANUAL position.

2. If the program is to be resumed at the point of manual interruption, depress

the SAVE P switch to preserve the contents of the P register. Also, record the contents of the A register on the log sheet.

3. Introduce a SET PST instruction (octal 2506015) into the computer through the control console using the technique described under 'Loading an Instruction Manually.'

4. If the program is to be resumed at the point of manual interruption, return the SAVE P switch to its normal position and reinstate the contents of the A register (as recorded in step 2) through the option switches.

B. MANUAL AIM TURN-OFF PROCEDURE

1. Set the AUTO/MANUAL switch to MANUAL position.

2. If the program is to be resumed at the point of manual interruption, depress the SAVE P switch to preserve the contents of the P register. Also, record the contents of the A register on the log sheet, or set the option switches.

3. Introduce a SET PST instruction (octal 2506015) into the computer through the console switches using the technique described under 'Loading an Instruction Manually.'

4. After the SET PST instruction has been set and executed, follow that command with a SET PBK instruction (octal 2506016) through the console switches.

5. Next, set a branch instruction with the console switches to return to the program.

   a. If the program is to be started over again, set a BRU 0 1 instruction (octal 2620000.)
   b. If the program is to be resumed at the point of manual interruption, set a BRU Y instruction (where Y represents the memory location preserved in the P register by the action described in step 2).

6. If the program is to be resumed at the point of manual interruption, return the SAVE P switch to its normal position and reinstate the contents of the A register (as recorded in step 2) through the option switches.

Resetting the PARITY Alarm

Two methods of resetting a PARITY alarm will be described. The first method is to be used when the operator is starting a program and the parity error is in location zero. The second method is to be used when the program is beyond location zero.

A. RESETTING A PARITY ALARM IN LOCATION ZERO

When the central processor's power is first turned on, a parity alert frequently occurs. Also, a parity alert is apt to occur during the initial loading of a program, assembly, or compiler. The following procedure should be used to clear these alerts:

1. Depress the RESET ALARM switch. It must be remembered that the RESET ALARM switch can damage a program, so this action must be taken only when directed by programmer instructions or when the operator is sure that the error is in location zero. If the PARITY alarm light goes off, the correction is made. If the PARITY alarm light does not go off, continue with steps 2 through 9.

2. Set the STOP ON PARITY ALARM/NORM switch to NORM.

3. Set the AUTO/MANUAL switch to MANUAL.

4. Toggle the RESET A switch.

5. Load the STA instruction (0300000) into the A register.

6. Depress the A to I switch.

7. Toggle the RESET A switch (leaves all zeros in A).

8. Depress the START switch (loads zeros into memory location zero where the parity error supposedly occurred).

9. Depress the RESET ALARM switch.

B. RESETTING A PARITY ALARM NOT IN LOCATION ZERO

It must be understood that any time the STOP ON PARITY ALARM switch is set and

a parity alert is detected during a production run, the central processor halts and all peripherals halt after completing their latest instruction. At this time it is mandatory that the operator consult the operating instructions (run book) before doing anything to the equipment. It will usually be necessary to return the program to the nearest restart point. The occurrence of a parity alert in the central processor indicates that erroneous information is present. To depress the RESET ALARM and continue the program is apt to produce incorrect results. The RESET ALARM switch resets the overflow flip-flop and the carry flip-flop, and these could compound the problem rather than remedy it.

The procedure for resetting a PARITY alarm in a location other than at the beginning of a program is as follows: (See Section XVI for an explanation of the meaning and use of memory resetters.)

1. Set the AUTO/MANUAL switch to MANUAL.
2. Set the STOP ON PARITY ALARM/NORM switch to NORM.
3. Put a memory resetter, followed by 2 blank cards, into the input hopper of the card reader. (8K or 16K depending on the size of the central processor, and either a zero or a minus resetter.)
4. Depress the LOAD CARD switch.
5. Depress the RESET ALARM switch.
6. Depress the LOAD CARD switch.
7. Depress the RESET P switch.
8. Set the AUTO/MANUAL switch to AUTO.
9. Depress the START switch. (Resetter will now clear memory.)
10. After memory has been cleared and the central processor stops, set the AUTO/MANUAL switch to MANUAL.
11. Engage the STOP ON PARITY ALARM switch.
12. Depress the RESET ALARM switch which should cause the PARITY alarm light to go out.
13. If the above steps do not clear the parity error condition, call the service engineer.

Starting the Program

Most operators are principally concerned with only three types of program input: cards, magnetic tape, and paper tape. The procedures for starting a program from each of these types of input are described in this section.

Before loading the program into memory, the operator should check the programmer's instructions to see what kind of memory resetter to use, if any.

Memory Resetters. Two types of memory resetters are often used. These are zero resetters and minus resetters. There are advantages and disadvantages to both types.

The zero memory resetter resets memory locations to zeros. This resetter is handy when a zero-delete memory dump is used, for it saves time and paper when printing out the contents of memory. The operator may use the zero resetter, then load a program and start running. If the machine should jump out of sequeace for any reason, it may land in a location with all zeros, which is an LDA instruction. It will then proceed to continue loading the A register until it comes back around to the program. It may enter the program at the wrong place and abort the program. Some Service Routines such as the Input/Output routines require a SPB resetter.

The minus resetter sets all memory locations with ones. If the central processor accidentally jumps out of sequence during a run when memory has been reset with a minus resetter, the machine will either jump into another part of the program or land in a location with all ones. Since all ones is a 37 which is an illegal instruction on most models, the central processor will halt.

Card Input. Procedures for loading cards into memory depend on whether the cards contain a program or merely data for use after the program is already loaded into memory. Assume that power is on to the central processor, the INSTR/WORD switch is set to INSTR, and the card reader has been made ready. The following steps apply to the 400 card per minute reader.

The following procedure loads a program deck of cards into memory. The first card must be a loader card punched in binary format and the last two cards must be blank.

1. Set the AUTO/MANUAL switch to MANUAL.

2. Depress the LOAD CARD switch to move the first card, (assuming no alarms were on).

3. Depress the RESET ALARM switch.

4. Depress the LOAD CARD switch to read the first card into memory.

5. Depress the RESET P switch.

6. Return the AUTO/MANUAL switch to AUTO.

7. Depress the START switch to begin automatic feed of the cards under program control.

The following procedure loads data cards to a program already in memory. One or two blank cards must be at the end of the deck, as required by the programmer.

1. Set the AUTO/MANUAL switch to MANUAL.

2. Depress the LOAD CARD switch to move the first card.

3. Depress the RESET ALARM switch.

4. Manually introduce a branch instruction into the A register (octal 26XXXXX); put address of first instruction of program in positions 7 through 19 of the BRU instruction.

5. Depress the A to I switch (transfers BRU instruction to the I register).

6. Return the AUTO/MANUAL switch to AUTO.

7. Depress the START switch to transfer control to the program, which automatically feeds the rest of the cards.

Magnetic Tape Input. With system configurations having both a card reader and the magnetic tape system, it is a simple matter to read a call card, which calls a taped program into memory. The entire program and data input can be on tape, or the program can be on cards and the input data on tape. Without the card reader, instructions must be fed manually into the central processor to get the program started.

Paper Tape Input. When a card reader is available, paper tape programs and data can easily be called into memory with a call card. Otherwise, a series of instructions must be fed manually into the central processor to get the program started.

ERRORS AND OPERATOR CORRECTIVE ACTION

The central processor may fail to operate correctly and cause program halts when the operator neglects to do any of the following operations.

Operator Checklist

1. Reset alarms before attempting to start.
2. Put SAVE P switch in normal (up) position.
3. Put INSTR/WORD switch in appropriate position.

Program Recovery or Restart

Watching and interpreting the indicator lights on the console will tell the operator much about the source of troubles when a program halts or refuses to start. The red alarm lights in the upper left corner of the console panel are danger signals which indicate that errors have been made, erroneous information has been received or transmitted, and the program may be aborted. The CARD PUNCH and CARD READER alarm lights mean the operator must restart or recover the program (see following sections). In some cases, the operator can exercise care and save the program run. It is a good general rule to go into the manual mode of operation before attempting to correct error situations indicated on the console.

Whether a program can be saved or is aborted depends on the answer to the questions: has erroneous information been received or transmitted, or has information been missed in a read or write operation? False or missing information will usually abort a program. By studying the charts on error and corrective action in the sections on individual pieces of equipment, the operator will often be able to determine whether a program can be saved.

When erroneous information has gotten into a run, the operator will correct any operator error or have the service engineer correct any serious machine errors. The run book should indicate the nearest programmed recovery point. Successful recovery will save going back to the beginning of the run.

When a program is aborted and no recovery procedures have been programmed, the operator will usually have to restart the program at the beginning. A good operator always looks in the run book or in other operator instructional material for programmer's instructions.

TABLE II.

CONTROL CONSOLE ERROR CONDITIONS

Error Condition	Possible Cause	Corrective Action
PRIORITY alarm light (red) comes on	Central processor is in the manual mode	When ready to go into automatic mode, press RESET ALARM and the AUTO portion of the AUTO/MANUAL switch.
	Alarm condition has occurred in card reader or card punch	See error and restart procedure on equipment concerned.
PARITY alarm light (red) comes on; if STOP ON PARITY ALARM switch is engaged, processor halts	A parity error was detected in memory	See run book for recovery or restart procedures; press RESET ALARM and START switches to start processing if run book so specifies.
	A parity error was detected while receiving information via the controller selector	Return to nearest rerun point; press RESET ALARM and START switches to start processing if run book so specifies.
	A parity error was detected in paper-tape reader operation	Check paper tape for damage; return to nearest rerun point; press RESET ALARM and START switches to start processing if run book so specifies.
	Random parity errors caused by system room overheating were detected on information coming from memory	Call service engineer to correct air conditioning
OVERFLOW alarm light (red) comes on (no halt in program)	Capacity of the arithmetic unit has been exceeded	Normally this alarm will be reset by the program; if not, check run book for instructions.
	The A register overflowed on a shift-left instruction	
	An illegal division was attempted	
ECHO alarm light (red) comes on; program stops	A peripheral controller that is operating through the controller selector was unable to respond when addressed; this pertains to every peripheral which has a controller. Off line, addressed plug not installed; power off; malfunction	Check peripheral for operator's error

Error Condition	Possible Cause	Corrective Action
CARD PUNCH alarm light (red) comes on; computer halts.	Card punch not ready when a WCB, WCF, or WCD instruction was given	Make card punch ready and consult run book for restart procedures
CARD READER alarm light (red) comes on; computer halts.	Card reader not ready when an RCB, RCF, or RCD instruction was given (busy, inoperable, card jam, or feed error)	Make card reader ready and consult run book for restart procedures
Central processor hangs in a loop and all peripherals halt.	Program is branching on a peripheral ready or not ready (determined by manually stepping through the loop)	Read I register to determine which peripheral is involved; refer to section of this manual on that peripheral for corrective action
Program executes same instruction over and over again (P counter does not increment).	SAVE P switch was left on (in down position)	Engage MANUAL switch, turn off SAVE P switch (to UP position) press RESET P, AUTO, and START switches
When loading a program deck of cards, the card reader reads one or two cards and halts; repeats condition on reruns.	Processor may be in decimal mode	Check maintenance panel; if DEC MODE light is on, reset to binary mode, rerun deck
	An index group (other than zero has been selected	If any INDEX GROUP lights are on, reset group to zero
Computer and peripherals halt	An illegal command is in I	Manually transfer contents of memory location indicated by P counter to the A register to determine if instruction is illegal. If programmer error, return program to originator. If machine error, try to rerun; if rerun fails, call service engineer
	Illegal command in I is all ones (a minus memory resetter was used), indicates machine has jumped out of the program	Restart and try to rerun program; if error recurs, call service engineer

