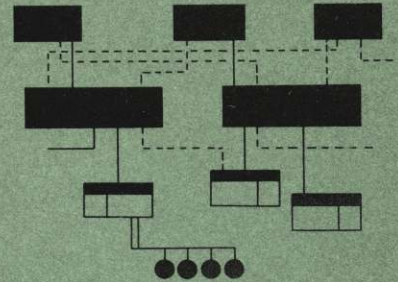# GE-625 / 635
Comprehensive
Operating Supervisor

GENERAL ELECTRIC

GE-625 / 635
COMPREHENSIVE
OPERATING SUPERVISOR

(GECOS)

REFERENCE MANUAL

July 1964
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GENERAL ELECTRIC
COMPUTER DEPARTMENT

PREFACE

This reference manual presents a description of the software system of the GE-635 and GE-625. It is assumed that the basic philosophy of GECOS will be used by all installations in the execution of their computer programs.

Chapter 1 provides a general description of GECOS, discussing many of its features and capabilities. Chapter 2, GESERV, describes the services provided to programs during execution. Most of the GESERV write-up, especially the area of input/output subroutines (and the Appendix, which relates to it) is presented for use by those who wish to program in assembly language (GMAP) without using GEFRC, or who wish to gain a more detailed understanding of the inner workings of the GE-625/635 software system. Chapter 3 presents the control cards involved in the flow of programs through the system, and will be of more universal interest.

For ease of reference, an index is included listing all Master Mode subroutines and all control cards.

Other Documentation:

The following manuals contain information which will be of interest to users of the GE-635 or GE-625:

GE-635 System Manual--CPB-371
GE-635 File and Record Control Reference Manual--CPB-1003
GE-635 Programming Reference Manual--CPB-1004
GE-635 Sort/Merge Reference Manual--CPB-1005
GE-635 FORTRAN IV Reference Manual--CPB-1006
GE-635 COBOL Reference Manual--CPB-1007
GE-635 General Loader Reference Manual--CPB-1008
GE-635 Operator's Reference Manual--CPB-1045
GE-600 Series Library Subroutine Manual

Comments on this publication may be addressed to Technical Publications, Computer Department, General Electric Company, P. O. Box 2961, Phoenix, Arizona, 85002.

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MAJOR STATUS AND SUBSTATUS CODES

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1. SYSTEM SUMMARY

INTRODUCTION TO GECOS

The General Comprehensive Operating Supervisor (GECOS) is the executive program which controls the sequencing and execution of all user programs on the GE-625 and GE-635. This supervisory system is designed to effectively control a multiprogramming environment, producing a significant increase in system throughput, with reduced turnaround time for the average job.

The development of GECOS was motivated as much by the need for a more automated machine room operation as by the need to synchronize peripherals with the processor.

- GECOS uses drums or discs for storage of system software, thereby reducing operator intervention.

- The media conversion routines available on-line through GECOS keep operator problems to an absolute minimum.

MULTIPROGRAMMING

Multiprogramming on the GE-625 and the GE-635 includes the following capabilities:

- Control is switched from a program awaiting an input/output operation to a program which can immediately use the Processor.

- Two or more programs can process I/O at the same time.

- Such functions as tape-to-printer and tape-to-card can be performed on-line by the GE-625 and the GE-635 concurrently with computation.

- The functions of GECOS are available without any special preparation by the programmer; he may write and execute his program unconcerned with the existence of other programs.

- User programs transfer control to GECOS without interfering with one another's proper execution. GECOS handles all necessary protection of memory and peripherals against illegal user access.

GECOS is permanently stored in the first 8192 cells of core and will automatically control the execution of up to eight user programs (all in core at the same time). GECOS calls in programs to be run, places them in their proper operating positions, and dynamically relocates the programs as required after a program has terminated.

HARDWARE ENVIRONMENT OF GECOS

In addition to the standard GE-625/635 modules of Memory, Processor, and Input/Output Controller (IOC), the following hardware components are utilized by GECOS:

8192 Words of Core
786,000 Words of Magnetic Drum (or Disc) Storage
3 Magnetic Tape Handlers
1 Card Reader
1 Card Punch
2 Printers
1 Console (with Typewriter)

Interrupts

A set of interrupts is included in the GE-625/635 hardware which allows the program controlling the I/O commands to be aware of the status of each peripheral device at all times. Interrupts occur in the event a command has been completed, or when the on-line portion of off-line commands have been completed, or when there is a change in the availability of a device. Interrupts are also provided to signal the occurrence of errors or exception conditions in the execution of I/O commands.

Faults

The GE-625/635 hardware includes a comprehensive repertoire of fault traps which will occur whenever invalid or exceptional conditions are sensed in the Central Processor. These may be due to hardware malfunctions or programming errors; in some instances they are utilized to perform software control functions.

Interval Timer

The Central Processor of each GE-625/635 system is provided with an interval timer which measures time to the nearest 1/64 of a millisecond. This is used as the basis for all time measurements maintained within the system. A primary function of the interval timer is to measure the length of time one program is on the Processor, and to signal when a specified time limit has been reached.

Master/Slave Mode

Two modes of execution exist in the GE-625/635 Processor: One is Master Mode, used by GECOS, in which it can execute all processor commands and address all of memory. The other, Slave Mode, is the mode in which all user programs are executed. A Slave Mode program is prevented from accessing memory not allocated to it, and from executing commands which could allow it to interfere with other programs.

Memory Protection

Only the section of memory allotted to the currently operating program is accessible to a Slave Mode program; when GECOS switches from one user program to another, it changes the areas of memory protection, opening one section and closing another. Memory protection is accomplished with the help of the Base Address Register, which assigns a starting address, in units of 1024 words, to a program. It indicates also how many 1024-word blocks are to be reserved for the program. When GECOS relocates a program, it uses the Base Address Register to facilitate the re-addressing of the program's relative addresses.

HANDLING OF JOBS BY THE GE-625/635

GECOS comprises two main segments: GEFLOW, which controls the flow of jobs and activities through the system (items 1, 2, 4, and 5, below); and GESERV, which provides services for use by a program during execution (item 3).

The overall processing of jobs by the GE-625/635 system is broken down into five functions: Input Media Conversion, Allocation, Execution, Termination, and Output Media Conversion.

1. Input Media Conversion (GEIN)

When a job is presented to the system (that is, in the form of a card deck) it is processed by Input Media Conversion (GEIN). Processing is initiated simply by placing the loaded card reader in Ready status.

With information obtained from control cards, GEIN generates a table (Control Stack) which lists information on peripheral requirements, plus storage and time limits, for use by the Allocator. Urgency levels indicated on the control cards are likewise kept in a table for later use by the Allocator. (The urgency indicator is a number from 1- 63, representing the relative importance of the job as assigned by operations.)

In the following discussion, the terms "job" and "activity" have specialized meanings. An "activity" consists of a single program (such as a FORTRAN compilation or an object program load and execution). A "job" is a set of activities which together constitute a problem or a production application.

GEIN segregates these activities and presents them in an ordered manner to the Allocator. If necessary, the activity itself is separated into files by GEIN for convenience in later processing. (See Figure 1, page 4.) Thus when the Allocator is ready to select an activity for execution, all preliminary work has been done by GEIN.
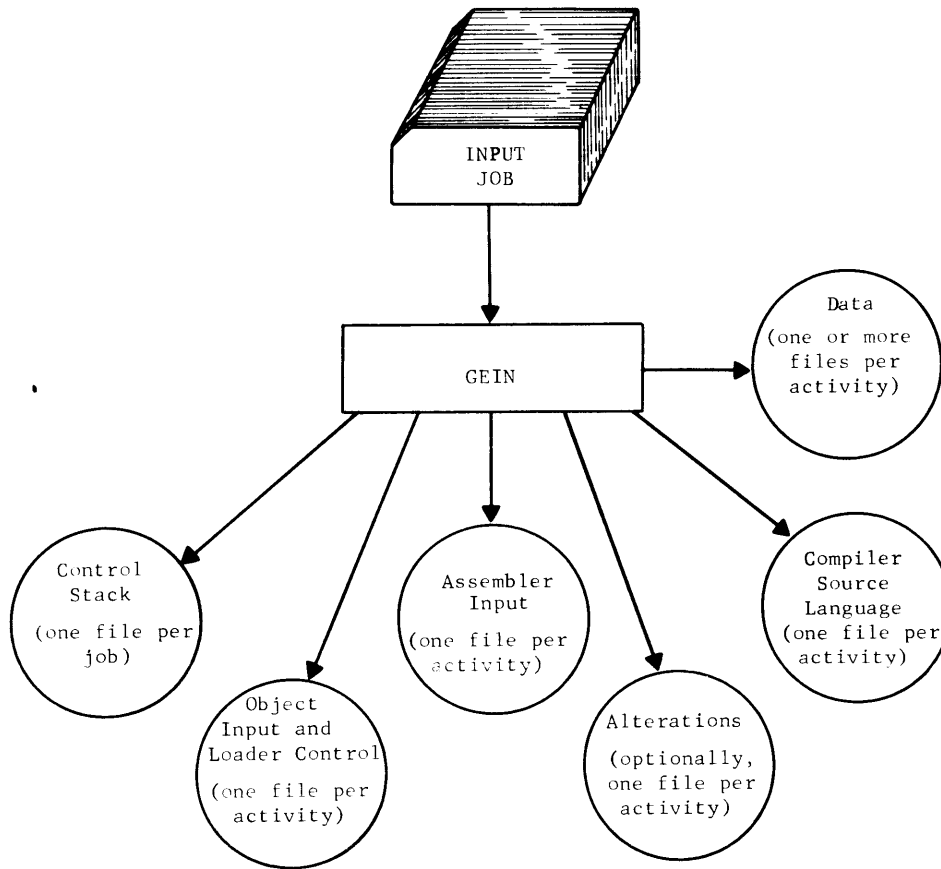
Figure 1. Input Destination Under GEIN Control

2. Allocation (GEALOC)

The Allocator (GEALOC) assigns peripherals and a memory area to the activity. If the peripheral requirements of an activity can be only partially met, the job is bypassed until all of its peripheral needs can be satisfied. GEALOC deals with the 18 most urgent jobs, as determined from the urgency table set up by GEIN. (The urgency indicator of a job is increased each time that job is delayed. When the urgency of a given job reaches a threshold value, other jobs are not considered for allocation until the peripheral requirements of this job have been satisfied, and it will be executed next.) No activity of a job is initiated until all prior activities of that job have been completed.

Look-ahead Parameter. GEALOC allocates peripheral units to several programs in advance of execution as availability permits. This look-ahead feature allows the operator to perform time-consuming chores such as mounting of tapes while a prior activity is in progress.

3. Execution (GESERV)

During program execution, 23 Master Mode Routines are available to the programmer via the MME instruction. These routines provide requests for service, exchanges of information, and control functions.

GEIOS. The I/O Supervisor, GEIOS, controls all I/O operations between the peripheral devices and memory. GEIOS automatically performs all housekeeping functions involved in I/O data transfer between peripheral devices and memory, as, for example:

- Queueing I/O commands on multidevice peripherals

- Measuring time consumed on each peripheral

- Responding to all interrupts

- Detecting I/O exception conditions and passing them to GEEPR for processing

GEEPR and GEFALT. For I/O exception conditions or Processor faults, GESERV performs standard action or gives the programmer (or sometimes the operator) the option of handling the situation his own way.

GEDISP. Maintaining high utilization of processor and peripherals with maximum synchronization between the two is the function of GEDISP, the Dispatcher. Each time a program yields control to GECOS, the Dispatcher has the opportunity to give control to another program in memory which can make effective and immediate use of the Processor. Programs are examined for a turn at the Processor in the order of their urgency.

GEROAD and GERELC. Yielding control of the Processor--done when a program is waiting for an I/O operation to be completed--is accomplished by either of two slightly different routines, the Roadblock and the Relinquish. The user is charged only for the Processor time used up to the point of Roadblock or Relinquish. I/O charges alone are accumulated after he has yielded control.

Courtesy Call and GEENDC. A program which handles mostly I/O with only sporadic processing (file maintenance, for example) and needs to maintain just enough control to keep its peripherals going will use the Courtesy Call, wherein a programmer initiates an I/O activity, then asks that he be given control (Courtesy Call) immediately after completion of that activity, for a very short time (enough to issue another I/O command).

Forced Relinquish. It is conceivable that a Processor-bound program will compute for a long period without ever relinquishing control. To avoid a program "hogging" the Processor, GECOS sets the Interval Timer to interrupt whenever straight Processor time (without relinquishing control) exceeds 62.5 milliseconds. Control is then given to the Dispatcher, with the interrupted program being considered inactive until some other program has had its turn.