V. CONSOLE TYPEWRITER

GENERAL DESCRIPTION

The console electric typewriter (Figure V-1) is an output device located on the operator's control console desk. Its principal purpose is to permit the computer to communicate with the operator by printing messages under program control. However, it is possible for the typewriter to be used by the programmer for more extensive informational output. This would usually happen only in situations when a high speed printer is not available. The typewriter receives output from the N register which is loaded, one character at a time, from the A register. The typewriter is capable of printing all of the following in upper case style at the rate of ten characters per second under program control:

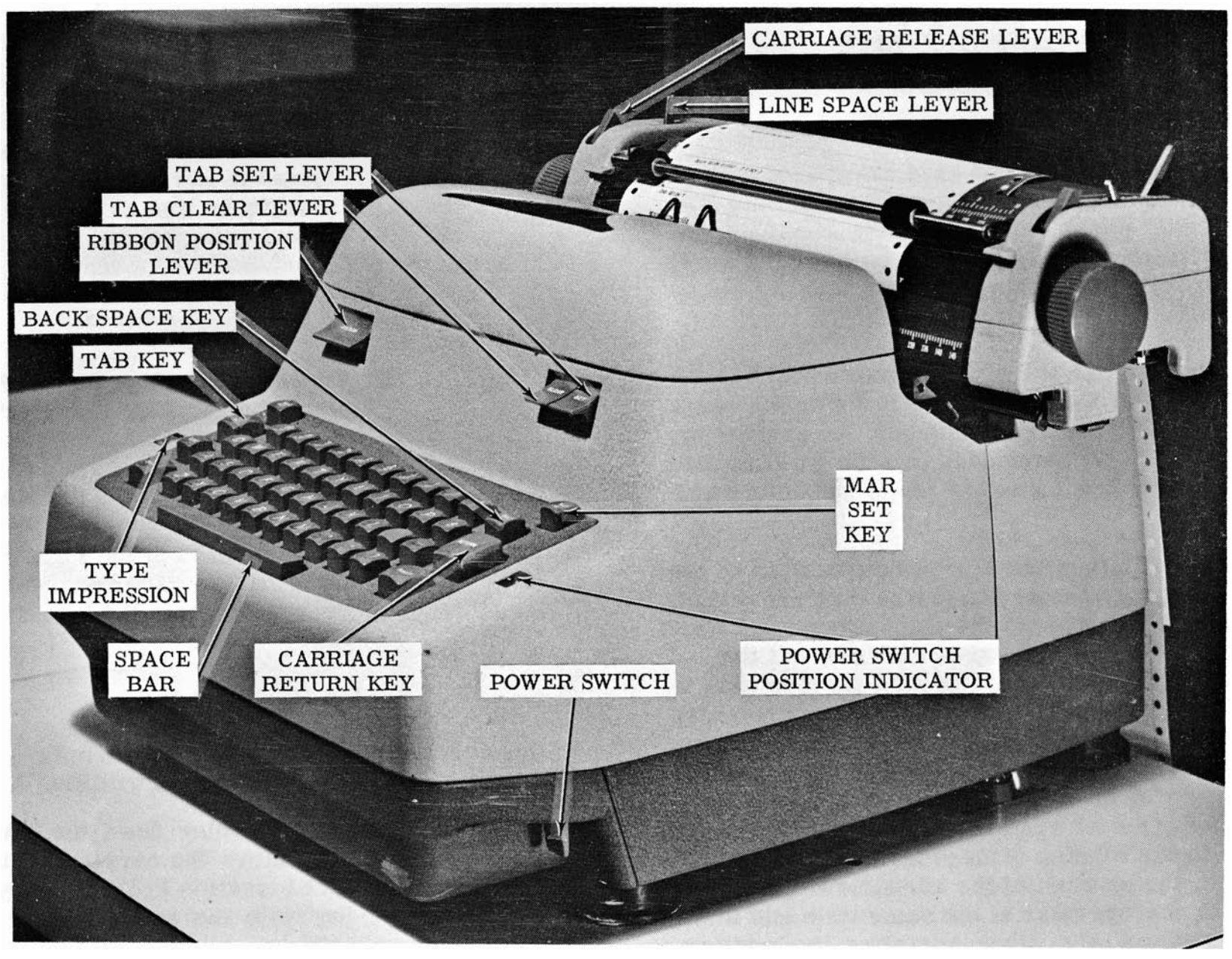


Figure V-1. Console Typewriter

Red printout
Black printout
Print characters 0-9, A-Z, minus, period, slash, dollar, and comma
Carriage return
Space (by operation of the blank key)
Tabulation

Messages are typed out automatically, requiring no assistance from the operator. However, a typeout should be immediately observed since the message may contain instructions requiring a decision and action on the operator's part. All error messages are printed in red. Program-controlled typeouts change the ribbon color automatically.

All messages logged on the console typewriter serve as a log of the performance of each program. If the program has been prepared with this in mind, it will cause the console typewriter to log the identification of the programs, a listing of tape labels, and instructions to the operator. If, however, the program is not complete to that extent, the operator may manually inject his own comments into the log. This can be done by operating the console typewriter keyboard in the same manner as any standard typewriter while the computer is temporarily halted. The typewriter can be used when the control console is set for either AUTO or MANUAL operation.

Since typewriter controls and keys are of such general familiarity, and most electric typewriter manuals describe the same parts as those on the console typewriter, no parts description will be included here. All parts mentioned in this writeup are called out on Figure V-1.

A lever under the left end of the keyboard controls the pressure, and the indicator above it shows the range from 0 to 10. The higher the number, the greater the impression. It is recommended that the type impression control be adjusted as low as is consistent with good copy.

The carriage return must always be specified by the program. If a programmer forgets the carriage return, the typewriter will type to the right margin and continue typing characters on top of each other at the end of the line (unless the operator notices it in time to manually move the carriage back). In the rather rare case when the program uses the typewriter for extensive output, the program may specify tabulation. All the program can do is specify 'activate the tab key,' so the setting of the tab stops must be done by the operator prior to the running of the program. When tabulation is used, the location of the tabulator stops will be specified to the operator at the same time and in the same manner as are other operating instructions.

The typewriter ribbon seldom causes the operator any concern, for a ribbon lasts a number of months and is replaced when necessary by the service engineer.

SETUP PROCEDURE

Only two steps in the setup procedure need to be done regularly at the beginning of each shift. They are:

1. Turn typewriter power on by moving the power toggle switch to the rear position. The veiwing window above the switch shows white to indicate that power is on.

2. Load paper in the typewriter in the same way as in any standard business typewriter. The paper is continuous strip, so the operator must make a mental note of whether the supply installed is sufficient to last throughout the shift.

The following steps are used less frequently, possibly only at time of initial setup. Spacing of margins, tabs, and lines depends somewhat upon policy at the individual computer site. This spacing may change, however, with a change in program printout format. In setting margins and tabs, typewriter power must be on.

1. Set the line space lever for one, two, or three spaces between lines. One or two spaces are most frequently used.

2. Set the margins. It is customary but not at all mandatory that the left margin be set ten spaces in from the left edge of the paper and the right margin be set as far right as is possible without going beyond the right edge of the paper.

   a. Set the left margin:

      (1) Touch the carriage RETURN key to place the carriage at the left margin.

      (2) While holding down the MAR SET key, move the carriage to the desired location to the right by spacing with the space bar or to the left by spacing with the BACK SPACE key.

   b. Set the right margin:

      (1) Move the carriage to the right margin by tabulating with the TAB KEY.

      (2) While holding down the MAR SET key, move the carriage to the desired location to the right by spacing with the space bar or to the left by spacing with the BACK SPACE key.

3. Set the tab stops. The GET Conventions manual specifies that the first two tab-

ulator settings will be at 10 and 20 spaces from the left margin. Messages of a general nature will originate at the left margin. Messages pertaining to input will be indented to the first tab setting and messages pertaining to output will be indented to the second tab setting.

The steps in setting tab stops are: (Only two settings are described, but the same procedure applies to any number of settings.)

a. Move the carriage to the right end of the writing line by tabulating with the TAB KEY.

b. While holding down the tab CLEAR lever, touch the carriage RETURN key to clear all tab stops previously set and move the carriage to the left margin (already set to the proper location).

c. Move the carriage the desired number of spaces to the right with the space bar (normally 10 spaces). Depress the tab SET lever to establish the first tab setting.

d. Move the carriage the desired number of spaces to the right again with the space bar (normally 10 spaces). Depress the tab SET lever to establish the second tab setting.

SPECIAL PROCEDURES

At the end of the running of a program, the typed log may be removed from the typewriter and returned to the programmer along with any appropriate operator comments pertaining to it. An alternate procedure is that it may be retained at the site for record purposes or removed only at the end of a shift.

ERRORS AND OPERATOR CORRECTIVE ACTION

Operator Errors

If the operator neglects to do any of the following, the typewriter will fail to operate properly:

1. Turn the typewriter on.
2. Set the margins and tabs correctly.
3. Set line space lever for correct spacing.

Program Errors

Three of the five possible types of program errors cause the typewriter to be 'hung up.' The term 'hung up' means that the program stops at the time of a TYP command, the typewriter is inoperative, and the required typeout does not occur. Table III describes five types of program errors, their meaning, and the recommended operator action. It will be seen from the table that the error indication is the same for three different types of program errors. It will also be seen that hitting any alphabetic key will correct three of the five types of errors. In all cases, notify the programmer of the errors in his program.

TABLE III

TYPEWRITER ERROR CONDITIONS

Error Condition	Possible Cause	Corrective Action
Keyboard is locked.	Typewriter was not manually turned on	Turn typewriter on, depress CLEAR N button on the console maintenance panel, and restart the program.
The typewriter is jammed and the N register ready light on the console is out.	The necessary 200 ms delay was not programmed between the TON and the TYP commands	Depress any alphabetic key. If the N-register ready light comes on, continue with the program
	The program transferred an illegal character into the N register before issuing the TYP command	Depress any alphabetic key. if the N-register ready light comes on, continue with the program. (The illegal character can be read from the N register lights on the maintenance panel inside the door above the operator's console).
	A TON command was not programmed before the TYP command.	1. Depress any alphabetic key. If the N-register ready light does not come on: 2. Manually enter a TON command into the A register by setting console switches to $(2500007)_8$ Save A. 3. Return to nearest restart point. 4. Make a note to tell the programmer that a TON command was missing.
The typewriter produces only garbled information.	The necessary 100 ms delay was not programmed after the TYP command	1. In most cases, stop the program and return it to the programmer. 2. In those cases where the operator is so familiar with the program that he doesn't need to read the typeouts, he can continue
The typewriter types to the end of a line and continues to type without returning to the left margin.	The necessary carriage return was not programmed	1. If possible, touch RETURN to move the carriage in time to prevent loss of data. 2. If data is lost, either rerun the program and manually return the carriage, or return the program to the programmer

NUMBER SYSTEMS

I NUMBER SYSTEMS IN GENERAL

To learn and understand new number systems, it is necessary to analyze principles which are true of all number systems:

A number is expressed as the sum of terms.

Each term is the product of a digit times a base raised to a power.

The base of a system is equal to the number of digits in the system.

In any number system, the largest single digit is always one less than the base.

The rightmost or least significant digit counts units. Each count in another column from the right contains a multiple of the base.

Whenever any column holds the highest valued digit of a particular number system, and one is added to it, the column goes back to zero and develops a carry to the next most significant column.