4. Termination (GETERM)

Activity (and overall job) termination is called upon by GECOS either as a result of user-program request or whenever it is determined that an activity must be removed due to a GECOS-detected error. The responsibilities of this routine are as follows:

- Providing a postmortem dump if the termination was due to error

- Providing a termination sentinel on the system output file

- Producing an accounting record on the system output file

- Deallocating peripherals

- Communicating with the operator for file removal when necessary

- Deleting appropriate GEIOS, GEDISP, and GEALOC table entries

After completing these tasks, the Termination module calls the Allocator for subsequent allocation of the released components to another activity.

5. Output Media Conversion (GEOUT)

Accounting information plus other output data are recorded on SYSOUT (the output collector) during execution. GEOUT processes the SYSOUT file, producing the printed or punched output.

PROGRAMMING ALTERNATIVES

GMAP--the General Macro Assembler--is the basic symbolic language used for coding on the GE-625/635. GEFRC--the General File and Record Control program--is an important tool for those programming in GMAP language. GEFRC provides automatic I/O routines to the programmer, saving him the trouble of writing calling sequences to the various GEIOS I/O routines.

Since GEFRC handles all I/O in compiled programs, users of GEFRC or compilers (FORTRAN, COBOL) need not concern themselves with most of the MME routines in Chapter 2 (GESERV) except GEFINI and GEBORT. Programmers who do not use GEFRC or compilers will find Chapter 2 invaluable as a guide to using the many MME functions available. All GE-625/635 users are expected to know the control cards requirements described in Chapter 3 (GEFLOW).

2. GESERV

INTRODUCTION TO GESERV

While the GEFLOW segment of GECOS controls the flow of programs from input to execution and from execution to final output, the GESERV segment performs services for programs during execution. This section of the manual describes the facilities provided by GESERV to the user program.

It should be noted that if the programmer is using GEFRC for his I/O operations or is using a compiler, he need not concern himself with much of the information described in this section. Many of the Master Mode Entry routines will be called upon automatically by the compilers and GEFRC. The use of others is optional, at all language levels, but the user may find he wishes to employ their functions.

Although the user need not use GEIOS and should not use GESYOT directly, an understanding of their operation will probably assist him in making intelligent use of the GE-625/635 system. Also, GEEPR and GEFALT both provide returns to which the user may wish to respond, hence these should be clearly understood. On the other hand, the general user will never use GEDISP directly; it is described briefly for information purposes only.

GEDISP comprises six functional modules:

GEMME	Master Mode Entry Routine. Allows a user program to place the processor in master mode to perform one of the 22 services available to each user (slave) program.
GEIOS	Input/Output Supervisor. Performs all input/output executed when the GE-625/635 is being run under GECOS control.
GESYOT	System Output Routine. Writes outputs on SYSOUT, the output collector. Prevents a user from writing too much on SYSOUT or malpositioning SYSOUT. Supplies needed information to GEOUT, the Output Media Conversion routine.
GEEPR	Exception Processing Routines. Takes standard actions in response to peripheral exception conditions or gives control to the user program or the operator where appropriate.
GEFALT	Fault Processing Routines. Performs standard actions on hardware faults and gives the user program the option of performing standard action, processing its own, or ignoring each program fault.
GEDISP	Dispatcher. Switches control of the processor from one program to another so as to maintain high utilization of processor and peripheral subsystems.

MASTER MODE ENTRY ROUTINE (GEMME)

Purpose

In the multiprogramming environment of the GE-625/635, programs in execution are, of necessity, restricted from accessing one another or any of the control programs. However, user programs do have the ability to call upon the master mode programs in GESERV for the various services which they require. A special instruction, MME (Master Mode Entry), is available within the GE-625/635 hardware, permitting access to GESERV facilities.

Description

When any MME instruction is encountered, the central processor places itself in master mode. It stores the instruction counter and the indicators (to allow reference and return to the requesting program) and then transfers control to the Master Mode Entry routine.

The Master Mode Entry routine examines the address portion of the MME instruction, which should contain a value of 1 to 22, corresponding to the 22 valid requests a user program may make in GESERV. A nonvalid address in the MME instruction will cause the program to be aborted.

Before returning to the user program, the Master Mode Entry routine will restore the exponent register and index registers 2-7. The contents of the A-register, the Q-register, and index registers 0 and 1 are not saved; the user should save these if necessary before performing an MME.

There are three types of functions available through GEMME:

1. Requests for service
2. Exchanges of information between user programs and GESERV
3. Multiprogram control

They are described in detail on the pages which follow.

● Perform Input/Output (GEINOS). This master mode entry is used in performing all I/O on the GE-625/635. Users of GEFRC or compilers will not call GEINOS explicitly; symbolic-language programmers may use GEINOS via the calling sequence. A detailed discussion of MME GEINOS begins on page 27.

● Write on SYSOUT (GESYOT). Limited volume outputs from any program in execution may be written on SYSOUT, the system's output collector, if the user program so elects. These outputs are written by entering GESYOT, which protects outputs of one program against destruction by incorrect output commands of another program. GESYOT calls upon GEIOS, the I/O Supervisor (as do all other programs), to perform its I/O commands. For additional description of GESYOT, see page 42.

● Interchange of Primary and Secondary Logical Units (GEFILS)

Initially

C(Q) required.

0	23 24	35
MBZ	File Code	

Calling Sequence

Entry   L   MME GEFILS
Return   L+1   Next instruction

Results

C(Q):

0	5 6	11 12 13 14	17 18	35
Zero	Device Address	IOC Ad-dress	Channel Address	Zero

Description. The secondary logical unit (physical device) for this file code becomes the primary logical unit, and the primary logical unit in turn becomes the secondary logical unit. If no secondary unit has been assigned, the physical device assigned to the primary logical unit is assumed. The physical device address of the resultant primary logical unit is returned in the Q-register.

This entry is for use with magnetic tape files only. It is the user's responsibility (the user may be GEFRC) to issue any mounting or dismounting instructions to the operator that may be required when files are switched. Users of GEFRC or compilers will not call GEFILS explicitly; symbolic-language programmers may use it via the calling sequence.

● Call for the System Loader (GECALL)

Calling Sequence

Entry	L	MME	GECALL
Parameter	L+1	BCI	1, xxxxxx
Parameter	L+2	ZERO	Origin
Parameter	L+3	ZERO	Transfer Address

Description. The system program identified by xxxxxx (GMAP ƀƀƀ) is loaded into memory beginning at the location specified by C(L+2). If the C(L+3)=0, processor control will be transferred to the system program's entry point when loading terminates. If the C(L+3)≠0, control will be transferred to the location specified by the C(L+3).

In contrast to GERSTR, which handles the local catalog of programs and data, GECALL is used to reference the permanent catalog of System Programs (FORTRAN, GMAP, etc.) supplied by General Electric to an installation.

● Save Data (GESAVE)

Initially

C(Q) required:

0	23 24	35
		FC
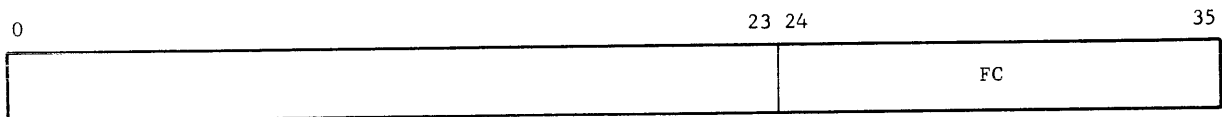
Calling Sequence

Entry	L	MME	GESAVE
Parameter	L+1	---	Identifier
Parameter	L+2	ZERO	L (First word), No. of words
Parameter	L+3	ZERO	L (transfer address), 0
Return	L+4	Next Instruction	

Description. The C(L+2) specifies the location of the first word and total number of words which are to be saved on the file specified by C(Q). This file can be tape, random disc or random drum. The C(L+1) is used as an identifier to uniquely identify this data. The C(L+3) specifies an address to which control will be transferred upon restoration of the saved file. This will be used only if the calling sequence for GERSTR contains 0 in the corresponding transfer address section. Bits 15 in the switch word must be set prior to the first referencing of any "save" file.

● Restore Data (GERSTR)

Initially

C(Q) required:

0	23 24	35
		FC
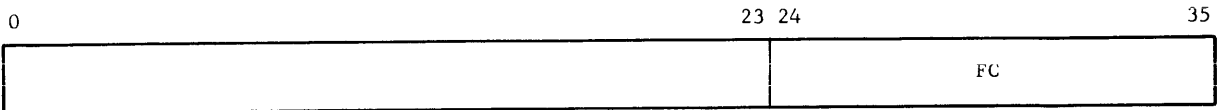
Calling Sequence

Entry	L	MME	GERSTR
Parameter	L+1	---	Identifier
Parameter	L+2	ZERO	Origin
Parameter	L+3	ZERO	Transfer Address
Return	L+4	Next instruction	

Description. GERSTR restores data saved by GESAVE. The data is identified by the C(L+1) from the file specified by C(Q) into memory starting at the location specified by C(L+2). If C(L+2)=0, the data will be placed into the same memory locations from which it was saved and the origin and number of words from the corresponding GESAVE calling sequence will be inserted into word L+2. The C(L+3) specifies the address to which control is to be returned. If C(L+3)=0, control will be returned to the address previously specified in C(L+3) of GESAVE calling sequence. The transfer address from GESAVE will be placed in L+3 for the users information. Any modification to or extraction from this calling sequence will be done before input of restored file. This allows overlay of the GERSTR calling sequence.

● Special Interrupt Action (GESPEC)

Initially

C(Q) required:

0 1	23 24	35
0/1	MBZ	File Code
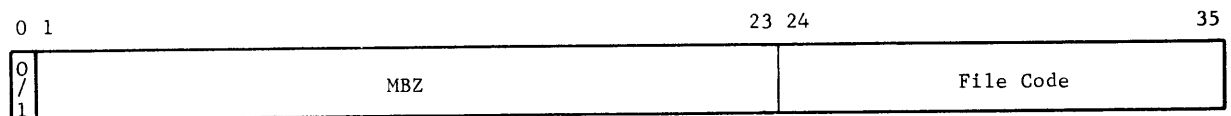
Calling Sequence

Entry	L	MME GESPEC
Return	L+1	Next instruction

Description. The execution of an I/O command on some peripherals can be made dependent on the occurrence of a special interrupt by preceding it by MME GESPEC. At the present time, this feature is implemented for the card reader, printer, and DATANET-30. Through its use an I/O request can be queued awaiting a signal from a remote device or an anticipated human response at a peripheral. This is done by executing the above calling sequence with $Q_0=0$. Such a queued request can also be canceled through the use of GESPEC with $Q_0=1$. Examples of the use of GESPEC are given on page 40.

● Checkpoint Dump (GECHEK)

Initially

C(Q) required:

0	17 18	35
L(Checkpoint File Control Block)	MBZ	
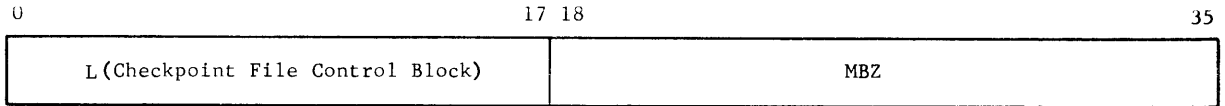
Calling Sequence

Entry	L	MME GECHEK
Return	L+1	Next instruction

Description. A checkpoint dump is written onto the file identified by the $C(Q)_{0-17}$. This file must have previously been opened via GEFRC. When the peripheral type is magnetic tape, any number of checkpoint dumps may be written on the file. However, when the file is identified as disc or drum, only a single checkpoint is permissible and must be the first item on the file. Each checkpoint dump will contain sufficient information for a restarting of the activity at a later time from the point at which the checkpoint occurred.

One reservation should be noted. Both the restart procedure and the rollback procedure (see GEROLL) provide the magnetic tape file positioning capabilities only for those files which were "open" at the time of checkpoint and have GEFRC file control blocks associated with them.

● Reinitiate or Rollback (GEROLL)

Calling Sequence

Entry   L   MME GEROLL

Description. Entry to GEROLL results in an output message to the operator, requesting the operator to initiate a restart of the program. If the operator's response is restart, the program is restarted at the last checkpoint within the current activity if such a checkpoint exists.

The user is advised to place a checkpoint (MME GECHEK) at the start of his program; otherwise, if no checkpoint exists, the program is aborted (since GELOAD releases any library files as well as memory itself prior to any possible reinitiation of an activity).