A. The Decimal System

Principles of a number system can be most easily understood by first relating them to an example in a familiar system-- the decimal system:

$$4789 = 4000 + 700 + 80 + 9$$

$$= (4 \times 10^3) + (7 \times 10^2) + (8 \times 10^1) + (9 \times 10^0)$$

The same number can be written as four sums as follows:

$$\begin{aligned} 4 \times 10^3 &= 4000 \\ 7 \times 10^2 &= 700 \\ 8 \times 10^1 &= 80 \\ 9 \times 10^0 &= 9 \\ &\overline{4789} \end{aligned}$$

The base of the decimal system is 10, and the base equals the total number of digits in the system (0 through 9). The largest single digit is 9, which is 1 less than the base. It must be remembered that $10^1 = 10$ and $10^0 = 1$. The last principle listed above is illustrated by the fact that when 1 is added to the 9 of 4789, the 9 goes to zero, and the number becomes 4790.

B. The Binary System

The base of the binary system is 2; the base equals the total number of digits in the system (0 through 1). The largest single digit is 1, which is 1 less than the base. The following is an example of a binary number:

$$11010_2 = (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$$

$$= (1 \times 16) + (1 \times 8) + (0 \times 4) + (1 \times 2) + (0 \times 1)$$

$$= 16 + 8 + 0 + 2 + 0 = 26_{10}$$

The number 26 is the decimal equivalent of binary 11010, so it is seen that the expansion of a binary number by powers is a simple method of converting from binary to decimal.

C. The Octal System

The base of the octal system is 8; the base equals the total number of digits in the system (0 through 7). The largest single digit is 7, which is 1 less than the base. The following is an example of an octal number:

$$144_8 = (1 \times 8^2) + (4 \times 8^1) + (4 \times 8^0)$$

$$= (1 \times 64) + (4 \times 8) + (4 \times 1)$$

$$= 64 + 32 + 4 = 100_{10}$$

The number 100 is the decimal equivalent of octal 144. Again it is seen that expansion of a number by powers is a simple method of converting to decimal--this time it is octal to decimal.

The following table illustrates various numbers in three systems:

Decimal Base 10	Octal Base 8	Binary Base 2
0	0	0
1	1	1
2	2	10
3	3	11
4	4	100
5	5	101
6	6	110
7	7	111
8	10	1000
9	11	1001
10	12	1010
11	13	1011
12	14	1100
16	20	10000
20	24	10100
32	40	100000
100	144	1100100
512	1000	1000000000

D. Octal Representation of Binary Numbers

Because the base "8" of the octal number system is a power of 2--the base of the binary system -- three binary numbers may be read as one octal number. This grouping of binary numbers into octal representation is easier to read than straight binary. To illustrate:

100111111000 = binary form of the
decimal number 2552

The binary number is long and awkward to read or copy, and cannot be easily converted to decimal. The same binary number may be written in groups of three digits dividing from the rightmost three as follows: 100 111 111 000. By reading each group as a binary number, one obtains: 4 7 7 0. This smaller number can be designated in octal as 4770_8.

E. Binary Coded Decimal

Besides using the number systems just described, computers use a code called binary coded decimal (BCD). The code represents letters of the alphabet and symbols such as dollar signs as well as decimal numbers. There are several ways of "coding" decimal digits by combining binary digits to represent one decimal digit. The code used with the GE 225 is often given in octal, as shown in the third column of the table, Appendix D. Each digit in octal stands for a three digit binary number. The Fourth column of the table, Appendix D, shows the code which is physically on the tape, but is never used in reading information into or out of the computer. The reason for the information being in a different form on the tape is that it is then in a form usable with equipment by manufacturers other than General Electric.

The table which follows contains a portion of the BCD code used in reading information into or out of the computer.

Decimal Number	BCD Octal Representation	BCD Binary Representation
0	00	000000
1	01	000001
2	02	000010
3	03	000011
4	04	000100
5	05	000101
6	06	000110
7	07	000111
8	10	001000
9	11	001001

II. ARITHMETIC COMPUTATIONS IN BINARY AND OCTAL

A. Binary Arithmetic

1. Addition:

0 + 0 = 0
1 + 0 = 1
1 + 1 = 10 (0 with 1 carried)

Additional examples:

```
      1 (carry)      1 11
   0001              110110
 + 0001            + 10111
 ------            -------
   0010            1001101
```

2. Subtraction:

0 - 0 = 0
1 - 1 = 0
1 - 0 = 1
0 - 1 = 1 (with 1 borrowed)

Borrowing can be confusing in binary, and there are several ways of thinking of it. One way is to think of each borrow as bringing twice the value to a number from the position immediately to the left of it. For example, binary positions double in value to the left, as is seen by the position values: 16, 8, 4, 2, 1. When borrowing a "1" from the 16 position and putting it in the 8 position, it is the same as borrowing two "1"s for the 8 position. In turn, one can borrow one of the borrowed "1"s from the 8 position to put two "1"s in the 4 position. The following examples use this principle:

Position value= 16 8 4 2 1

```
Borrow          =    1 1
Borrow          =    2 2 2
Binary number=   1  0  0  0 1 (Decimal value = 17)
Binary number=   1  0  1  1 0 (Decimal value = 10)
Binary diff.     0  0  1  1 1 (Decimal diff. =  7)
```

Decimal	Binary
	2 1
	0 2 0 0 2 2
354	1 0 1 1 0 0 0 1 0
- 170	- 1 0 1 0 1 0 1 0
184	1 0 1 1 1 0 0 0

More Examples:

	45	101101	354	101100010
	-25	- 11001	-170	- 10101010
Difference:	20	10100	184	10111000

	44	101100
	- 34	-100010
Difference:	10	001010

A second method of subtracting, called the 2's complement method, is particularly good to understand, for it is the way the computer handles subtraction in its internal operation. Subtraction is actually accomplished by forming the complement of the subtrahend and adding the complement to the minuend. In binary, the 2's complement of the subtrahend is obtained by merely changing all zeros to ones and ones to zeros, and then adding a one. For example, in a computer having a storage capacity of six bit positions, subtraction would be:

$101100 - 100010 = 101100 + 011101 + 1 = \underline{1}/001010$

$44_{10} - 34_{10} = 10_{10}$

There is a 1 bit carried out of the high-order end of the sum. This carry is lost in computers not using a sign bit, because it exceeds the storage capacity of the six bit positions of the register, and would therefore not affect the answer. Computers incorporating the sign bit position will use the carry to form the correct sign of the result.

3. Multiplication:

0 x 0 = 0
1 x 0 = 0
1 x 1 = 1

Multiplication is the same as it is in the decimal system except that the addition portion of a problem must follow the binary addition rules. In the computer, multiplication is in binary and is merely repeated additions.

Problem: Multiply 35 by 13.

Decimal	Binary
35	100011
x 13	x 1101
105	100011
35	1000110
455	100011
	111000111

4. Division:

0 ÷ 0 0
0 ÷ 1 0
1 ÷ 1 1
No ÷ by 0

Division by the computer is in binary, and is a series of repeated subtractions.

Problem: Divide 144 by 12

Decimal	Binary
12	1100
12/144	1100/10010000
12	1100
24	1100
24	1100
0	0000

B. Octal Arithmetic

There is really little need to perform calculations in octal, and the computer does not calculate in octal. Since it is difficult to accustom oneself to handle octal addition, subtraction, multiplication, and division, it is recommended that for all but the simplest problems, conversion be made first to decimal.

1. Addition:

The following are examples of octal addition:

$7 + 1 = 10$	$17 + 1 = 20$
$7 + 2 = 11$	$27 + 1 = 30$
$7 + 6 = 15$	

To add single-digit octal numbers having a sum greater than 7_8 but not exceeding 17_8, the following rule applies: Add the digits as decimal digits, then add 2 to get the digits of the octal sum. For example:

$5_8 + 7_8 = (5 + 7 = 12,\ 12 + 2 = 14) = 14_8$

Decimal	Octal
54	11 (carry)
23	66
77	27
	115

2. Subtraction:

The following are examples of octal subtraction:

$10 - 1 = 7$	$30 - 1 = 27$
$20 - 1 = 17$	$40 - 1 = 37$

3. Multiplication:

Multiplication in octal can best be done by using the table below.

Octal	X	1	2	3	4	5	6	7	10
43	1	1	2	3	4	5	6	7	10
15									
257	2	2	4	6	10	12	14	16	20
43									
707	3	3	6	11	14	17	22	25	30
	4	4	10	14	20	24	30	34	40
	5	5	12	17	24	31	36	43	50
	6	6	14	22	30	36	44	52	60
	7	7	16	25	34	43	52	61	70
	10	10	20	30	40	50	60	70	100

4. Division:

As shown by the following example, the subtraction involved in division must be carefully checked against octal subtraction rules.

Octal

```
   14
14/220
   14
   60
   60
    0
```

III. CONVERSION FROM ONE NUMBER SYSTEM TO ANOTHER

A. Decimal to Binary

A decimal number is converted to a binary number by repeated division by 2, using the remainder as a binary digit. For example, given decimal 37, find its binary equivalent.

```
    0  remainder 1
   2/1 remainder 0
   2/2 remainder 0
   2/4 remainder 1      Reading down, the re-
   2/9 remainder 0      mainders give
  2/18 remainder 1      the answer of 100101
Start
here → 2/37
```

The binary number 100101 is equal to decimal 37.

B. Binary to Decimal

The expansion method used in paragraph IB of this Annex converts a binary number to its decimal equivalent. This method raises the base 2 to the proper power and then multiplies by 0 or 1.

Given the binary number 100101, find its decimal equivalent:

$$100101 = (1x2^5)+(0x2^4)+(0x2^3)+(1x2^2)+(0x2^1)+(1x2^0)$$

$$= (1x32)+(0x16)+(0x8)+(1x4)+(0x2)+(1x1)$$

$$= 32+0+0+4+0+1 = 37$$

C. Decimal to Octal

A decimal number is converted to an octal number by repeated divisions by 8 using the remainder as the octal digit. For example, given decimal 144, find its octal equivalent.

```
    0  remainder 2
   8/2 remainder 2      Reading down, the
   8/18 remainder 0     remainders give
Start                   the answer of 220
here → 8/144
```

Octal becomes 220, which is equal to decimal 144.

D. Octal to Decimal

The expansion method used in paragraph IC of this Annex converts an octal number to its decimal equivalent. This method raises the base 8 to the proper power and then multiplies by the appropriate octal digit.

Given the octal number 220, find its decimal equivalent.

$$220 = (2x8^2) + (2x8^1) + (0x8^0)$$

$$= (2x64) + (2x8) + (0x1)$$

$$= 128 + 16 + 0 = 144$$

E. Octal to Binary

Since the octal base 8 is the third power of the binary base 2, each octal digit can be written as three binary digits. For example,

octal 220 = binary 010 010 000

octal 703 = binary 111 000 011

F. Binary to Octal

Binary digits can easily be converted to octal by dividing the digits into groups of three, beginning the grouping at the right with the least significant digit as follows:

111010100 = 1 110 101 100

= 1 6 5 4

which is 1654 in octal.