If the operator's response is no restart, the program is also aborted.

When restart is attempted, positioning of magnetic tape files is accomplished using information available within the user's file control blocks at the time of the checkpoint. The positioning of linked drum and disc files is accomplished using information contained in the user's peripheral assignment table at the time of the checkpoint.

After the checkpoint recovery has taken place, control is returned to the address specified by the contents of the address field of location 15 within the user's assigned memory. If at the time a checkpoint is taken (via GECHEK) the address field of this location is zero, the checkpoint routine will place the address of the MME GECHEK plus one into this location.

Note: Following any file switch, file release, or memory release procedures, the user should issue a MME GECHEK. This will ensure that peripheral unit assignments have not been disturbed between current instruction and last checkpoint.

Multiprogram Control

In any computer system capable of overlapping input/output operations with central processor execution, synchronization of processor and I/O operations is essential. When the processor consumes input more rapidly than the input devices can provide it, there is a delay each time the processor waits for a new input record. Similarly, when the processor develops output more rapidly than it can be disposed of by the output devices, a point is reached at which the processor must wait for an output area to be emptied.

Under these circumstances, a reasonable improvement in overall throughput can often be realized through the use of various buffer strategies; but the great disparity between compute speed and I/O speed means that such ploys will often fail in attaining their intended goals.

In the multiprogramming environment of the GE-625/635, a program is allowed to give control to GESERV at those points beyond which processing may not continue until I/O is completed. This approach has the dual advantage of (a) allowing the program which cannot proceed to avoid being billed for unproductive waiting time, and (b) allowing the system to look for another program which may use the available processor time.

The following Master Mode Entries are provided to enable the user to take full advantage of the multiprogramming capabilities of the GE-625/635.

● Roadblock (GEROAD)

Calling Sequence

Entry	L	MME GEROAD
Return	L+1	Next instruction

Description. When a point is reached in a program beyond which processing may not continue until I/O is completed, control may be given to GESERV via the roadblock instruction MME GEROAD. GESERV will attempt to find another program that can use the processor until all of the I/O of the "roadblocked" program has been completed. Sometime after all of its I/O has been completed, the program which issued the MME GEROAD is given control again by the GEDISP function of GESERV, at the instruction following the MME GEROAD. (See Figure 2, page 16.)

Users of GEFRC or compilers need not call GEROAD explicitly; symbolic-language programmers may use it via the calling sequence.

● Relinquish Control (GERELC)

Calling Sequence

Entry	L	MME GERELC
Return	L+1	Next instruction

Description. If, at the time MME GERELC is executed, the program has no outstanding I/O requests, then transfer is made to GEDISP so that it may select a different program for execution.

Otherwise (i.e., if I/O requests exist) execution of MME GERELC has exactly the same effect as MME GEROAD except that control will be returned to the relinguishing program after completion of any I/O command. This is useful when the program is awaiting completion of a particular I/O command. The program may test each time it regains control to see if the awaited I/O operation has been completed and relinquishing control again if it hasn't. (See Figure 3 and 4, page 17.)

Users of GEFRC or compilers need not call GERELC explicitly; symbolic-language programmers may use it via the calling sequence.

```
                    ┌─────────────────┐
                    │     Object      │
                    │   Program  B    │
                    └────────┬────────┘
                             │
                             ▼
        ┌──────────────────────┐          ┌──────────────────────┐
        │ I/O Action Requested │─────────▶│     GECOS Starts     │
        │                      │          │   I/O Device Action  │
        └──────────────────────┘          └──────────┬───────────┘
                             ◀───────────────────────┘
                             ▼
        ┌──────────────────────┐          ┌──────────────────────┐
        │      Roadblock       │─────────▶│   Dispatcher Action  │
        │                      │          │                      │
        └──────────────────────┘          └──────────┬───────────┘
                                                      │
    ┌──────────────────────┐    highest priority      │
    │      n ms. of        │◀─────────────────────────┘
    │  Object Program A    │
    └──────────────────────┘
         └── (interrupt caused by I/O device terminate) ──▶ ┌──────────────────────┐
                                                            │ Program B I/O Action │
                                                            │   Terminate Routine  │
                                                            └──────────┬───────────┘
                                                                       │
                                                                       ▼
    ┌──────────────────────┐                            ┌──────────────────────┐
    │     62.5 ms. of      │◀───────────────────────────│       Return         │
    │  Object Program A    │                            │                      │
    └──────────────────────┘                            └──────────────────────┘
         │
         └── (forced relinquish) ──────────────────────▶ ┌──────────────────────┐
                                                         │   Dispatcher Action  │
                                                         │                      │
                                                         └──────────┬───────────┘
                                               ┌────────────────────┘
                                               ▼
                                  ┌──────────────────────┐
                                  │    Object Program    │
                                  │     B Continues      │
                                  └──────────────────────┘
```
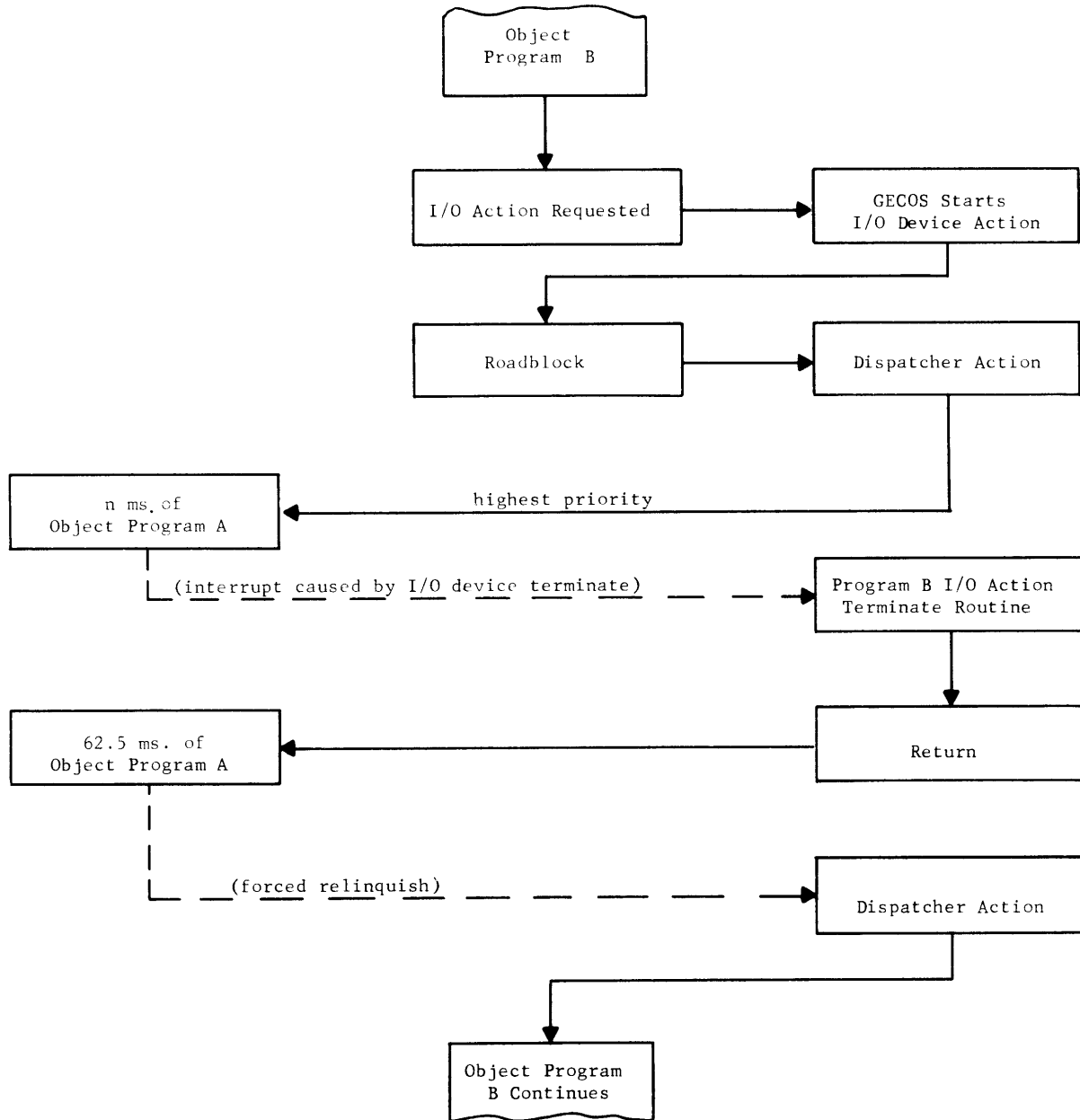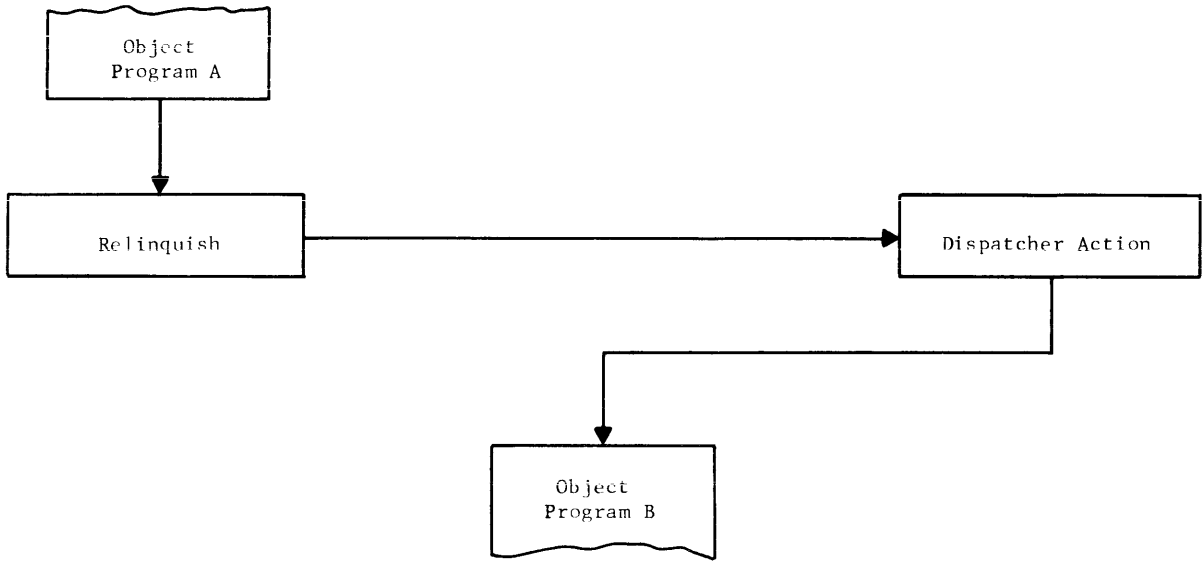
Figure 2. Roadblock
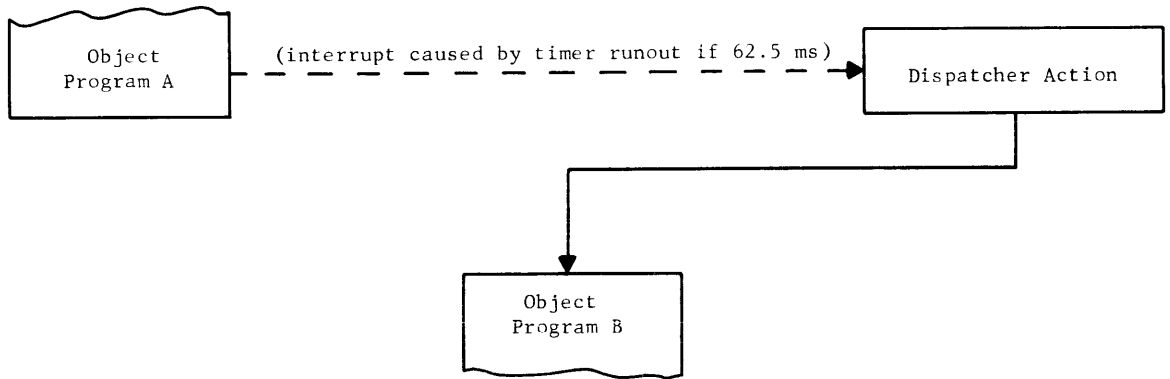
Figure 3. Relinquish