Table of Powers of 2

2^n	n	2^{-n}
1	0	1.0
2	1	0.5
4	2	0.25
8	3	0.125
16	4	0.062 5
32	5	0.031 25
64	6	0.015 625
128	7	0.007 812 5
256	8	0.003 906 25
512	9	0.001 953 125
1 024	10	0.000 976 562 5
2 048	11	0.000 488 281 25
4 096	12	0.000 244 140 625
8 192	13	0.000 122 070 312 5
16 384	14	0.000 061 035 156 25
32 768	15	0.000 030 517 578 125
65 536	16	0.000 015 258 789 062 5
131 072	17	0.000 007 629 394 531 25
262 144	18	0.000 003 814 697 265 625
524 288	19	0.000 001 907 348 632 812 5
1 048 576	20	0.000 000 953 674 316 406 25
2 097 152	21	0.000 000 476 837 158 203 125
4 194 304	22	0.000 000 238 418 579 101 562 5
8 388 608	23	0.000 000 119 209 289 550 781 25
16 777 216	24	0.000 000 059 604 644 775 390 625
33 554 432	25	0.000 000 029 802 322 387 695 312 5
67 108 864	26	0.000 000 014 901 161 193 847 656 25
134 217 728	27	0.000 000 007 450 580 596 923 828 125
268 435 456	28	0.000 000 003 725 290 298 461 914 062 5
536 870 912	29	0.000 000 001 862 645 149 230 957 031 25
1 073 741 824	30	0.000 000 000 931 322 574 615 478 515 625
2 147 483 648	31	0.000 000 000 465 661 287 307 739 257 812 5
4 294 967 296	32	0.000 000 000 232 830 643 653 869 628 906 25
8 589 934 592	33	0.000 000 000 116 415 321 826 934 814 453 125
17 179 869 184	34	0.000 000 000 058 207 660 913 467 407 226 562 5
34 359 738 368	35	0.000 000 000 029 103 830 456 733 703 613 281 25
68 719 476 736	36	0.000 000 000 014 551 915 228 366 851 806 640 625
137 438 953 472	37	0.000 000 000 007 275 957 614 183 425 903 320 312 5
274 877 906 944	38	0.000 000 000 003 637 978 807 091 712 951 660 156 25
549 755 813 888	39	0.000 000 000 001 818 989 403 545 856 475 830 078 125
1 099 511 627 776	40	0.000 000 000 000 909 494 701 772 928 237 915 039 062 5

Octal-Decimal Integer Conversion Table

Octal	10000	20000	30000	40000	50000	60000	70000
Decimal	4096	8192	12288	16384	20480	24576	28672

Octal	0000 to 0377
Decimal	0000 to 0255

Octal	0	1	2	3	4	5	6	7
0000	0000	0001	0002	0003	0004	0005	0006	0007
0010	0008	0009	0010	0011	0012	0013	0014	0015
0020	0016	0017	0018	0019	0020	0021	0022	0023
0030	0024	0025	0026	0027	0028	0029	0030	0031
0040	0032	0033	0034	0035	0036	0037	0038	0039
0050	0040	0041	0042	0043	0044	0045	0046	0047
0060	0048	0049	0050	0051	0052	0053	0054	0055
0070	0056	0057	0058	0059	0060	0061	0062	0063
0100	0064	0065	0066	0067	0068	0069	0070	0071
0110	0072	0073	0074	0075	0076	0077	0078	0079
0120	0080	0081	0082	0083	0084	0085	0086	0087
0130	0088	0089	0090	0091	0092	0093	0094	0095
0140	0096	0097	0098	0099	0100	0101	0102	0103
0150	0104	0105	0106	0107	0108	0109	0110	0111
0160	0112	0113	0114	0115	0116	0117	0118	0119
0170	0120	0121	0122	0123	0124	0125	0126	0127
0200	0128	0129	0130	0131	0132	0133	0134	0135
0210	0136	0137	0138	0139	0140	0141	0142	0143
0220	0144	0145	0146	0147	0148	0149	0150	0151
0230	0152	0153	0154	0155	0156	0157	0158	0159
0240	0160	0161	0162	0163	0164	0165	0166	0167
0250	0168	0169	0170	0171	0172	0173	0174	0175
0260	0176	0177	0178	0179	0180	0181	0182	0183
0270	0184	0185	0186	0187	0188	0189	0190	0191
0300	0192	0193	0194	0195	0196	0197	0198	0199
0310	0200	0201	0202	0203	0204	0205	0206	0207
0320	0208	0209	0210	0211	0212	0213	0214	0215
0330	0216	0217	0218	0219	0220	0221	0222	0223
0340	0224	0225	0226	0227	0228	0229	0230	0231
0350	0232	0233	0234	0235	0236	0237	0238	0239
0360	0240	0241	0242	0243	0244	0245	0246	0247
0370	0248	0249	0250	0251	0252	0253	0254	0255

Octal	1000 to 1377
Decimal	0512 to 0767

Octal	0	1	2	3	4	5	6	7
1000	0512	0513	0514	0515	0516	0517	0518	0519
1010	0520	0521	0522	0523	0524	0525	0526	0527
1020	0528	0529	0530	0531	0532	0533	0534	0535
1030	0536	0537	0538	0539	0540	0541	0542	0543
1040	0544	0545	0546	0547	0548	0549	0550	0551
1050	0552	0553	0554	0555	0556	0557	0558	0559
1060	0560	0561	0562	0563	0564	0565	0566	0567
1070	0568	0569	0570	0571	0572	0573	0574	0575
1100	0576	0577	0578	0579	0580	0581	0582	0583
1110	0584	0585	0586	0587	0588	0589	0590	0591
1120	0592	0593	0594	0595	0596	0597	0598	0599
1130	0600	0601	0602	0603	0604	0605	0606	0607
1140	0608	0609	0610	0611	0612	0613	0614	0615
1150	0616	0617	0618	0619	0620	0621	0622	0623
1160	0624	0625	0626	0627	0628	0629	0630	0631
1170	0632	0633	0634	0635	0636	0637	0638	0639
1200	0640	0641	0642	0643	0644	0645	0646	0647
1210	0648	0149	0650	0651	0652	0653	0654	0655
1220	0656	0657	0658	0659	0660	0661	0662	0663
1230	0664	0665	0666	0667	0668	0669	0670	0671
1240	0672	0673	0674	0675	0676	0677	0678	0679
1250	0680	0681	0682	0683	0684	0685	0686	0687
1260	0688	0689	0690	0691	0692	0693	0694	0695
1270	0696	0697	0698	0699	0700	0701	0702	0703
1300	0704	0705	0706	0707	0708	0709	0710	0711
1310	0712	0713	0714	0715	0716	0717	0718	0719
1320	0720	0721	0722	0723	0724	0725	0726	0727
1330	0728	0729	0730	0731	0732	0733	0734	0735
1340	0736	0737	0738	0739	0740	0741	0742	0743
1350	0744	0745	0746	0747	0748	0749	0750	0751
1360	0752	0753	0754	0755	0756	0757	0758	0759
1370	0760	0761	0762	0763	0764	0765	0766	0767

Octal	0400 to 0777
Decimal	0256 to 0511

Octal	0	1	2	3	4	5	6	7
0400	0256	0257	0258	0259	0260	0261	0262	0263
0410	0264	0265	0266	0267	0268	0269	0270	0271
0420	0272	0273	0274	0275	0276	0277	0278	0279
0430	0280	0281	0282	0283	0284	0285	0286	0287
0440	0288	0289	0290	0291	0292	0293	0294	0295
0450	0296	0297	0298	0299	0300	0301	0302	0303
0460	0304	0305	0306	0307	0308	0309	0310	0311
0470	0312	0313	0314	0315	0316	0317	0318	0319
0500	0320	0321	0322	0323	0324	0325	0326	0327
0510	0328	0329	0330	0331	0332	0333	0334	0335
0520	0336	0337	0338	0339	0340	0341	0342	0343
0530	0344	0345	0346	0347	0348	0349	0350	0351
0540	0352	0353	0354	0355	0356	0357	0358	0359
0550	0360	0361	0362	0363	0364	0365	0366	0367
0560	0368	0369	0370	0371	0372	0373	0374	0375
0570	0376	0377	0378	0379	0380	0381	0382	0383
0600	0384	0385	0386	0387	0388	0389	0390	0391
0610	0392	0393	0394	0395	0396	0397	0398	0399
0620	0400	0401	0402	0403	0404	0405	0406	0407
0630	0408	0409	0410	0411	0412	0413	0414	0415
0640	0416	0417	0418	0419	0420	0421	0422	0423
0650	0424	0425	0426	0427	0428	0429	0430	0431
0660	0432	0433	0434	0435	0436	0437	0438	0439
0670	0440	0441	0442	0443	0444	0445	0446	0447
0700	0448	0449	0450	0451	0452	0453	0454	0455
0710	0456	0457	0458	0459	0460	0461	0462	0463
0720	0464	0465	0466	0467	0468	0469	0470	0471
0730	0472	0473	0474	0475	0476	0477	0478	0479
0740	0480	0481	0482	0483	0484	0485	0486	0487
0750	0488	0489	0490	0491	0492	0493	0494	0495
0760	0496	0497	0498	0499	0500	0501	0502	0503
0770	0504	0505	0506	0507	0508	0509	0510	0511

Octal	1400 to 1777
Decimal	0768 to 1023

Octal	0	1	2	3	4	5	6	7
1400	0768	0769	0770	0771	0772	0773	0774	0775
1410	0776	0777	0778	0779	0780	0781	0782	0783
1420	0784	0785	0786	0787	0788	0789	0790	0791
1430	0792	0793	0794	0795	0796	0797	0798	0799
1440	0800	0801	0802	0803	0804	0805	0806	0807
1450	0808	0809	0810	0811	0812	0813	0814	0815
1460	0816	0817	0818	0819	0820	0821	0822	0823
1470	0824	0825	0826	0827	0828	0829	0830	0831
1500	0832	0833	0834	0835	0836	0837	0838	0839
1510	0840	0841	0842	0843	0844	0845	0846	0847
1520	0848	0849	0850	0851	0852	0853	0854	0855
1530	0856	0857	0858	0859	0860	0861	0862	0863
1540	0864	0865	0866	0867	0868	0869	0870	0871
1550	0872	0873	0874	0875	0876	0877	0878	0879
1560	0880	0881	0882	0883	0884	0885	0886	0887
1570	0888	0889	0890	0891	0892	0893	0894	0895
1600	0896	0897	0898	0899	0900	0901	0902	0903
1610	0904	0905	0906	0907	0908	0909	0910	0911
1620	0912	0913	0914	0915	0916	0917	0918	0919
1630	0920	0921	0922	0923	0924	0925	0926	0927
1640	0928	0929	0930	0931	0932	0933	0934	0935
1650	0936	0937	0938	0939	0940	0941	0942	0943
1660	0944	0945	0946	0947	0948	0949	0950	0951
1670	0952	0953	0954	0955	0956	0957	0958	0959
1700	0960	0961	0962	0963	0964	0965	0966	0967
1710	0968	0969	0970	0971	0972	0973	0974	0975
1720	0976	0977	0978	0979	0980	0981	0982	0983
1730	0984	0985	0986	0987	0988	0989	0990	0991
1740	0992	0993	0994	0995	0996	0997	0998	0999
1750	1000	1001	1002	1003	1004	1005	1006	1007
1760	1008	1009	1010	1011	1012	1013	1014	1015
1770	1016	1017	1018	1019	1020	1021	1022	1023

Octal-Decimal Integer Conversion Table

Octal	10000	20000	30000	40000	50000	60000	70000
Decimal	4096	8192	12288	16384	20480	24576	28672

Octal	2000 to 2377
Decimal	1024 to 1279

Octal	0	1	2	3	4	5	6	7
2000	1024	1025	1026	1027	1028	1029	1030	1031
2010	1032	1033	1034	1035	1036	1037	1038	1039
2020	1040	1041	1042	1043	1044	1045	1046	1047
2030	1048	1049	1050	1051	1052	1053	1054	1055
2040	1056	1057	1058	1059	1060	1061	1062	1063
2050	1064	1065	1066	1067	1068	1069	1070	1071
2060	1072	1073	1074	1075	1076	1077	1078	1079
2070	1080	1081	1082	1083	1084	1085	1086	1087
2100	1088	1089	1090	1091	1092	1093	1094	1095
2110	1096	1097	1098	1099	1100	1101	1102	1103
2120	1104	1105	1106	1107	1108	1109	1110	1111
2130	1112	1113	1114	1115	1116	1117	1118	1119
2140	1120	1121	1122	1123	1124	1125	1126	1127
2150	1128	1129	1130	1131	1132	1133	1134	1135
2160	1136	1137	1138	1139	1140	1141	1142	1143
2170	1144	1145	1146	1147	1148	1149	1150	1151
2200	1152	1153	1154	1155	1156	1157	1158	1159
2210	1160	1161	1162	1163	1164	1165	1166	1167
2220	1168	1169	1170	1171	1172	1173	1174	1175
2230	1176	1177	1178	1179	1180	1181	1182	1183
2240	1184	1185	1186	1187	1188	1189	1190	1191
2250	1192	1193	1194	1195	1196	1197	1198	1199
2260	1200	1201	1202	1203	1204	1205	1206	1207
2270	1208	1209	1210	1211	1212	1213	1214	1215
2300	1216	1217	1218	1219	1220	1221	1222	1223
2310	1224	1225	1226	1227	1228	1229	1230	1231
2320	1232	1233	1234	1235	1236	1237	1238	1239
2330	1240	1241	1242	1243	1244	1245	1246	1247
2340	1248	1249	1250	1251	1252	1253	1254	1255
2350	1256	1257	1258	1259	1260	1261	1262	1263
2360	1264	1265	1266	1267	1268	1269	1270	1271
2370	1272	1273	1274	1275	1276	1277	1278	1279

Octal	3000 to 3377
Decimal	1356 to 1791

Octal	0	1	2	3	4	5	6	7
3000	1536	1537	1538	1539	1540	1541	1542	1543
3010	1544	1545	1546	1547	1548	1549	1550	1551
3020	1552	1553	1554	1555	1556	1557	1558	1559
3030	1560	1561	1562	1563	1564	1565	1566	1567
3040	1568	1569	1570	1571	1572	1573	1574	1575
3050	1576	1577	1578	1579	1580	1581	1582	1583
3060	1584	1585	1586	1587	1588	1589	1590	1591
3070	1592	1593	1594	1595	1596	1597	1598	1599
3100	1600	1601	1602	1603	1604	1605	1606	1607
3110	1608	1609	1610	1611	1612	1613	1614	1615
3120	1616	1617	1618	1619	1620	1621	1622	1623
3130	1624	1625	1626	1627	1628	1629	1630	1631
3140	1632	1633	1634	1635	1636	1637	1638	1639
3150	1640	1641	1642	1643	1644	1645	1646	1647
3160	1648	1649	1650	1651	1652	1653	1654	1655
3170	1656	1657	1658	1659	1660	1661	1662	1663
3200	1664	1665	1666	1667	1668	1669	1670	1671
3210	1672	1673	1674	1675	1676	1677	1678	1679
3220	1680	1681	1682	1683	1684	1685	1686	1687
3230	1688	1689	1690	1691	1692	1693	1694	1695
3240	1696	1697	1698	1699	1700	1701	1702	1703
3250	1704	1705	1706	1707	1708	1709	1710	1711
3260	1712	1713	1714	1715	1716	1717	1718	1719
3270	1720	1721	1722	1723	1724	1725	1726	1727
3300	1728	1729	1730	1731	1732	1733	1734	1735
3310	1736	1737	1738	1739	1740	1741	1742	1743
3320	1744	1745	1746	1747	1748	1749	1750	1751
3330	1752	1753	1754	1755	1756	1757	1758	1759
3340	1760	1761	1762	1763	1764	1765	1766	1767
3350	1768	1769	1770	1771	1772	1773	1774	1775
3360	1776	1777	1778	1779	1780	1781	1782	1783
3370	1784	1785	1786	1787	1788	1789	1790	1791

Octal	2400 to 2777
Decimal	1280 to 1535

Octal	0	1	2	3	4	5	6	7
2400	1280	1281	1282	1283	1284	1285	1286	1287
2410	1288	1289	1290	1291	1292	1293	1294	1295
2420	1296	1297	1298	1299	1300	1301	1302	1303
2430	1304	1305	1306	1307	1308	1309	1310	1311
2440	1312	1313	1314	1315	1316	1317	1318	1319
2450	1320	1321	1322	1323	1324	1325	1326	1327
2460	1328	1329	1330	1331	1332	1333	1334	1335
2470	1336	1337	1338	1339	1340	1341	1342	1343
2500	1344	1345	1346	1347	1348	1349	1350	1351
2510	1352	1353	1354	1355	1356	1357	1358	1359
2520	1360	1361	1362	1363	1364	1365	1366	1367
2530	1368	1369	1370	1371	1372	1373	1374	1375
2540	1376	1377	1378	1379	1380	1381	1382	1383
2550	1384	1385	1386	1387	1388	1389	1390	1391
2560	1392	1393	1394	1395	1396	1397	1398	1399
2570	1400	1401	1402	1403	1404	1405	1406	1407
2600	1408	1409	1410	1411	1412	1413	1414	1415
2610	1416	1417	1418	1419	1420	1421	1422	1423
2620	1424	1425	1426	1427	1428	1429	1430	1431
2630	1432	1433	1434	1435	1436	1437	1438	1439
2640	1440	1441	1442	1443	1444	1445	1446	1447
2650	1448	1449	1450	1451	1452	1453	1454	1455
2660	1456	1457	1458	1459	1460	1461	1462	1463
2670	1464	1465	1466	1467	1468	1469	1470	1471
2700	1472	1473	1474	1475	1476	1477	1478	1479
2710	1480	1481	1482	1483	1484	1485	1486	1487
2720	1488	1489	1490	1491	1492	1493	1494	1495
2730	1496	1497	1498	1499	1500	1501	1502	1503
2740	1504	1505	1506	1507	1508	1509	1510	1511
2750	1512	1513	1514	1515	1516	1517	1518	1519
2760	1520	1521	1522	1523	1524	1525	1526	1527
2770	1528	1529	1530	1531	1532	1533	1534	1535

Octal	3400 to 3777
Decimal	1792 to 2047

Octal	0	1	2	3	4	5	6	7
3400	1792	1793	1794	1795	1796	1797	1798	1799
3410	1800	1801	1802	1803	1804	1805	1806	1807
3420	1808	1809	1810	1811	1812	1813	1814	1815
3430	1816	1817	1818	1819	1820	1821	1822	1823
3440	1824	1825	1826	1827	1828	1829	1830	1831
3450	1832	1833	1834	1835	1836	1837	1838	1839
3460	1840	1841	1842	1843	1844	1845	1846	1847
3470	1848	1849	1850	1851	1852	1853	1854	1855
3500	1856	1857	1858	1859	1860	1861	1862	1863
3510	1864	1865	1866	1867	1868	1869	1870	1871
3520	1872	1873	1874	1875	1876	1877	1878	1879
3530	1880	1881	1882	1883	1884	1885	1886	1887
3540	1888	1889	1890	1891	1892	1893	1894	1895
3550	1896	1897	1898	1899	1900	1901	1902	1903
3560	1904	1905	1906	1907	1908	1909	1910	1911
3570	1912	1913	1914	1915	1916	1917	1918	1919
3600	1920	1921	1922	1923	1924	1925	1926	1927
3610	1928	1929	1930	1931	1932	1933	1934	1935
3620	1936	1937	1938	1939	1940	1941	1942	1943
3630	1944	1945	1946	1947	1948	1949	1950	1951
3640	1952	1953	1954	1955	1956	1957	1958	1959
3650	1960	1961	1962	1963	1964	1965	1966	1967
3660	1968	1969	1970	1971	1972	1973	1974	1975
3670	1976	1977	1978	1979	1980	1981	1982	1983
3700	1984	1985	1986	1987	1988	1989	1990	1991
3710	1992	1993	1994	1995	1996	1997	1998	1999
3720	2000	2001	2002	2003	2004	2005	2006	2007
3730	2008	2009	2010	2011	2012	2013	2014	2015
3740	2016	2017	2018	2019	2020	2021	2022	2023
3750	2024	2025	2026	2027	2028	2029	2030	2031
3760	2032	2033	2034	2035	2036	2037	2038	2039
3770	2040	2041	2042	2043	2044	2045	2046	2047

Octal-Decimal Integer ConversionTable

Octal	10000	20000	30000	40000	50000	60000	70000
Decimal	4096	8192	12288	16384	20480	24576	28672

Octal	4000 to 4377
Decimal	2048 to 2303

Octal	0	1	2	3	4	5	6	7
4000	2048	2049	2050	2051	2052	2053	2054	2055
4010	2056	2057	2058	2059	2060	2061	2062	2063
4020	2064	2065	2066	2067	2068	2069	2070	2071
4030	2072	2073	2074	2075	2076	2077	2078	2079
4040	2080	2081	2082	2083	2084	2085	2086	2087
4050	2088	2089	2090	2091	2092	2093	2094	2095
4060	2096	2097	2098	2099	2100	2101	2102	2103
4070	2104	2105	2106	2107	2108	2109	2110	2111
4100	2112	2113	2114	2115	2116	2117	2118	2119
4110	2120	2121	2122	2123	2124	2125	2126	2127
4120	2128	2129	2130	2131	2132	2133	2134	2135
4130	2136	2137	2138	2139	2140	2141	2142	2143
4140	2144	2145	2146	2147	2148	2149	2150	2151
4150	2152	2153	2154	2155	2156	2157	2158	2159
4160	2160	2161	2162	2163	2164	2165	2166	2167
4170	2168	2169	2170	2171	2172	2173	2174	2175
4200	2176	2177	2178	2179	2180	2181	2182	2183
4210	2184	2185	2186	2187	2188	2189	2190	2191
4220	2192	2193	2194	2195	2196	2197	2198	2199
4230	2200	2201	2202	2203	2204	2205	2206	2207
4240	2208	2209	2210	2211	2212	2213	2214	2215
4250	2216	2217	2218	2219	2220	2221	2222	2223
4260	2224	2225	2226	2227	2228	2229	2230	2231
4270	2232	2233	2234	2235	2236	2237	2238	2239
4300	2240	2241	2242	2243	2244	2245	2246	2247
4310	2248	2249	2250	2251	2252	2253	2254	2255
4320	2256	2257	2258	2259	2260	2261	2262	2263
4330	2264	2265	2266	2267	2268	2269	2270	2271
4340	2272	2273	2274	2275	2276	2277	2278	2279
4350	2280	2281	2282	2283	2284	2285	2286	2287
4360	2288	2289	2290	2291	2292	2293	2294	2295
4370	2296	2297	2298	2299	2300	2301	2302	2303