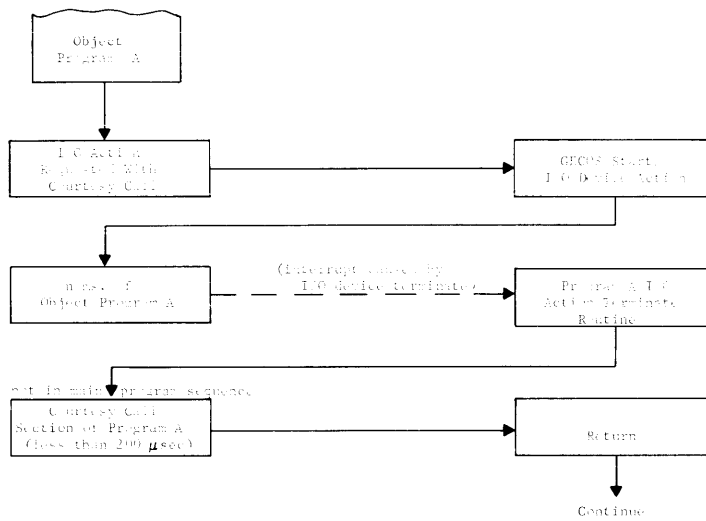Figure 4. Forced Relinquish
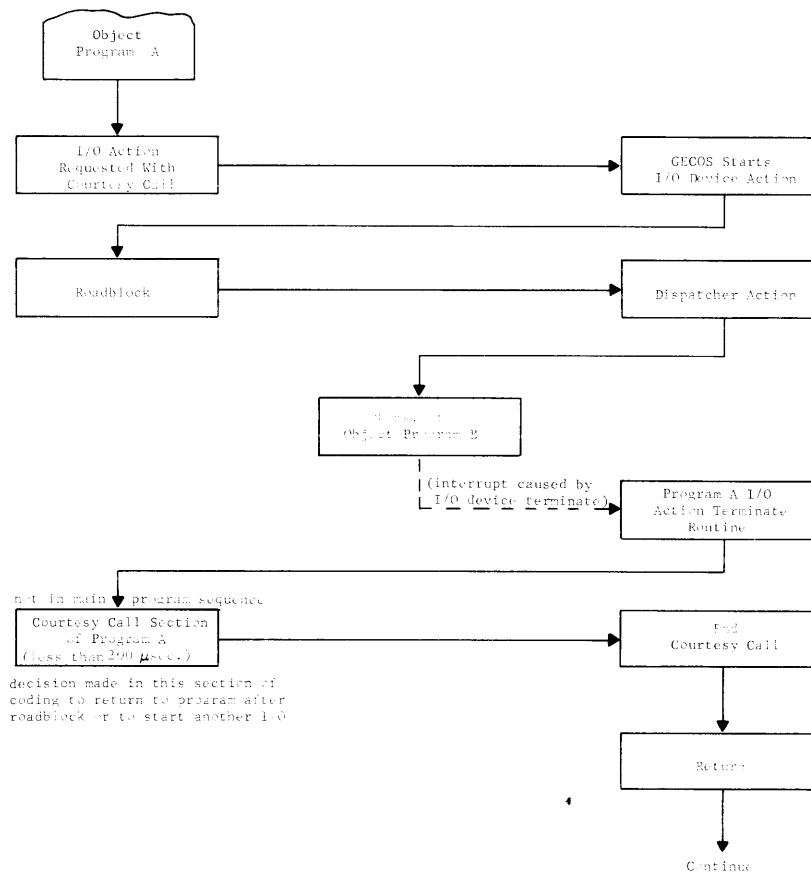
Figure 5a. Courtesy Call

Figure 5b. Courtesy Call (with Roadblock)

● End Courtesy Call (GEENDC)

Philosophy. When a user program surrenders control of the processor through the use of GEROAD or GERELC, it will not usually regain control immediately after completion of the requested I/O. (Its successor program, even though of lower urgency, will be allowed to maintain control for a fixed time interval or until it surrenders control. Then there may be more urgent programs which have also surrendered control and will regain control first.)

There are some circumstances in which one might wish to gain control without delay after a specific I/O operation has terminated. The most common example of this is a media conversion program where one wishes to keep the slower peripherals (such as card reader, card punch, printer) operating at rated speeds by giving a new I/O command immediately upon completion of each previous I/O operation. To achieve this capability, an address may be specified in any I/O request, to which control will be transferred instantaneously when the I/O operation terminates. Such a transfer of control is referred to as a "courtesy call."

Although courtesy calls serve their intended purpose, their uncontrolled use would lead to severely undesirable consequences, such as the following:

1. Possibility of recursive entries into the slave program

2. Loss of the significance of internal urgency due to frequent demands of programs with many I/O requirements

3. Degeneration of control by GESERV, because all programs could be executed under courtesy call, thus denying GESERV the opportunity to tend to its own needs

To prevent the misuse of courtesy calls, the time which may be spent in a courtesy call is limited to that which is needed for the perpetuation of I/O. The interval timer is set to 200 microseconds on entering a courtesy call on the GE-635 and 400 microseconds on the GE-625. If the courtesy call processing is not completed in the specified interval, it is considered to be a programming error and the program will be aborted.

To signal the end of a courtesy call, the user performs MME GEENDC:

Calling Sequence

Entry   L   MME GEENDC

No other method of ending a courtesy call is allowed. Furthermore, the use of GECALL, GESAVE, GERSTR, GEBORT, GECHEK, GEFCON, GEFILS, GEFINI, GERELC, GEROAD, or GEROLL is not allowed in courtesy calls.

See figures 5a and 5b, opposite page.

- Date and Time of Day (GETIME)

Calling Sequence

Entry	L	MME GETIME
Return	L+1	Next instruction

Results

C(A):

0	11 12	23 24	35
M O	D A	Y R	

C(Q):

0	35
Time of Day	
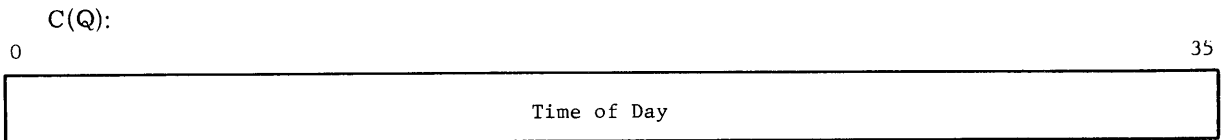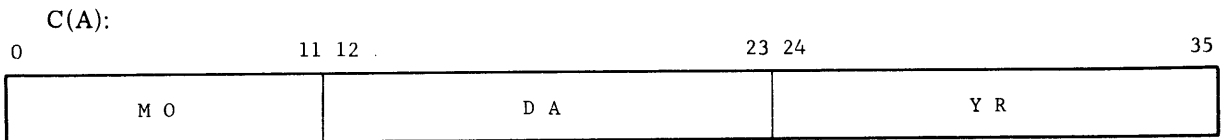
Description. The date, as a 6-character numeric field, is returned in the A-register. The time of day is returned in the Q-register as a right-justified binary integer with a resolution of 1/64 millisecond.

- -

- Elapsed Processor Time (GELAPS)

Calling Sequence

Entry	L	MME GELAPS
Return	L+1	Next instruction

Results

C(Q):

0	35
Elapsed Processor Time	
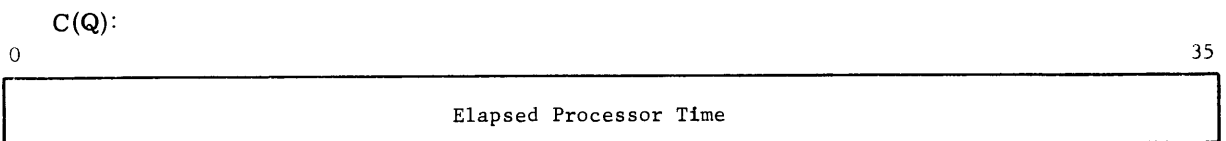
Description. The elapsed processor time charged to the requesting program is provided as a right-justified binary integer in the Q-register. This represents elapsed time with a resolution of 1/64 millisecond.

- Physical File Address (GEFADD)

<u>Initially</u>

C(Q) required:

0	23 24	35
MBZ	File Code	
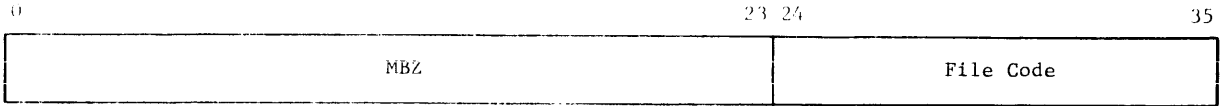
<u>Calling Sequence</u>

Entry   L   MME GEFADD
Return   L+1   Next instruction

<u>Results</u>

C(Q):

0 5	6 11	12 13	14 17	18 35
Zero	Device Address	IOC Ad- dress	Channel Address	Zero
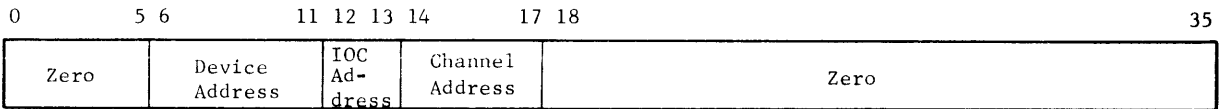
C(A): If a physical address exists for the file code supplied in the Q-register, the A-register
will contain a non-zero value. However, if an invalid file code is specified by the user, both
the A and Q will contain zero when return is made to the user. This use of the A-register
distinguishes between an unsuccessful search and a successful one in which the IOC, channel,
and device addresses are legitimately all zero.

<u>Description.</u> The device address, IOC address and channel address are returned in the
Q-register corresponding to the file whose file code is supplied in the Q. This MME is
useful mostly for obtaining physical addresses for use in operator messages since slave
programs may not use physical addresses in I/O commands.

Users of GEFRC or compilers need not call GEFADD explicitly; symbolic-language
programmers may use it via the calling sequence.

● File Control Block Information (GEFCON)

<u>Initially</u>

C(Q) required:

0	17 18	35
L(First File Control Block)	MBZ	
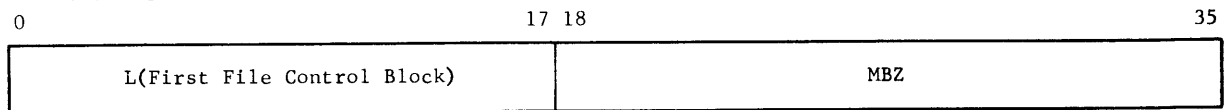
<u>Calling Sequence</u>

Entry	L	MME GEFCON
Return	L+1	Next instruction

<u>Description.</u> The following information is placed in the file control block identified by the <u>C(Q):</u>

   Link/Random Bit (provided for disc or drum)
   SYSOUT indicator
   Type of device
   Physical device address
   File serial number (provided only when the file is defined as magnetic tape)
   Reel sequence number (provided only when the file is defined as magnetic tape)
   File present indicator
   C or D disposition indicator (provided for magnetic tape)

When additional file control blocks are linked to the original file control block, the above information pertaining to these blocks is also provided.

This master mode entry is provided for the exclusive use of GEFRC and is not expected to be used outside of GEFRC.

● Set Switch Word (GESETS)

<u>Initially</u>

C(Q) required:

```
0                                                                    35
┌───────────────────────────────────────────────────────────────────┐
│                            36-bit mask                              │
└───────────────────────────────────────────────────────────────────┘
```
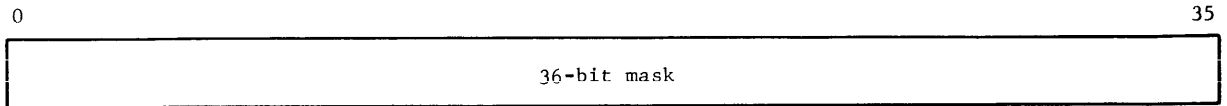
<u>Calling Sequence</u>

Entry	L	MME GESETS
Return	L+1	Next instruction
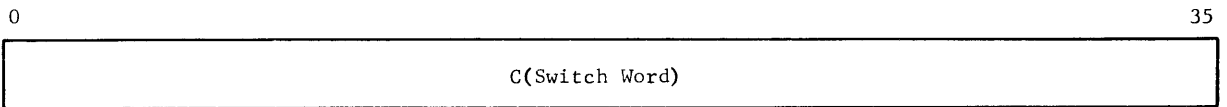
<u>Results</u>

C(Q):

```
0                                                                    35
┌───────────────────────────────────────────────────────────────────┐
│                          C(Switch Word)                             │
└───────────────────────────────────────────────────────────────────┘
```

<u>Description.</u>   For each bit position of the Q-register that contains a 1, the corresponding bit position of the Switch Word is set to 1.   For each bit position of the Q that contains a 0, the corresponding bit position of the Switch Word is undisturbed.   The resultant setting of the Switch Word is returned in the Q.

● Reset Switch Word (GERETS)

Initially

C(Q) required:

```
0                                                                        35
┌─────────────────────────────────────────────────────────────────────────┐
│                            36-bit mask                                    │
└─────────────────────────────────────────────────────────────────────────┘
```
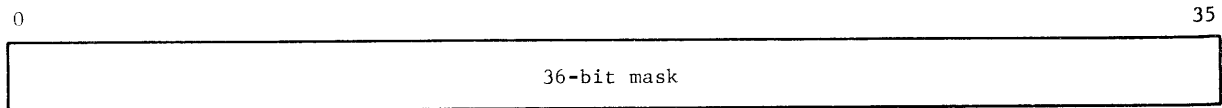
Calling Sequence

Entry	L	MME GERETS
Return	L+1	Next instruction
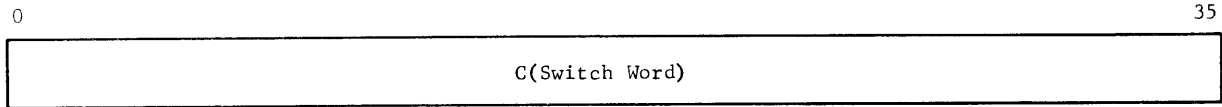
Results

C(Q):

```
0                                                                        35
┌─────────────────────────────────────────────────────────────────────────┐
│                          C(Switch Word)                                   │
└─────────────────────────────────────────────────────────────────────────┘
```

Description. For each bit position of the Q-register that contains a 1, the corresponding bit position of the Switch Word is set to 0. For each bit position of the Q that contains a 0, the corresponding bit position of the Switch Word is undisturbed. The resultant setting of the Switch Word is returned in the Q.

● Release Peripheral File (GERELS)

Calling Sequence

Entry	L	MME GERELS
Parameter	L+1	ZERO No. of files
Parameter	L+2	BCI 1,0000 F1
Parameter	L+3	BCI 1,0000 F2
.	.	.
.	.	.
.	.	.
Parameter	L+N+1	BCI 1,0000 FN
Return	L+N+2	Next instruction

F1, F2, ..., FN=File Codes

Description. For each file code listed in the sequence, the corresponding peripheral file is de-allocated from the requesting program. Dismounting instructions are issued for this file if it is on magnetic tape and has disposition code D. The C(L+1) identifies the number of file codes appearing in the calling sequence. Disposition code S, indicating a saved file, will prevent release of that file.

● Release Memory (GEMREL)

<u>Initially</u>

C(A) required:

0	17 18	35
Return Address	MBZ	

C(Q) required:

0	17 18	35
Number of Words of Lower Memory	Number of Words of Upper Memory	

<u>Calling Sequence</u>

Entry	MME GEMREL
Return	Defined by C(A). When lower memory is released, there will be a change in the base address of the requesting program, and in this case the return address is assumed to be relative to the base address after memory de-allocation.

<u>Description.</u> The amount of memory specified by C(Q) is de-allocated from the requesting program's total assigned memory. Actual memory de-allocation is in multiples of 1024-word blocks. If memory remaining after release is less than 2048 words, the program will be aborted.

● Terminate (GEFINI)

Calling Sequence

Entry   MME GEFINI

Description. All peripherals allocated to this activity, except those which have been designated as "save," are de-allocated, and dismounting instructions are issued if necessary. Core storage allocated to this activity is released.

Note. It is the user's responsibility to insure that all his I/O activity has terminated before executing this Master Mode Entry. If this is not done, I/O which is incomplete at activity termination is in danger of being lost.

MME GEFINI is the standard method of bringing an activity to successful completion. Therefore, the programmer is expected to code this in all programs.

● Abort (GEBORT)

Initially

C(Q) required:

0	29	30	35
MBZ		Reason Code	

Calling Sequence

Entry   MME GEBORT

Description. All peripherals allocated to this job are de-allocated, and dismounting instructions are issued, if necessary. A memory dump of the user's core storage is produced on SYSOUT. Core storage allocated to this activity is released. Any remaining activities for this job are deleted.

INPUT/OUTPUT SUPERVISOR (GEIOS)

Features

A single instruction, MME GEINOS, leads to the performance of all I/O operations on the GE-625/635. This instruction gives control to the Input/Output Supervisor (GEIOS) which initiates activity on the Card Reader, Card Punch, Printer, Magnetic Tape Unit, Drum, Disc, Perforated Tape Reader/Punch, and DATANET-30. In addition, GEIOS provides the following features and capabilities:

- **Symbolic-to-Physical Unit Translation.** Users of the GE-625/635 will refer to files symbolically in the various source languages available within the software system. This enables maximum flexibility of assignment of files at execution time and permits a degree of device independence of the files that a program may call upon. GEIOS will convert the symbolic file designations to absolute physical assignments at execution time.

- **File Protection.** GEIOS insures that one program may not refer to the files of another. In this way, it is possible for several programs to be in core concurrently without any of them suffering damage to their files due to the erroneous behavior of another.

- **Simulated Tape Processing on Disc/Drum.** GEIOS provides a method of processing on disc and drum which simulates the serial mode of processing normally peculiar to magnetic tape. This mode of processing not only provides a degree of device independence to computer configuration but also allows the opportunity to reduce program setup time by eliminating the use of magnetic tape for some files.

- **Supervision of Interrupts.** GEIOS responds to all I/O interrupts and takes appropriate action. The programmer will normally not be required to concern himself with the interrupt system of the computer.

- **Queueing of Input/Output Requests.** GEIOS maintains queues of I/O commands. A single command can be queued for each I/O device. In multidevice channel subsystems, such as magnetic tape and disc, GEIOS will select queued commands for execution in the order in which they were requested.

- **Utilization of GEIOS with Crossbarred Magnetic Tape Subsystems.** If the primary channel is busy at the time I/O is to be initiated, GEIOS will automatically select an alternate channel (if available) on a crossbarred magnetic tape subsystem.

- **Pseudo-Command.** In the special case of the typewriter, a Pseudo-command is provided which will allow a programmer to type a message requiring an answer. By the use of this command, it is guaranteed that the answer to a question will follow in sequence behind its asking. (See Write then Read, page 30)

- **Awareness.** The GE-625/635 I/O equipment provides information to the central processor which allows GEIOS to maintain awareness of the status of each peripheral device. GEIOS maintains tables which allow it to record such information as: a magnetic tape is rewinding; some peripheral device is in a Power Off condition; a magnetic tape handler is in Ready status, or has been rewound and is in Standby status.

GE-600 SERIES —————————————————————————— GECOS

● Accounting. GEIOS keeps a complete record of the time spent by the central processor and each peripheral for every program executed. These statistics are later recorded on cards for use in billing and analysis.

Initiation of Input/Output

When a user program wishes to initiate I/O, it executes a MME GEINOS which is followed by a Select sequence specifying additional information pertaining to the I/O operation. When the I/O Supervisor is entered as a result of the MME GEINOS, the file code in the Select sequence is used as a basis for determining physical device and channel. If the channel is not busy, GEIOS will load the communication cells (subsequently to be examined by the IOC) and will issue a Connect instruction which will cause the IOC to initiate the requested I/O operation.

If, when GEIOS receives a request to perform an I/O operation, it finds that the channel upon which the request was made is busy, it will queue the request if it was made on a multidevice channel and return control to the requesting program. If in any event the request queue on the device and channel for which the request was issued was found by GEIOS to be full, GEIOS will remember the location at which the request was issued and give control to another program by way of the Dispatcher (GEDISP).

Termination of Input/Output

Whenever an I/O operation terminates (as signaled by a termination interrupt) control will be given to the termination portion of GEIOS after all registers and indicators for the interrupted program have been saved. Assuming that the termination was successful (that is, no error condition existed) GEIOS will return the status of the peripheral device to the program which requested the termination I/O operation and remove the terminated request from the queue for the device which was involved. If there is another queued request which can now be serviced, GEIOS immediately initiates pertinent I/O action.

After GEIOS has processed the termination interrupt and attempted to start other I/O as described above, it will determine if a courtesy call was requested. If it finds that a courtesy call was requested, it will give control to the user program for a limited time at the specified courtesy call address. After the courtesy call (if present) has been processed, the registers of the computer are restored to the condition at which the interrupt occurred and control is returned to the interrupted program.

The above information has presented a considerably condensed description of the sequence of events that takes place in the execution of a typical I/O operation.

Ground Rules for GEIOS

One I/O request will be queued for each peripheral device.

For those channels which can control more than one device (for example, magnetic tape or disc), I/O requests will be serviced in the order in which they are received.

The magnetic disc commands Seek, Read Continuous and Release Seek, Write Continuous and Release Seek, Write Continuous Verify and Release Seek, will be provided.

Seek commands addressed to different file units are overlapped automatically by GEIOS to im- |
prove the total throughput of the disc channel.

Inhibition of interrupts will be kept to a minimum so as to reduce response time to such occur-
rences as peripheral termination.

Return from an I/O request submitted from within a courtesy call will always be made directly
to the requesting program, even if other master mode programs require service.

Return from other I/O requests will be made directly to the requesting program unless master
mode programs require service.

After responding to a peripheral interrupt and paying any courtesy calls requested, GEIOS will
always return to the interrupted program.

Routines to handle the most frequently occurring I/O commands and circumstances will be coded
for speed, even at the possible expense of increasing execution time in abnormal cases.

● __File Codes__. A file code is a two-letter symbolic designation used universally to refer to |
files in the GE-625/635 software system. If the programmer is writing in GMAP (symbolic) |
language, but not using GEFRC, the file code will be provided by the programmer using a BCI
pseudo-operation. The file code is contained in the calling sequence following the MME
GEINOS which initiates each I/O operation. If the programmer is using GEFRC to perform
his I/O operation, GEFRC will automatically synthesize a GEINOS calling sequence which
contains an appropriate file code (specified in the FILCB macro).

In FORTRAN source language, the file code is created as a function of the file number re-
ferred to in the READ or WRITE commands in the FORTRAN source language. For instance,
WRITE (1) would imply file code F1. In COBOL source language, the file name is related to
the file code in the Environment Division using the "assigned to" clause.

When a user prepares his program for execution, he will prepare file control cards. (See
GEFLOW section, page 51.) These will relate the specific file that is to be used in each
case to the file code by which it has been referenced internally. GEIOS will translate the
file code references at execution time to the actual physical file assignments made by
GEALOC.

● __Mass Storage Files__. Two types of mass storage files are treated by GEIOS. The first is
the familiar random access file in which a segment of contiguous storage is allocated on the
disc or drum to contain the information of some unique file. GEIOS may refer to one or
more such files for each program. It will make each file appear as though it begins at block
0 and extends upward to an allowable limit. GEIOS, with the assistance of hardware features,
will prevent a user from writing beyond the area allocated to him on a mass storage device.

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For many applications it is desirable to be able to interchange disc, drum, and magnetic tape as storage media. To achieve this interchangeability, a type of file referred to as a linked file is provided through GEIOS. This type of file causes the mass storage devices to perform as if they were magnetic tape, if the following restrictions are observed:

The file may not be backspaced, forward-spaced, or changed in density.

Standard system format must be used.
(Variable block size, 320-word maximum; block sequence number and size of block for each data block; high density, binary mode; variable-length records with record size control word; standard header and trailer labels.) See GE File and Record Control manual, page 23, for details on System Format.

● <u>Write then Read</u>. In the multiprogramming environment of the GE-625/635, it is necessary occasionally to type a message on the typewriter which requires an operator reply. If such messages were typed just as they were encountered at execution time, it would often be difficult for the operator to keep up with the multitude of questions which might present themselves to him within a short time interval.

To alleviate this problem, GEIOS provides an I/O pseudo-command which consists of a Read Typewriter command to be executed immediately following the successful termination of a preceding Write Typewriter command. This pseudo-command will allow the operator to respond to each message as it is presented to him.

If after 30 seconds the operator has not responded to a question which has been typed, the console will automatically terminate its Read command with a unique substatus indication to the requesting program. At this time the requesting program can reissue the command and continue to do so until the operator responds.

GEIOS Usage

In general, a request for I/O is made by means of the instruction MME GEINOS followed by a
Select sequence of three or five words, depending on the number of peripheral commands in the
sequence. Normally, the Select sequence contains three words: Operation Word, Identification
Word, and Return Word.