Octal	5000 to 5377
Decimal	2560 to 2815

Octal	0	1	2	3	4	5	6	7
5000	2560	2561	2562	2563	2564	2565	2566	2567
5010	2568	2569	2570	2571	2572	2573	2574	2575
5020	2576	2577	2578	2579	2580	2581	2582	2583
5030	2584	2585	2586	2587	2588	2589	2590	2591
5040	2592	2593	2594	2595	2596	2597	2598	2599
5050	2600	2601	2602	2603	2604	2605	2606	2607
5060	2608	2609	2610	2611	2612	2613	2614	2615
5070	2616	2617	2618	2619	2620	2621	2622	2623
5100	2624	2625	2626	2627	2628	2629	2630	2631
5110	2632	2633	2634	2635	2636	2637	2638	2639
5120	2640	2641	2642	2643	2644	2645	2646	2647
5130	2648	2649	2650	2651	2652	2653	2654	2655
5140	2656	2657	2658	2659	2660	2661	2662	2663
5150	2664	2665	2666	2667	2668	2669	2670	2671
5160	2672	2673	2674	2675	2676	2677	2678	2679
5170	2680	2681	2682	2683	2684	2685	2686	2687
5200	2688	2689	2690	2691	2692	2693	2694	2695
5210	2696	2697	2698	2699	2700	2701	2702	2703
5220	2704	2705	2706	2707	2708	2709	2710	2711
5230	2712	2713	2714	2715	2716	2717	2718	2719
5240	2720	2721	2722	2723	2724	2725	2726	2727
5250	2728	2729	2730	2731	2732	2733	2734	2735
5260	2736	2737	2738	2739	2740	2741	2742	2743
5270	2744	2745	2746	2747	2748	2749	2750	2751
5300	2752	2753	2754	2755	2756	2757	2758	2759
5310	2760	2761	2762	2763	2764	2765	2766	2767
5320	2768	2769	2770	2771	2772	2773	2774	2775
5330	2776	2777	2778	2779	2780	2781	2782	2783
5340	2784	2785	2786	2787	2788	2789	2790	2791
5350	2792	2793	2794	2795	2796	2797	2798	2799
5360	2800	2801	2802	2803	2804	2805	2806	2807
5370	2808	2809	2810	2811	2812	2813	2814	2815

Octal	4400 to 4777
Decimal	2304 to 2559

Octal	0	1	2	3	4	5	6	7
4400	2304	2305	2306	2307	2308	2309	2310	2311
4410	2312	2313	2314	2315	2316	2317	2318	2319
4420	2320	2321	2322	2323	2324	2325	2326	2327
4430	2328	2329	2330	2331	2332	2333	2334	2335
4440	2336	2337	2338	2339	2340	2341	2342	2343
4450	2344	2345	2346	2347	2348	2349	2350	2351
4460	2352	2353	2354	2355	2356	2357	2358	2359
4470	2360	2361	2362	2363	2364	2365	2366	2367
4500	2368	2369	2370	2371	2372	2373	2374	2375
4510	2376	2377	2378	2379	2380	2381	2382	2383
4520	2384	2385	2386	2387	2388	2389	2390	2391
4530	2392	2393	2394	2395	2396	2397	2398	2399
4540	2400	2401	2402	2403	2404	2405	2406	2407
4550	2408	2409	2410	2411	2412	2413	2414	2415
4560	2416	2417	2418	2419	2420	2421	2422	2423
4570	2424	2425	2426	2427	2428	2429	2430	2431
4600	2432	2433	2434	2435	2436	2437	2438	2439
4610	2440	2441	2442	2443	2444	2445	2446	2447
4620	2448	2449	2450	2451	2452	2453	2454	2455
4630	2456	2457	2458	2459	2460	2461	2462	2463
4640	2464	2465	2466	2467	2468	2469	2470	2471
4650	2472	2473	2474	2475	2476	2477	2478	2479
4660	2480	2481	2482	2483	2484	2485	2486	2487
4670	2488	2489	2490	2491	2492	2493	2494	2495
4700	2496	2497	2498	2499	2500	2501	2502	2503
4710	2504	2505	2506	2507	2508	2509	2510	2511
4720	2512	2513	2514	2515	2516	2517	2518	2519
4730	2520	2521	2522	2523	2524	2525	2526	2527
4740	2528	2529	2530	2531	2532	2533	2534	2535
4750	2536	3537	2538	2539	2540	2541	2542	2543
4760	2544	2545	2546	2547	2548	2549	2550	2551
4770	2552	2553	2554	2555	2556	2557	2558	2559

Octal	5400 to 5777
Decimal	2816 to 3071

Octal	0	1	2	3	4	5	6	7
5400	2816	2817	2818	2819	2820	2821	2822	2823
5410	2824	2825	2826	2827	2828	2829	2830	2831
5420	2832	2833	2834	2835	2836	2837	2838	2839
5430	2840	2841	2842	2843	2844	2845	2846	2847
5440	2848	2849	2850	2851	2852	2853	2854	2855
5450	2856	2857	2858	2859	2860	2861	2862	2863
5460	2864	2865	2866	2867	2868	2869	2870	2871
5470	2872	2873	2874	2875	2876	2877	2878	2879
5500	2880	2881	2882	2883	2884	2885	2886	2887
5510	2888	2889	2890	2891	2892	2893	2894	2895
5520	2896	2897	2898	2899	2900	2901	2902	2903
5530	2904	2905	2906	2907	2908	2909	2910	2911
5540	2912	2913	2914	2915	2916	2917	2918	2919
5550	2920	2921	2922	2923	2924	2925	2926	2927
5560	2928	2929	2930	2931	2932	2933	2934	2935
5570	2936	2937	2938	2939	2940	2941	2942	2943
5600	2944	2945	2946	2947	2948	2949	2950	2951
5610	2952	2953	2954	2955	2956	2957	2958	2959
5620	2960	2961	2962	2963	2964	2965	2966	2967
5630	2968	2969	2970	2971	2972	2973	2974	2975
5640	2976	2977	2978	2979	2980	2981	2982	2983
5650	2984	2985	2986	2987	2988	2989	2990	2991
5660	2992	2993	2994	2995	2996	2997	2998	2999
5670	3000	3001	3002	3003	3004	3005	3006	3007
5700	3008	3009	3010	3011	3012	3013	3014	3015
5710	3016	3017	3018	3019	3020	3021	3022	3023
5720	3024	3025	3026	3027	3028	3029	3030	3031
5730	3032	3033	3034	3035	3036	3037	3038	3039
5740	3040	3041	3042	3043	3044	3045	3046	3047
5750	3048	3049	3050	3051	3052	3053	3054	3055
5760	3056	3057	3058	3059	3060	3061	3062	3063
5770	3064	3065	3066	3067	3068	3069	3070	3071

Octal-Decimal Integer Conversion Table

Octal	10000	20000	30000	40000	50000	60000	70000
Decimal	4096	8192	12288	16384	20480	24576	28672

Octal	6000 to 6377
Decimal	3072 to 3327

Octal	0	1	2	3	4	5	6	7
6000	3072	3073	3074	3075	3076	3077	3078	3079
6010	3080	3081	3082	3083	3084	3085	3086	3087
6020	3088	3089	3090	3091	3092	3093	3094	3095
6030	3096	3097	3098	3099	3100	3101	3102	3103
6040	3104	3105	3106	3107	3108	3109	3110	3111
6050	3112	3113	3114	3115	3116	3117	3118	3119
6060	3120	3121	3122	3123	3124	3125	3126	3127
6070	3128	3129	3130	3131	3132	3133	3134	3135
6100	3136	3137	3138	3139	3140	3141	3142	3143
6110	3144	3145	3146	3147	3148	3149	3150	3151
6120	3152	3153	3154	3155	3156	3157	3158	3159
6130	3160	3161	3162	3163	3164	3165	3166	3167
6140	3168	3169	3170	3171	3172	3173	3174	3175
6150	3176	3177	3178	3179	3180	3181	3182	3183
6160	3184	3185	3186	3187	3188	3189	3190	3191
6170	3192	3193	3194	3195	3196	3197	3198	3199
6200	3200	3201	3202	3203	3204	3205	3206	3207
6210	3208	3209	3210	3211	3212	3213	3214	3215
6220	3216	3217	3218	3219	3220	3221	3222	3223
6230	3224	3225	3226	3227	3228	3229	3230	3231
6240	3232	3233	3234	3235	3236	3237	3238	3239
6250	3240	3241	3242	3243	3244	3245	3246	3247
6260	3248	3249	3250	3251	3252	3253	2354	3255
6270	3256	3257	3258	3259	3260	3261	3262	3263
6300	3264	3265	3266	3267	3268	3269	3270	3271
6310	3272	3273	3274	3275	3276	3277	3278	3279
6320	3280	3281	3282	3283	3284	3285	3286	3287
6330	3288	3289	3290	3291	3292	3293	3294	3295
6340	3296	3297	3298	3299	3300	3301	3302	3303
6350	3304	3305	3306	3307	3308	3309	3310	3311
6360	3312	3313	3314	3315	3316	3317	3318	3319
6370	3320	3321	3322	3323	3324	3325	3326	3327

Octal	7000 to 7377
Decimal	3584 to 3839

Octal	0	1	2	3	4	5	6	7
7000	3584	3585	3586	3587	3588	3589	3590	3591
7010	3592	3593	3594	3595	3596	3597	3598	3599
7020	3600	3601	3602	3603	3604	3605	3606	3607
7030	3608	3609	3610	3611	3612	3613	3614	3615
7040	3616	3617	3618	3619	3620	3621	3622	3623
7050	3624	3625	3626	3627	3628	3629	3630	3631
7060	3632	3633	3634	3635	3636	3637	3638	3639
7070	3640	3641	3642	3643	3644	3645	3646	3647
7100	3648	3649	3650	3651	3652	3653	3654	3655
7110	3656	3657	3658	3659	3660	3661	3662	3663
7120	3664	3665	3666	3667	3668	3669	3670	3671
7130	3672	3673	3674	3675	3676	3677	3678	3679
7140	3680	3681	3682	3683	3684	3685	3686	3687
7150	3688	3689	3690	3691	3692	3693	3694	3695
7160	3696	3697	3698	3699	3700	3701	3702	3703
7170	3704	3705	3706	3707	3708	3709	3710	3711
7200	3712	3713	3714	3715	3716	3717	3718	3719
7210	3720	3721	3722	3723	3724	3725	3726	3727
7220	3728	3729	3730	3731	3732	3733	3734	3735
7230	3736	3737	3738	3739	3740	3741	3742	3743
7240	3744	3745	3746	3747	3748	3749	3750	3751
7250	3752	3753	3754	3755	3756	3757	3758	3759
7260	3760	3761	3762	3763	3764	3765	3766	3767
7270	3768	3769	3770	3771	3772	3773	3774	3775
7300	3776	3777	3778	3779	3780	3781	3782	3783
7310	3784	3785	3786	3787	3788	3789	3790	3791
7320	3792	3793	3794	3795	3796	3797	3798	3799
7330	3800	3801	3802	3803	3804	3805	3806	3807
7340	3808	3809	3810	3811	3812	3813	3814	3815
7350	3816	3817	3818	3819	3820	3821	3822	3823
7360	3824	3825	3826	3827	3828	3829	3830	3831
7370	3832	3833	3834	3835	3836	3837	3838	3839

Octal	6400 to 6777
Decimal	3328 to 3583

Octal	0	1	2	3	4	5	6	7
6400	3328	3329	3330	3331	3332	3333	3334	3335
6410	3336	3337	3338	3339	3340	3341	3342	3343
6420	3344	3345	3346	3347	3348	3349	3350	3351
6430	3352	3353	3354	3355	3356	3357	3358	3359
6440	3360	3361	3362	3363	3364	3365	3366	3367
6450	3368	3369	3370	3371	3372	3373	3374	3375
6460	3376	3377	3378	3379	3380	3381	3382	3383
6470	3384	3385	3386	3387	3388	3389	3390	3391
6500	3392	3393	3394	3395	3396	3397	3398	3399
6510	3400	3401	3402	3403	3404	3405	3406	3407
6520	3408	3409	3410	3411	3412	3413	3414	3415
6530	3416	3417	3418	3419	3420	3421	3422	3423
6540	3424	3425	3426	3427	3428	3429	3430	3431
6550	3432	3433	3434	3435	3436	3437	3438	3439
6560	3440	3441	3442	3443	3444	3445	3446	3447
6570	3448	3449	3450	3451	3452	3453	3454	3455
6600	3456	3457	3458	3459	3460	3461	3462	3463
6610	3464	3465	3466	3467	3468	3469	3470	3471
6620	3472	3473	3474	3475	3476	3477	3478	3479
6630	3480	3481	3482	3483	3484	3485	3486	3487
6640	3488	3489	3490	3491	3492	3493	3494	3495
6650	3496	3497	3498	3499	3500	3501	3502	3503
6660	3504	3505	3506	3507	3508	3509	3510	3511
6670	3512	3513	3514	3515	3516	3517	3518	3519
6700	3520	3521	3522	3523	3524	3525	3526	3527
6710	3528	3529	3530	3531	3532	3533	3534	3535
6720	3536	3537	3538	3539	3540	3541	3542	3543
6730	3544	3545	3546	3547	3548	3549	3550	3551
6740	3552	3553	3554	3555	3556	3557	3558	3559
6750	3560	3561	3562	3563	3564	3565	3566	3567
6760	3568	3569	3570	3571	3572	3573	3574	3575
6770	3576	3577	3578	3579	3580	3581	3582	3583

Octal	7400 to 7777
Decimal	3840 to 4095

Octal	0	1	2	3	4	5	6	7
7400	3840	3841	3842	3843	3844	3845	3846	3847
7410	3848	3849	3850	3851	3852	3853	3854	3855
7420	3856	3857	3858	3859	3860	3861	3862	3863
7430	3864	3865	3866	3867	3868	3869	3870	3871
7440	3872	3873	3874	3875	3876	3877	3878	3879
7450	3880	3881	3882	3883	3884	3885	3886	3887
7460	3888	3889	3890	3891	3892	3893	3894	3895
7470	3896	3897	3898	3899	3900	3901	3902	3903
7500	3904	3905	3906	3907	3908	3909	3910	3911
7510	3912	3913	3914	3915	3916	3917	3918	3919
7520	3920	3921	3922	3923	3924	3925	3926	3927
7530	3928	3929	3930	3931	3932	3933	3934	3935
7540	3936	3937	3938	3939	3940	3941	3942	3943
7550	3944	3945	3946	3947	3948	3949	3950	3951
7560	3952	3953	3954	3955	3956	3957	3958	3959
7570	3960	3961	3962	3963	3964	3965	3966	3967
7600	3968	3969	3970	3971	3972	3973	3974	3975
7610	3976	3977	3978	3979	3980	3981	3982	3983
7620	3984	3985	3986	3987	3988	3989	3990	3991
7630	3992	3993	3994	3995	3996	3997	3998	3999
7640	4000	4001	4002	4003	4004	4005	4006	4007
7650	4008	4009	4010	4011	4012	4013	4014	4015
7660	4016	4017	4018	4019	4020	4021	4022	4023
7670	4024	4025	4026	4027	4028	4029	4030	4031
7700	4032	4033	4034	4035	4036	4037	4038	4039
7710	4040	4041	4042	4043	4044	4045	4046	4047
7720	4048	4049	4050	4051	4052	4053	4054	4055
7730	4056	4057	4058	4059	4060	4061	4062	4063
7740	4064	4065	4066	4067	4068	4069	4070	4071
7750	4072	4073	4074	4075	4076	4077	4078	4079
7760	4080	4081	4082	4083	4084	4085	4086	4087
7770	4088	4089	4090	4091	4092	4093	4094	4095

Octal-Decimal Fraction Conversion Table

OCTAL	DECIMAL	OCTAL	DECIMAL	OCTAL	DECIMAL	OCTAL	DECIMAL
.000	.000000	.100	.125000	.200	.250000	.300	.375000
.001	.001953	.101	.126953	.201	.251953	.301	.376953
.002	.003906	.102	.128906	.202	.253906	.302	.378906
.003	.005859	.103	.130859	.203	.255859	.303	.380859
.004	.007812	.104	.132812	.204	.257812	.304	.382812
.005	.009765	.105	.134765	.205	.259765	.305	.384765
.006	.011718	.106	.136718	.206	.261718	.306	.386718
.007	.013671	.107	.138671	.207	.263671	.307	.388671
.010	.015625	.110	.140625	.210	.265625	.310	.390625
.011	.017578	.111	.142578	.211	.267578	.311	.392578
.012	.019531	.112	.144531	.212	.269531	.312	.394531
.013	.021484	.113	.146484	.213	.271484	.313	.396484
.014	.023437	.114	.148437	.214	.273437	.314	.398437
.015	.025390	.115	.150390	.215	.275390	.315	.400390
.016	.027343	.116	.152343	.216	.277343	.316	.402343
.017	.029296	.117	.154296	.217	.279296	.317	.404296
.020	.031250	.120	.156250	.220	.281250	.320	.406250
.021	.033203	.121	.158203	.221	.283203	.321	.408203
.022	.035156	.122	.160156	.222	.285156	.322	.410156
.023	.037109	.123	.162109	.223	.287109	.323	.412109
.024	.039062	.124	.164062	.224	.289062	.324	.414062
.025	.041015	.125	.166015	.225	.291015	.325	.416015
.026	.042968	.126	.167968	.226	.292968	.326	.417968
.027	.044921	.127	.169921	.227	.294921	.327	.419921
.030	.046875	.130	.171875	.230	.296875	.330	.421875
.031	.048828	.131	.173828	.231	.298828	.331	.423828
.032	.050781	.132	.175781	.232	.300781	.332	.425781
.033	.052734	.133	.177734	.233	.302734	.333	.427734
.034	.054687	.134	.179687	.234	.304687	.334	.429687
.035	.056640	.135	.181640	.235	.306640	.335	.431640
.036	.058593	.136	.183593	.236	.308593	.336	.433593
.037	.060546	.137	.185546	.237	.310546	.337	.435546
.040	.062500	.140	.187500	.240	.312500	.340	.437500
.041	.064453	.141	.189453	.241	.314453	.341	.439453
.042	.066406	.142	.191406	.242	.316406	.342	.441406
.043	.068359	.143	.193359	.243	.318359	.343	.443359
.044	.070312	.144	.195312	.244	.320312	.344	.445312
.045	.072265	.145	.197265	.245	.322265	.345	.447265
.046	.074218	.146	.199218	.246	.324218	.346	.449218
.047	.076171	.147	.201171	.247	.326171	.347	.451171
.050	.078125	.150	.203125	.250	.328125	.350	.453125
.051	.080078	.151	.205078	.251	.330078	.351	.455078
.052	.082031	.152	.207031	.252	.332031	.352	.457031
.053	.083984	.153	.208984	.253	.333984	.353	.458984
.054	.085937	.154	.210937	.254	.335937	.354	.460937
.055	.087890	.155	.212890	.255	.337890	.355	.462890
.056	.089843	.156	.214843	.256	.339843	.356	.464843
.057	.091796	.157	.216796	.257	.341796	.357	.466796
.060	.093750	.160	.218750	.260	.343750	.360	.468750
.061	.095703	.161	.220703	.261	.345703	.361	.470703
.062	.097656	.162	.222656	.262	.347656	.362	.472656
.063	.099609	.163	.224609	.263	.349609	.363	.474609
.064	.101562	.164	.226562	.264	.351562	.364	.476562
.065	.103515	.165	.228515	.265	.353515	.365	.478515
.066	.105468	.166	.230468	.266	.355468	.366	.480468
.067	.107421	.167	.232421	.267	.357421	.367	.482421
.070	.109375	.170	.234375	.270	.359375	.370	.484375
.071	.111328	.171	.236328	.271	.361328	.371	.486328
.072	.113281	.172	.238281	.272	.363281	.372	.488281
.073	.115234	.173	.240234	.273	.365234	.373	.490234
.074	.117187	.174	.242187	.274	.367187	.374	.492187
.075	.119140	.175	.244140	.275	.369140	.375	.494140
.076	.121093	.176	.246093	.276	.371093	.376	.496093
.077	.123046	.177	.248046	.277	.373046	.377	.498046

Octal-Decimal Fraction Conversion Table

OCTAL	DECIMAL	OCTAL	DECIMAL	OCTAL	DECIMAL	OCTAL	DECIMAL
.000000	.000000	.000100	.000244	.000200	.000488	.000300	.000732
.000001	.000003	.000101	.000247	.000201	.000492	.000301	.000736
.000002	.000007	.000102	.000251	.000202	.000495	.000302	.000740
.000003	.000011	.000103	.000255	.000203	.000499	.000303	.000743
.000004	.000015	.000104	.000259	.000204	.000503	.000304	.000747
.000005	.000019	.000105	.000263	.000205	.000507	.000305	.000751
.000006	.000022	.000106	.000267	.000206	.000511	.000306	.000755
.000007	.000026	.000107	.000270	.000207	.000514	.000307	.000759
.000010	.000030	.000110	.000274	.000210	.000518	.000310	.000762
.000011	.000034	.000111	.000278	.000211	.000522	.000311	.000766
.000012	.000038	.000112	.000282	.000212	.000526	.000312	.000770
.000013	.000041	.000113	.000286	.000213	.000530	.000313	.000774
.000014	.000045	.000114	.000289	.000214	.000534	.000314	.000778
.000015	.000049	.000115	.000293	.000215	.000537	.000315	.000782
.000016	.000053	.000116	.000297	.000216	.000541	.000316	.000785
.000017	.000057	.000117	.000301	.000217	.000545	.000317	.000789
.000020	.000061	.000120	.000305	.000220	.000549	.000320	.000793
.000021	.000064	.000121	.000308	.000221	.000553	.000321	.000797
.000022	.000068	.000122	.000312	.000222	.000556	.000322	.000801
.000023	.000072	.000123	.000316	.000223	.000560	.000323	.000805
.000024	.000076	.000124	.000320	.000224	.000564	.000324	.000808
.000025	.000080	.000125	.000324	.000225	.000568	.000325	.000812
.000026	.000083	.000126	.000328	.000226	.000572	.000326	.000816
.000027	.000087	.000127	.000331	.000227	.000576	.000327	.000820
.000030	.000091	.000130	.000335	.000230	.000579	.000330	.000823
.000031	.000095	.000131	.000339	.000231	.000583	.000331	.000827
.000032	.000099	.000132	.000343	.000232	.000587	.000332	.000831
.000033	.000102	.000133	.000347	.000233	.000591	.000333	.000835
.000034	.000106	.000134	.000350	.000234	.000595	.000334	.000839
.000035	.000110	.000135	.000354	.000235	.000598	.000335	.000843
.000036	.000114	.000136	.000358	.000236	.000602	.000336	.000846
.000037	.000118	.000137	.000362	.000237	.000606	.000337	.000850
.000040	.000122	.000140	.000366	.000240	.000610	.000340	.000854
.000041	.000125	.000141	.000370	.000241	.000614	.000341	.000858
.000042	.000129	.000142	.000373	.000242	.000617	.000342	.000862
.000043	.000133	.000143	.000377	.000243	.000621	.000343	.000865
.000044	.000137	.000144	.000381	.000244	.000625	.000344	.000869
.000045	.000141	.000145	.000385	.000245	.000629	.000345	.000873
.000046	.000144	.000146	.000389	.000246	.000633	.000346	.000877
.000047	.000148	.000147	.000392	.000247	.000637	.000347	.000881
.000050	.000152	.000150	.000396	.000250	.000640	.000350	.000885
.000051	.000156	.000151	.000400	.000251	.000644	.000351	.000888
.000052	.000160	.000152	.000404	.000252	.000648	.000352	.000892
.000053	.000164	.000153	.000408	.000253	.000652	.000353	.000896
.000054	.000167	.000154	.000411	.000254	.000656	.000354	.000900
.000055	.000171	.000155	.000415	.000255	.000659	.000355	.000904
.000056	.000175	.000156	.000419	.000256	.000663	.000356	.000907
.000057	.000179	.000157	.000423	.000257	.000667	.000357	.000911
.000060	.000183	.000160	.000427	.000260	.000671	.000360	.000915
.000061	.000186	.000161	.000431	.000261	.000675	.000361	.000919
.000062	.000190	.000162	.000434	.000262	.000679	.000362	.000923
.000063	.000194	.000163	.000438	.000263	.000682	.000363	.000926
.000064	.000198	.000164	.000442	.000264	.000686	.000364	.000930
.000065	.000202	.000165	.000446	.000265	.000690	.000365	.000934
.000066	.000205	.000166	.000450	.000266	.000694	.000366	.000938
.000067	.000209	.000167	.000453	.000267	.000698	.000367	.000942
.000070	.000213	.000170	.000457	.000270	.000701	.000370	.000946
.000071	.000217	.000171	.000461	.000271	.000705	.000371	.000949
.000072	.000221	.000172	.000465	.000272	.000709	.000372	.000953
.000073	.000225	.000173	.000469	.000273	.000713	.000373	.000957
.000074	.000228	.000174	.000473	.000274	.000717	.000374	.000961
.000075	.000232	.000175	.000476	.000275	.000720	.000375	.000965
.000076	.000236	.000176	.000480	.000276	.000724	.000376	.000968
.000077	.000240	.000177	.000484	.000277	.000728	.000377	.000972