A request to perform I/O using a three-word Select sequence may be viewed schematically as
follows:

MME GEINOS

I/O command to be executed

ZERO File Pointer,   DCW Pointer

One word containing file identification

First of a list of words describing
memory locations to be read or
written (scatter/gather list)

ZERO Status Return Pointer,   Courtesy Call Address

First of two words (status returns) de-
scribing the circumstances under which
execution of the request was terminated

Entry point to user's
courtesy call routine

The first word of the Select sequence--the operation word--specifies what actual operation is to
be performed; the second--the identification word--indirectly identifies which peripheral device
is involved and what data, if any, is listed. The additional word--the return word--returns in-
formation on the success or failure of the command's execution plus a special entry to the user's
program.

Certain I/O requests involve two related operations which must be performed sequentially. These are: Seek, then Read or Write Disc; Select, then Read or Write Drum; and Write, then Read Typewriter. In these cases, the Select sequence is five words long.

In a 3-word Select sequence, then, the order of words is:

Operation word 1
Identification word 1
Return word

while in a 5-word Select sequence, the order is:

Operation word 1
Identification word 1
Operation word 2
Identification word 2
Return word

The formats of the individual words in a Select sequence and descriptions of the various fields therein are given on the pages following.

a. Operation Word

0	5 6	17 18	22 23 24	29 30	35
Device Command	MBZ	IOC Command	M B Z	Control	Count

The octal configurations of the various Device commands recognized by the GE-625/635 software are as follows:

All Devices		Octal Code
REQS	Request status	00
RESS	Reset status	40

Card Reader		
RCB	Read Card Binary	01
RCD	Read Card Decimal	02
RCM	Read Card Mixed	03

Card Punch		
WCB	Write Card Binary	11
WCD	Write Card Decimal	12
WCDE	Write Card Decimal Edited	13

Printer		
WPR	Write Printer	10 (see Note 1)
WPRE	Write Printer Edited	30 (see Note 1)

Magnetic Tape		
RTB	Read Tape Binary	05
RTD	Read Tape Decimal	04
WTB	Write Tape Binary	15
WTD	Write Tape Decimal	14
WEF	Write End-of-File	15 (see Note 2)
WFM	Write File Mark	15 (see Note 2)
ERASE	Erase	54
BSR	Backspace Record (s)	46
BSF	Backspace File (s)	47
FSR	Forward-Space Record (s)	44
FSF	Forward-Space File (s)	45
REW	Rewind	70
REWS	Rewind and Standby	72
SLD	Set Low Density	61
SHD	Set High Density	60

Disc		Octal Code
SDIA	Seek Disc Address	34 (see Note 3)
RDIC	Read Disc Continuous	25
WDIC	Write Disc Continuous	31
WDICV	Write Disc Continuous and Verify	33

Drum

SDRA	Select Drum Address	34 (see Note 4)
RDR	Read Drum	25
WDR	Write Drum	31
WDRV	Write Drum and Verify	33
DRCV	Drum Compare and Verify	11

DATANET-30

WDN	Write DATANET	10
RDN	Read DATANET	01

Perforated Tape

RDPT	Read Perforated Tape	02 (see Note 5)
WPT	Write Perforated Tape	11
WPTE	Write Perforated Tape Edited	31
WPTSC	Write Perforated Tape, Single Character	16
WPTDC	Write Perforated Tape, Double Character	13

Console Typewriter

RTYP	Read Typewriter	03
WTYP	Write Typewriter	13

Note 1: Printer Slew commands will not be recognized, so that GECOS can have the ability to assign the output either directly to the printer or to another device for subsequent printing. When slewing is to be performed, the escape character and appropriate slew character must appear in the line to be printed.

Note 2: An end-of-file or tape mark is written by a combination of the "write tape binary" Device command and the "write single-character record" IOC command.

Note 3: When requesting disc I/O involving data transfer, the Select sequence contains two operation words; the Device command in operation word 1 must be Seek Disc Address, and that in operation word 2 must be the appropriate Read or Write command.

Note 4: When requesting drum I/O involving data transfer, the Select sequence contains two operation words; the Device command in operation word 1 must be Select Drum Address, and that in operation word 2 must be the appropriate Read or Write command.

Note 5: Before issuing a Read Perforated Tape command, the program should first issue an REQS or RESS to insure that a reader plug board is present. If a Read Perforated Tape command is issued and there is no reader plug board present, tape movement will begin and will continue until the end of the input reel is reached, at which time a "Device Attention -- Out of Paper" status will be sent.

The various IOC command codes and their meanings are as follows:

> 00001 = Continuous Mode Non-Data-Transfer (used for backspacing or forward-spacing records or files on magnetic tape, and for all other non-data-transfer operations including Request Status and Reset Status)
>
> 00010 = Card Punch (used whenever a binary or decimal card is to be punched)
>
> 00100 = Write Single-Character Record (used to write an end-of-file or tape mark on magnetic tape)
>
> 01000 = Program Load (used only for initial start-up)
>
> 00000 = Unit Record Transfer (used for all operations not defined above)

The Control field must be zero except in the following cases:

> When writing an end-of-file or tape mark on magnetic tape, the control field contains the binary representation of the character to be written as a single-character record.
>
> For disc I/O involving data transfer, the control field of operation word 2 must contain 010100.

The Count field must be zero except in the following cases:

> When the Continuous Mode Non-Data-Transfer (00001) IOC command code is used, the count field must be 000001 unless the operation is "backspace or forward-space n records," in which case the count field contains n as a binary integer.
>
> When the Card Punch (00010) IOC command code is used, the count field must contain 001011 (=11_{10}).
>
> For disc or drum I/O, the count field (initialized by GMAP) in operation word 1 must contain a binary integer whose value is equal to the number of commands in the Select sequence.

b. Identification Word

```
0                          17 18                                    35
┌────────────────────────────┬─────────────────────────────────────┐
│                            │                                      │
│        File Pointer        │             DCW Pointer              │
│                            │                                      │
└────────────────────────────┴─────────────────────────────────────┘
```
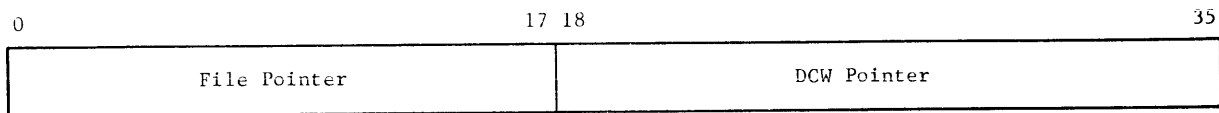
In identification word 1, the File Pointer is the address of the word containing the File Code used to identify the file to which the I/O request pertains. In identification word 2, the file pointer, regardless of actual value, is assumed to be the same as that in identification word 1.
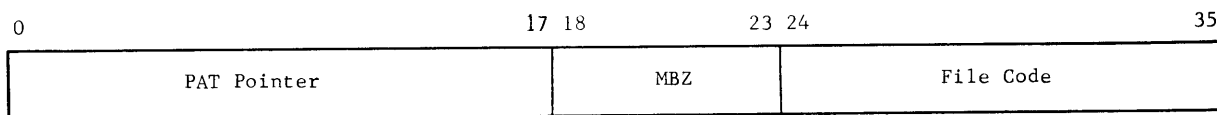
The format of the File Code word is as follows:

```
0                     17 18        23 24                            35
┌──────────────────────┬────────────┬───────────────────────────────┐
│                      │            │                               │
│      PAT Pointer     │    MBZ     │          File Code            │
│                      │            │                               │
└──────────────────────┴────────────┴───────────────────────────────┘
```
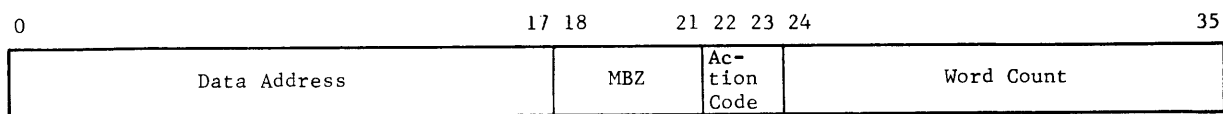
The PAT pointer must initially be zero; it is subsequently maintained by GEIOS and should not be altered by the user program. If the PAT pointer is inadvertently modified, the offending program may destroy one of its own files, or it may be aborted, but in no case can the files of another program be affected.

The file code is the two-character code used for purposes of file identification. (See page 29.)

The DCW (Data Control Word) pointer contains the address of the first of one or more DCW words which specifies and is used in the control of data transmission. If no data transmission is involved, there are no DCW words; in such a case, the DCW pointer must be zero.

Note: The Seek Disc Address and Select Drum Address commands involve the transmission of an address as data, and therefore require a DCW word and a DCW pointer.

The format of a DCW word is as follows:

```
0                          17 18     21 22 23 24                    35
┌────────────────────────────┬─────────┬──┬──┬───────────────────────┐
│                            │         │  │Ac│                       │
│       Data Address         │   MBZ   │  │ti│     Word Count        │
│                            │         │  │on│                       │
│                            │         │  │Co│                       │
│                            │         │  │de│                       │
└────────────────────────────┴─────────┴──┴──┴───────────────────────┘
```

The Data Address contains the location of the first word to be transmitted or, when the action code specifies a DCW transfer, the location of the next DCW word.

In the case of the DCW word associated with a Seek Disc Address or Select Drum Address command, the word referred to in the data address field must, for random files, be initialized with the desired relative block address each time that I/O is requested on that file; the block address is converted to absolute by GEIOS at the time of I/O initiation. For linked files, all maintenance of the block address is performed by GEIOS.

Note: When reading or writing linked files, a standard record length of 320 words will always be assumed. Since a block on disc accommodates 40 words, GEIOS increments the block address by 8 (except across link boundaries) whenever a linked file is accessed. For linked drum files, the block address increment is 5, since a block contains 64 words. For random files, however, transmission can start at any block of 40 words on disc, or of 64 words on drum, by means of the relative block address.

The Action Codes and their meanings are as follows:

00 -- Transmit and Disconnect. Move the number of words to or from memory specified by the count and then terminate the I/O command.

01 -- Transmit and Proceed. Move the number of words specified by the count to or from memory, then continue to the next DCW and do as it indicates.

10 -- Transfer to DCW. Don't move any data. Go to the DCW at the address specified in this DCW and do as it indicates.

11 -- Non-transmit and Proceed. Skip the number of words specified in the count of this DCW, then go to the next DCW and do as it indicates.

The following restrictions apply to Action Codes:

The first DCW in a series must not contain the action code 10.

The DCW referred to by the DCW pointer associated with a Seek Disc Address or Select Drum Address command must contain the action code 00.

The action code 10 must not be used in a DCW associated with drum I/O unless it is executed between 64-word blocks.

The Word Count contains a binary integer indicative of the number of words to be transmitted under control of the DCW. A count of 0 is interpreted as if it were 4096.

The following restriction applies to Word Count:

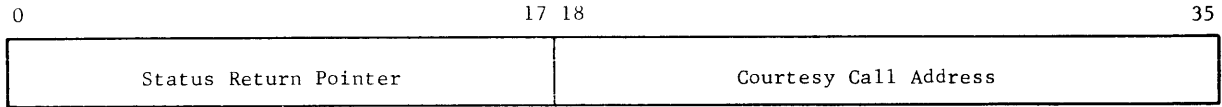The DCW referred to by the DCW pointer associated with a Seek Disc Address or Select Drum Address command must contain a word count of 1.

c. __Return Word__

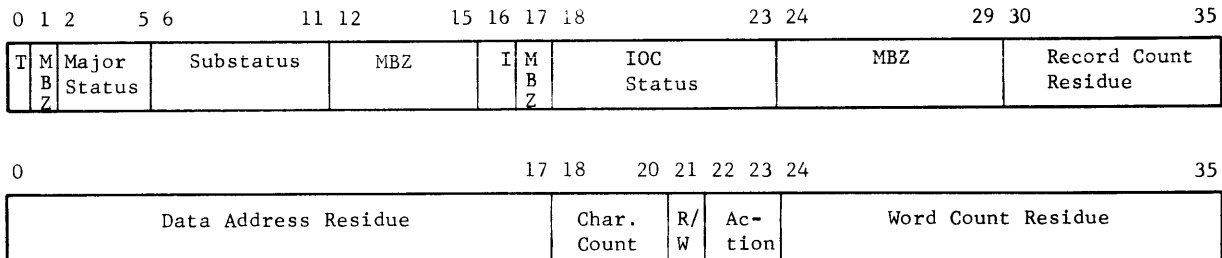| Status Return Pointer	Courtesy Call Address

__Status Return Pointer.__ This field contains the address of the first of two sequential words which are set to zero by GEIOS when the I/O request is received, and into which the status returns will be placed when I/O has terminated. Note that if the requested I/O action is Request Status or Reset Status, the status conditions will be returned to the user program exactly as GEIOS receives them from the IOC. Otherwise, the Exception Processing Routine will have taken all possible recovery action on any indicated errors before GEEPR returns the final status to the program. In any case, no status returns will be made if the Status Return Pointer is zero.