Octal-Decimal Fraction Conversion Table

OCTAL	DECIMAL	OCTAL	DECIMAL	OCTAL	DECIMAL	OCTAL	DECIMAL
.000400	.000976	.000500	.001220	.000600	.001464	.000700	.001708
.000401	.000980	.000501	.001224	.000601	.001468	.000701	.001712
.000402	.000984	.000502	.001228	.000602	.001472	.000702	.001716
.000403	.000988	.000503	.001232	.000603	.001476	.000703	.001720
.000404	.000991	.000504	.001235	.000604	.001480	.000704	.001724
.000405	.000995	.000505	.001239	.000605	.001483	.000705	.001728
.000406	.000999	.000506	.001243	.000606	.001487	.000706	.001731
.000407	.001003	.000507	.001247	.000607	.001491	.000707	.001735
.000410	.001007	.000510	.001251	.000610	.001495	.000710	.001739
.000411	.001010	.000511	.001255	.000611	.001499	.000711	.001743
.000412	.001014	.000512	.001258	.000612	.001502	.000712	.001747
.000413	.001018	.000513	.001262	.000613	.001506	.000713	.001750
.000414	.001022	.000514	.001266	.000614	.001510	.000714	.001754
.000415	.001026	.000515	.001270	.000615	.001514	.000715	.001758
.000416	.001029	.000516	.001274	.000616	.001518	.000716	.001762
.000417	.001033	.000517	.001277	.000617	.001522	.000717	.001766
.000420	.001037	.000520	.001281	.000620	.001525	.000720	.001770
.000421	.001041	.000521	.001285	.000621	.001529	.000721	.001773
.000422	.001045	.000522	.001289	.000622	.001533	.000722	.001777
.000423	.001049	.000523	.001293	.000623	.001537	.000723	.001781
.000424	.001052	.000524	.001296	.000624	.001541	.000724	.001785
.000425	.001056	.000525	.001300	.000625	.001544	.000725	.001789
.000426	.001060	.000526	.001304	.000626	.001548	.000726	.001792
.000427	.001064	.000527	.001308	.000627	.001552	.000727	.001796
.000430	.001068	.000530	.001312	.000630	.001556	.000730	.001800
.000431	.001071	.000531	.001316	.000631	.001560	.000731	.001804
.000432	.001075	.000532	.001319	.000632	.001564	.000732	.001808
.000433	.001079	.000533	.001323	.000633	.001567	.000733	.001811
.000434	.001083	.000534	.001327	.000634	.001571	.000734	.001815
.000435	.001087	.000535	.001331	.000635	.001575	.000735	.001819
.000436	.001091	.000536	.001335	.000636	.001579	.000736	.001823
.000437	.001094	.000537	.001338	.000637	.001583	.000737	.001827
.000440	.001098	.000540	.001342	.000640	.001586	.000740	.001831
.000441	.001102	.000541	.001346	.000641	.001590	.000741	.001834
.000442	.001106	.000542	.001350	.000642	.001594	.000742	.001838
.000443	.001110	.000543	.001354	.000643	.001598	.000743	.001842
.000444	.001113	.000544	.001358	.000644	.001602	.000744	.001846
.000445	.001117	.000545	.001361	.000645	.001605	.000745	.001850
.000446	.001121	.000546	.001365	.000646	.001609	.000746	.001853
.000447	.001125	.000547	.001369	.000647	.001613	.000747	.001857
.000450	.001129	.000550	.001373	.000650	.001617	.000750	.001861
.000451	.001132	.000551	.001377	.000651	.001621	.000751	.001865
.000452	.001136	.000552	.001380	.000652	.001625	.000752	.001869
.000453	.001140	.000553	.001384	.000653	.001628	.000753	.001873
.000454	.001144	.000554	.001388	.000654	.001632	.000754	.001876
.000455	.001148	.000555	.001392	.000655	.001636	.000755	.001880
.000456	.001152	.000556	.001396	.000656	.001640	.000756	.001884
.000457	.001155	.000557	.001399	.000657	.001644	.000757	.001888
.000460	.001159	.000560	.001403	.000660	.001647	.000760	.001892
.000461	.001163	.000561	.001407	.000661	.001651	.000761	.001895
.000462	.001167	.000562	.001411	.000662	.001655	.000762	.001899
.000463	.001171	.000563	.001415	.000663	.001659	.000763	.001903
.000464	.001174	.000564	.001419	.000664	.001663	.000764	.001907
.000465	.001178	.000565	.001422	.000665	.001667	.000765	.001911
.000466	.001182	.000566	.001426	.000666	.001670	.000766	.001914
.000467	.001186	.000567	.001430	.000667	.001674	.000767	.001918
.000470	.001190	.000570	.001434	.000670	.001678	.000770	.001922
.000471	.001194	.000571	.001438	.000671	.001682	.000771	.001926
.000472	.001197	.000572	.001441	.000672	.001686	.000772	.001930
.000473	.001201	.000573	.001445	.000673	.001689	.000773	.001934
.000474	.001205	.000574	.001449	.000674	.001693	.000774	.001937
.000475	.001209	.000575	.001453	.000675	.001697	.000775	.001941
.000476	.001213	.000576	.001457	.000676	.001701	.000776	.001945
.000477	.001216	.000577	.001461	.000677	.001705	.000777	.001949

REPRESENTATION OF GE-225 CHARACTERS

CHARACTER	HIGH SPEED PRINTER SYMBOLS	CONSOLE TYPEWRITER CHARACTER OR ACTION	PAPER TAPE CHARACTER (8 CHANNEL)	HOLLERITH CODE (PUNCH IN ROWS)	BCD MEMORY (OCTAL)**	BCD MAGNETIC TAPE (OCTAL)
0	0	0	Space	0	00	12
1	1	1	1	1	01	01
2	2	2	2	2	02	02
3	3	3	3	3	03	03
4	4	4	4	4	04	04
5	5	5	5	5	05	05
6	6	6	6	6	06	06
7	7	7	7	7	07	07
8	8	8	8	8	10	10
9	9	9	9	9	11	11
A	A	A	/	12-1	21	61
B	B	B	S	12-2	22	62
C	C	C	T	12-3	23	63
D	D	D	U	12-4	24	64
E	E	E	V	12-5	25	65
F	F	F	W	12-6	26	66
G	G	G	X	12-7	27	67
H	H	H	Y	12-8	30	70
I	I	I	Z	12-9	31	71
J	J	J	J	11-1	41	41
K	K	K	K	11-2	42	42
L	L	L	L	11-3	43	43
M	M	M	M	11-4	44	44
N	N	N	N	11-5	45	45
O	O	O	O	11-6	46	46
P	P	P	P	11-7	47	47
Q	Q	Q	Q	11-8	50	50
R	R	R	R	11-9	51	51
S	S	S	B	0-2	62	22
T	T	T	C	0-3	63	23
U	U	U	D	0-4	64	24
V	V	V	E	0-5	65	25
W	W	W	F	0-6	66	26
X	X	X	G	0-7	67	27
Y	Y	Y	H	0-8	70	30
Z	Z	Z	I	0-9	71	31
+	+		0	12	20	60
-	-	-	-	11	40	40
Space	Blank	Blank	&	Blank	60	20
/	/		A	0-1	61	21
				2-8	12	12
#	#	/	Stop	3-8	13	13
@	@			4-8	14	14
(Underline)	-			5-8	15	15
=	=			6-8	16	16
				7-8	17	
				12-2-8	32*	72
+0				12-0	32*	
.	.	.		12-3-8	33	73
				12-4-8	34	74
				12-5-8	35	75
			Tab	12-6-8	36	76
		Carriage Return		12-7-8	37	77
-0				11-0	52*	52
				11-2-8	52*	52
$	$	$	$	11-3-8	53	53
*	*			11-4-8	54	54
				11-5-8	55	55
				11-6-8	56	56
				11-7-8	57	57
		Print Red		0-2-8	72	32
,	,			0-3-8	73	33
%	%			0-4-8	74	34
(	⌐	Print Black		0-5-8	75	35
)	¬	Tab		0-6-8	76	36
			Delete	0-7-8	77	37

*The 400 card per minute card reader reads 11-0 and 11-2-8 as 52 and 12-0 and 12-2-8 as 32. The 1000 cards per minute card reader treats 11-2-8 and 12-2-8 as invalid characters. The card punch punches only 11-0 for 52 and 12-0 for 32.

**The OCTAL notation is a shorthand for binary representation. Conversion between the two representations can be done mentally. In the OCTAL system, there are eight admissible symbols: 0, 1, 2, 3, 4, 5, 6, 7. Each may represent (when used) a maximum of three binary bits.

LISTING OF SEPARATE SUBSYSTEM MANUALS

The peripheral subsystems formerly described in Chapters VI through XVIII of the GE-225 System Operating Manual (CPB-247) are now covered in separate manuals. These manuals contain complete programming and operating information for these subsystems.

Peripheral Subsystem	Manual Title and Publication No.
400-cpm Card Reader	Punched Card Subsystems Reference Manual (CPB-302)
1000-cpm Card Reader	
100-cpm Card Punch	
300-cpm Card Punch	
15- and 15/41-KC. Magnetic Tape Subsystems	Magnetic Tape Subsystems Reference Manual (CPB-339)
Paper Tape Reader/Punch	Paper Tape Subsystem Reference Manual (CPB-308)
900-lpm On-Line High-Speed Printer	High-Speed On-Line Printer Reference Manual (CPB-321)
900-lpm Off/On High-Speed Printer	High-Speed Off-Line/On-Line Printer Reference Manual (CPB-1075)
Auxiliary Arithmetic Unit	Auxiliary Arithmetic Unit Reference Manual (CPB-325)
Disc Storage Unit	Disc Storage Unit Reference Manual (CPB-323)
12-Pocket Document Handler (1200-dpm)	Document Handler Reference Manual (1200-dpm) (CPB-307)
12-Pocket Document Handler (750-dpm)	Document Handler Reference Manual (750-dpm) (CPB-333)
Peripheral Switch Control Unit	Peripheral Switch Control Subsystem Reference Manual (CPB-313)

E-1

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