It should be pointed out that status returns in response to Rewind, Rewind and Standby, Set Low Density, or Set High Density commands are meaningless other than to signify that the I/O action has started. Status is not provided when any of these actions terminate.

In addition, when an I/O request involves two or more I/O actions (for example, Select, then Read Drum), the status returns pertain to the request as a whole.

The formats of the two status return words are as follows:

0 1 2	5 6	11 12	15 16	17 18	23 24	29 30	35

T	MBZ	Major Status	Substatus	MBZ	I	MBZ	IOC Status	MBZ	Record Count Residue

0	17 18	20 21	22	23 24	35

Data Address Residue	Char. Count	R/W	Ac-tion	Word Count Residue

The Termination Indicator (T) will be set to 1 when the I/O (and any pertinent recovery action) has terminated.

For a complete discussion of Major Status and Substatus, see Appendix, Page 69.

The Interrupt Indicator (I) will be set to 0 if the status was returned by the IOC as a result of a termination interrupt, but will be 1 in the case of an initiation interrupt.

The latter occurs in the following cases:

The command was Request Status or Reset Status.

The command was Rewind, Rewind and Standby, Set Low Density, or Set High Density with respect to magnetic tape.

The command Backspace Record, Backspace File, Write End-of-File, or Erase was addressed to a magnetic tape at the load point and was consequently rejected.

An attempt was made to initiate I/O for the Perforated Tape Reader/Punch when it was out of tape.

On the printer, the previous operation resulted in a slew with a top-of-page echo.

The IOC Status will always be 0 except for a Request Status in which case this status will be returned by GEIOS as it is received from the IOC.

The Record Count Residue pertains to magnetic tape backspace or forward-space operations only. It reflects the number of records remaining that were not spaced over due to detection of either the beginning of tape or an end-of-file mark. (Note: an end-of-file mark will have been counted as a record.)

The second status return word reflects the condition of the last DCW processed by the IOC when the I/O terminated. The fields in this word are as follows:

The Data Address Residue is the address +1 of the last complete word of data moved.

The Character Count reflects the number of characters transmitted in the last word if it was a partial word; it will be zero if the last word was complete.

The Read/Write Control (R/W) is used by the IOC for control purposes. Normally it is meaningless to the user program but can be used by hardware diagnostic routines.

The Action Code is that which was provided in the DCW (see page 37).

The Word Count Residue reflects the number of words still left to be transmitted under control of the DCW when I/O terminated.

Courtesy Call Address. This field contains the address to which GEIOS will transfer as soon as the specified I/O has terminated. Courtesy calls will be made only if the I/O resulted in a termination interrupt. Certain restrictions apply:

It is illegal to use any of the following instructions within a courtesy call: MME GEBORT, MME GECALL, MME GECHEK, MME GEFCON, MME GEFILS, MME GEFINI, MME GERELC, MME GEROAD, MME GEROLL, MME GERSTR, MME GESAVE. The appearance of any of these instructions within a courtesy call will cause the program to be aborted.

If only a single I/O request is given during a courtesy call and it pertains to the device whose I/O termination caused the courtesy call, there will always be room for the request in the queue for that device; in this case the I/O request will be processed normally. On the other hand, if any I/O request is submitted during a courtesy call to a different device from that on which I/O terminated, room in the queue can not be guaranteed; if the queue happens to be full, completion of the courtesy call will be postponed until the queue can accommodate the request.

Return from a courtesy call must be made by means of the instruction MME GEENDC.

The length of time permitted to a courtesy call is limited to 200 microseconds on the GE-635 and 400 microseconds on the GE-625, exclusive of the time required for GEIOS to process I/O requests. If this time limit is exceeded, the program will be aborted.

GE-600 SERIES ———————————————————————— GECOS

Usage of GESPEC (Special Interrupt Action Request)

At certain times it may be desirable to issue a latent request for I/O which would be executed upon the occurrence of some external condition. This capability is provided in GEIOS by entering master mode at GESPEC before issuing the conditional I/O request.

This facility may be used in connection with three peripherals: Card Reader, Printer, and Remote Terminals.

Card Reader. A particular card reader will normally be assigned to accept system inputs on the GE-625/635; its identity will be standard for each installation. This system reader may be utilized also by user programs such as bulk media conversion. Its availability for use by GEIN will be announced to the operator on the console typewriter.

GEIN will be activated automatically when the operator places the deck in the hopper and pushes OPERATE/RESET. This ability to initiate input media conversion without the use of the operator's console is made possible by a latent Read command issued by GEIN whenever the system reader is available for operator use.

When GEIN is entered, the sequence MME GESPEC, MME GEINOS, MME GEROAD is executed.

The MME GESPEC refers to the system card reader; the MME GEINOS requests a Read operation (this Read command will not be executed until a special interrupt is issued by virtue of the reader changing from Standby to Ready status.) The MME GEROAD prevents GEIN from executing until the Read is complete.

Printer. Controls are provided on the General Electric Common Peripheral High-Speed Printer which allow an operator to control both printer and input media from the printer. The controls available to him are:

> Print One Line
> Backspace One Line
> Forward-Space One Line
> Backspace to Top of Page
> Forward-Space to Top of Page
> Backspace One Block/Rewind
> Print PREV LINE IN ERROR

The operator controls obtain their capabilities through the use of a standard subroutine; the hardware merely returns a numeric substatus corresponding to depression of each of the control switches. These controls will be used whenever a Device Attention major status is returned in response to a Write Printer command.

When using the printer, the programmer should write a CALL PRTATN at the point in his program where status returns are to be tested. The PRTATN subroutine will test the major status for the Device Attention condition and return control to the main program if this condition is not found. If Device Attention is encountered, PRTATN will perform MME GESPEC, MME GEINOS, MME GEROAD.

The command portion of the MME GEINOS will call for the execution of a Request Status (REQS) on the printer. This latent command will be executed as soon as the operator has cleared the Attention condition and readied the printer by depressing the Operate/Reset switch. The status returned will be Device/Channel Ready major status and a numeric substatus which will depend on what control switch the operator depressed.

The PRTATN subroutine will then perform the action specified. (See the Library Subroutine Manual for a detailed description of PRTATN.)

Remote Terminals. To assure rapid response to requests from remote devices via the DATANET-30, a latent Read command may be issued. If a need arises to write to a remote terminal after the command has been issued but before an external request arrives, the latent command may be removed by issuing another MME GESPEC with the Q-register set negative. This will allow the Write to be issued, after which the system can be reconditioned to receive information from remote terminals as before.

SYSTEM OUTPUT COLLECTOR (GESYOT)

Purpose

A collector tape is provided in the GE-625/635 for recording outputs of limited size. This collector works in conjunction with two additional tapes which supply output to GEOUT (the Output Media Conversion routine).

Many outputs which are to be ultimately printed or punched are of relatively small size but occur frequently. To eliminate the need for assigning a separate output unit for each such output, the GESYOT facility is provided in GESERV. With this facility the user is able to write all of his small outputs onto the unit referred to as SYSOUT, thereby alleviating the need for the mounting, dismounting, and allocation of many output files. Within certain format limitations the user may place any or all of his output files on SYSOUT so long as the total output from any activity does not exceed 10,000 unit records and the total punch output does not exceed 1,000 cards.

Some reports and decks, of course, will exceed the limits specified for writing to SYSOUT. These should each be assigned to its own output unit and converted to printed page or punched cards through the use of Bulk Output Media Conversion.

In addition to being able to receive several outputs from a single program, SYSOUT may receive the outputs of several programs concurrently. This capability quite effectively utilizes the GE-625/635 hardware. But note that user programs are prohibited from writing on SYSOUT via the Master Mode Entry to GEINOS. This eliminates the danger of one program performing an operation which would adversely affect the objectives of another (for instance, one program might have inadvertently rewound the output collector tape so that the outputs from many other programs might have been destroyed). Instead of the user program writing on SYSOUT via a normal Master Mode Entry to GEINOS, the special subroutine GESYOT is provided. GESYOT has as its primary purpose and capability the writing of records on SYSOUT on demand from various user and system programs. In addition to protecting information recorded on SYSOUT, GESYOT provides control information which will be used ultimately by GEOUT.

The specific functions of GESYOT are:

1. To write records on SYSOUT on demand from user or master mode programs

2. To maintain a record count of the number of print lines and punch records written to SYSOUT by each user program and to abort the program if the number of print lines exceeds 10,000 (or the limit specified on the user's LIMITS card) or if the number of punch records exceeds 1,000

3. To provide consecutive block sequence numbers (The outputs produced by each user program will start with block sequence number one.)

4. To coordinate the utilization of tapes with GEOUT and to redirect SYSOUT output to an alternate collector tape and/or the drum during switching of collector tapes

Usage

To write a record on SYSOUT from a user (slave mode) program, the following calling sequence is executed:

```
Entry        L     MME  GESYOT
Parameter L + 1  ZERO L (File Control Block)
Return      L + 2  Next instruction
```

Normally, this GESYOT calling sequence is used only by GEFRC. GEOUT expects a certain format, which GEFRC produces automatically. Use of GESYOT outside of GEFRC is discouraged, since it would be very cumbersome and error prone.

EXCEPTION PROCESSING ROUTINES (GEEFR)

Interrupts

The IOC and the peripheral I/O devices of the GE-625/635 hardware system generate signals which interrupt the processor whenever a significant event takes place with regard to I/O. For example, interrupt signals occur when an I/O command has not been successfully initiated, when an I/O operation terminates successfully or otherwise, when a magnetic tape rewind is completed, when any peripheral device changes from a standby to a ready condition, or when a device at a remote terminal desires to communicate with the GE-625/635.

In general, whenever an interrupt takes place, the IOC also transmits status information so that GEIOS can determine the specific cause of the interrupt. If the status indicates that the I/O was completed successfully and that the hardware is ready to perform a subsequent I/O operation, GEIOS returns the status information to the user program and immediately starts the next I/O (provided, of course, that a request is waiting in the queue). On the other hand, if the status reflects some abnormal condition, GEIOS will pass the status information to GEEPR (Exception Processing routines) for further action.

Types of Exception Routines

The occurrence of exception conditions is rare compared to the frequency of occurrence of normal interrupts. Therefore, the Exception Processing routines are called from the drum as overlays so as to save space in core. The Exception routines can be classified into several categories:

1. Those whose occurrence is normal but which require operator response. Exception conditions such as full stacker, empty hopper, chad box full, fall in this category. These interrupts are handled entirely by GEEPR and will never be seen by any user program. If one of these conditions occurs, GEEPR will issue appropriate instructions to the operator and will resume operation on the affected device as soon as the operator has complied.

2. Those whose occurrence is normal and which are handled by the requesting program. Such conditions as end of file, end of reel, and magnetic tape at load point, provide information to which the user program may wish to respond. In such cases, the status and substatus are merely passed on to the user program which will take appropriate action.

3. Those whose occurrence is caused by unsuccessful completion of the I/O. This class of exception conditions is handled in a variety of ways depending upon the nature of the error and the peripheral device involved.

The Appendix describes in detail the various exception conditions and the action taken by GEEPR in each case. The information contained in the Appendix applies to exception conditions encountered in slave programs. Special consideration must be given to the occurrence of errors in master mode programs. If an I/O error which cannot be recovered is sensed in a master mode program, the operator is informed and given an opportunity to initiate a Rollback procedure. The Rollback will restart execution at the last available checkpoint.

FAULT PROCESSING ROUTINES (GEFALT)

Whenever a fault occurs within the GE-625/635, the processor enters the master mode and executes a pair of instructions at a fixed memory location within master mode memory. The location of this instruction pair is determined by the particular fault. The instructions save the contents of the instruction counter and indicators and transfer processor control to a master mode program for interpretation of the fault.

Standard Action vs. User Option

Faults are classified as either program or hardware faults according to the possible cause. If a fault could have been caused by a program error, it is considered a program fault; if it could only have been caused by a hardware error it is considered a hardware fault.

A standard action is taken by the system for any hardware fault that may occur, and for any program fault which the user chooses not to handle himself.

When the system processes a fault, it produces a comment on SYSOUT. Wherever possible, the standard system action allows processing to continue.

In the case of program faults, the user has the option of substituting his own fault routine for that provided by the system. If he exercises this option, the SYSOUT comment will not be produced. The option, which may be exercised by a slave program in processing faults, is controlled by a fault vector.

Fault Vector

The fault vector comprises the first 14 locations (relative to the contents of the Base Address register) of each slave program and is organized into seven successive pairs with each pair being related to one type of fault.

Base Address

+	0	(Illegal Op Code, Command, Connect)
+	2	(Memory)
+	4	(Fault Tag)
+	6	(Divide Check)
+	8	(Overflow)
+	10	(Lockup)
+	12	(Derail)

If the user wishes to override the system option on a particular fault, he places a transfer instruction (TRA) to his own Fault routine in the second word of the pair corresponding to the fault.

If the user wishes to ignore the fault, he places a return instruction (RET) in the second word of the pair with an address pointing to the first word of the pair.

If the user wishes to go along with the system option, then the second word of the pair must be zero.

Bit positions 0-17 of the first word of the pair will always contain the C (Instruction Counter) +1 at which the fault occurred. The status of the indicators when the fault occurred will be stored in bit positions 18-35.

Standard Fault Processing Procedures

The following list indicates the standard action taken by the system for each fault.

Program Faults

1. Illegal operation code

   Description: An operation code of all zeros has been executed.

   SYSOUT: ILLEGAL OP CODE AT XXXXXX

   Action: Abort

2. Lockup

   Description: A program lockup (for example, a TRA to its own address) has existed for 64 milliseconds.

   SYSOUT: LOCKUP AT XXXXXX

   Action: Abort

3. Divide check

   Description: A divide check fault has been generated.

   SYSOUT: DIVIDE CHECK   (This message will be added to the end of the execution report)

   Action: Continue (If the divide check is caused by division by zero, the largest positive number is returned. In the case where the divide check is caused by division other than zero, the largest magnitude and correct sign is returned. In either event, bit 29 of word 25--accumulated fault status--of the user program will be set to 1.)

4. Overflow

Description: An arithmetic overflow, floating-point underflow or floating-point overflow has been generated.

SYSOUT: OVERFLOW
UNDERFLOW
EXPONENT OVERFLOW (one or more of these will be added to the execution report at termination time)

Action: Continue (The largest magnitude and correct sign are returned when the fault is detected as floating-point overflow, and bit 22 of word 25--accumulated fault status--of the user program is set to 1. When the fault is detected as floating-point underflow, 0 is returned and bit 23 of word 25--accumulated fault status--is set to 1. On all other overflow conditions, the result is left undisturbed and bit 21 of word 25 of the user program is set to 1.)

5. Command

Description: The processor has given a Connect or has attempted to alter the mask or protect registers and is not the control processor for that memory or is not in the master mode, or the processor has given a Connect to a channel which is masked or switched off.

SYSOUT: ATTEMPT TO ALTER MASK OR PROTECT REGISTER AT XXXXXX

Action: Abort

6. Memory

Description: The memory did not respond within 50-100 μs to a data cycle request, or no physical memory existed for the address, or a program in slave mode referenced protected memory, or the memory closed out a double-precision or BAR cycle, or program exceeds boundary.

SYSOUT: MEMORY FAULT AT XXXXXX

Action: Abort

7. Fault Tag

Description: The Fault Tag has been recognized.

SYSOUT: (None)

Action: Abort

8. Derail

    Description: The instruction Derail has been executed.

    SYSOUT: ILLEGAL OP CODE AT XXXXXX

    Action: Abort

9. Connect

    Description: The Connect flip-flop has been set.

    SYSOUT: ILLEGAL OP CODE AT XXXXXX

    Action: Abort

10. Master Mode Entry

    Description: The instruction MME has been executed.

    SYSOUT: (None)

    Action: (See page 8.)

Hardware Faults

11. Startup

    Description: A power startup has occurred.

    SYSOUT: (None)

    Action: Continue

12. Execute

    Description: The EXECUTE switch on the processor control panel has been
                 activated.

    SYSOUT: (None)

    Action: Continue

13. Shutdown

    Description: Power will be shut off in 1 millisecond.

    SYSOUT: (None)

    Action: Discontinue program processing and attempt to communicate this
            fault condition to the operator.

14. Operation not complete

  Description: The processor has not generated a memory operation within
      50-100 μs and is not in DIS.

  SYSOUT: OP NOT COMPLETE AT XXXXXX

  Action: Abort

15. Parity

  Description: A parity error has been found in either the word referenced
      or the other word of the memory pair.

  SYSOUT: PARITY AT XXXXXX

  Action: Abort

16. Timer Runout

  Description: This fault will be generated when the Timer count reaches
      zero. If the processor is in master mode, recognition of
      the fault will be delayed until the processor returns to
      slave mode.

  SYSOUT: (None)

  Action: Dispatcher selects another program for execution

Faults in Master Mode Programs

The standard action for several of the faults calls for aborting the program. This is clearly
not the desired action if the fault occurs in a master mode program. In such a case, the
operator will be informed so that he may call a Product Service man who will arrange to
localize the hardware problem via tests. After the hardware has been repaired, a system
restart will be initiated.

DISPATCHER (GEDISP)

Purpose and Method

The purpose of GEDISP is to try to keep as many system components as possible in simultaneous use. It does this by first allowing one program to be executed, then another, etc., so that the I/O operations required by the different programs can be overlapped as much as possible.

In selecting a program for execution, GEDISP gives preference first to master mode programs and then to slave programs. Within each of these categories, the relative urgency of the programs is considered. However, GEDISP will not select a program which just relinquished control or for which the interval timer just ran out, unless no other program is ready for execution.

Entry into GEDISP

Entry into GEDISP takes place whenever a master mode program completes its task and has nothing further to do at that time, or whenever a slave program has used up the interval of time allotted to it by the Dispatcher, or when any program requests to be roadblocked or to relinquish control. In addition, GEDISP will assume control, following the acceptance of an I/O request by GEIOS, whenever a master mode program is ready for execution, provided that the I/O request was not given during a courtesy call.

3.   GEFLOW   CONTROL   CARDS

INTRODUCTION TO GEFLOW

The GEFLOW module of the Comprehensive Operating Supervisor is concerned with the preparation of programs for execution, the initiation and termination of execution, and the conversion of standard outputs to printed or punched form. To perform these functions, GEFLOW is divided into four sections:

1. GEIN--Transcribes program inputs to drum, collects control information, and organizes inputs for convenience at execution time

2. GEALOC--Determines availability of hardware components for each program and initiates execution as sufficient components are found

3. GETERM--Removes programs from the computer, records accounting information, releases components, and compacts memory

4. GEOUT--Transcribes outputs written on SYSOUT (the standard system output file) into printer output or punch cards

Each section of GEFLOW, although independent in function, interfaces with the other sections. Frequently referenced sections reside permanently in master memory, while less frequently used sections exist as temporary overlays, being called from drum or disc storage when needed.

USE OF CONTROL CARDS

All job identification and file control information required for execution of the job is on control cards in the input deck. The user, through these control cards, can instruct the Operating Supervisor in the execution of the individual activities of his job. This section explains the purpose and format of all control cards used by the Operating Supervisor.

All control cards pertaining to an activity must immediately precede the data for the activity, with the control card defining the activity being the first such card. All control cards are identified by a $ in column 1. Except for the $ symbol, the label field must be blank. The control field begins in column 8. Operands, when present, begin in column 16 and are separated by commas. No imbedded blanks are permitted. (A blank terminates the field definition.)

The Basic Input Deck

The first control cards in any input deck are used for identification. These cards are SNUMB, the job identifier, and IDENT, which contains basic accounting information. A discussion of these control cards follows:

SNUMB

1	8	16	
$	SNUMB	Job Identifier, Urgency	
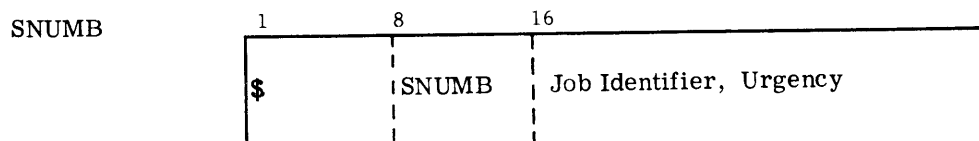
The SNUMB control card is the first card of every job. This card is supplied by the operations section at every installation. In the operand field, the first entry is from one to five characters long and is called the "job identifier." The job identifier is used by the Operating Supervisor to identify the job internally. The second entry is the "urgency." This entry is also supplied by the installation and determines the internal priority of the job. If urgency is omitted, a value of 1 is assumed. For a discussion of urgency, consult the System Summary pages 3 and 4.

IDENT

1	8	16	
$	IDENT	Number, Name, Class, Comments	
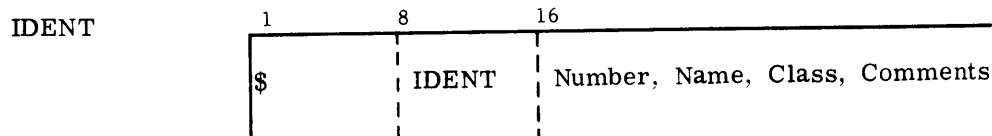
The IDENT control card is used to supply accounting information. At least one IDENT card must immediately follow the SNUMB control card. However, each activity may be preceded with an IDENT CARD; or an IDENT card may be used for a series of activities, in which case all accounting information for these activities contains the same identification information.

The operand field is defined by the individual installation. An accounting routine is available from the General Electric Computer Department for use at the option of the installation. This routine uses the following operand entries: The first entry is a 5-character account number. The second entry is the requestor's identification and may not exceed 12 characters. The third entry specifies the type of run (compile, sort, debug, etc.). The fourth entry may contain additional comments.

OBJECT

```
1          8          16
|----------T----------T------------------------------------
|          |          |
| $        | OBJECT   |
|          |          |
|          |          |
```
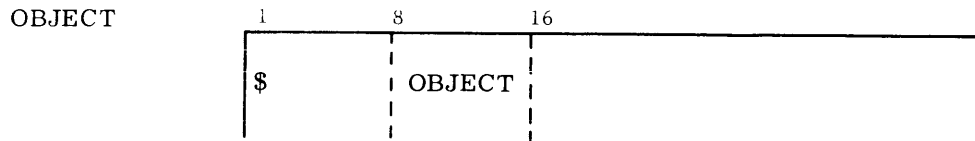
The OBJECT control card is used to identify the beginning of an object program or subprogram in the input sequence of a job. This control card is produced by the Assembler as the first card of an object program or subprogram deck.

DKEND

```
1          8          16
|----------T----------T------------------------------------
|          |          |
| $        | DKEND    |
|          |          |
|          |          |
```

The DKEND control card is used to identify the end of an object program or subprogram in the input sequence of a job. It is produced by the Assembler as the last card of an object program or subprogram deck.

EXECUTE

```
1          8          16
|----------T----------T------------------------------------
|          |          |
| $        | EXECUTE  | On 1,  On 2... On 6
|          |          |
|          |          |
```
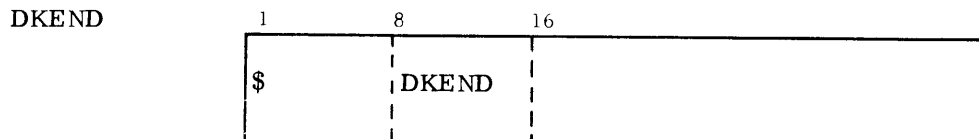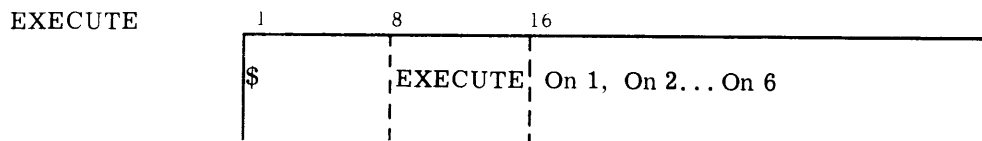
The EXECUTE control card is used to request the loading of object programs. This card must appear after all subprograms to be executed but before their data. Effectively, the EXECUTE control card requests the Operating Supervisor to call the Loader, which then loads all subprograms of the activity. The entries in the operand field specify variables which may be sensed during program execution. The sense switches 1 through 6 may be turned on this way; if not noted, the switches are assumed to be off.

LIMITS

```
1          8          16
|----------T----------T------------------------------------
|          |          |
| $        | LIMITS   | Time, Storage 1, Storage 2,
|          |          | Print Lines
|          |          |
```
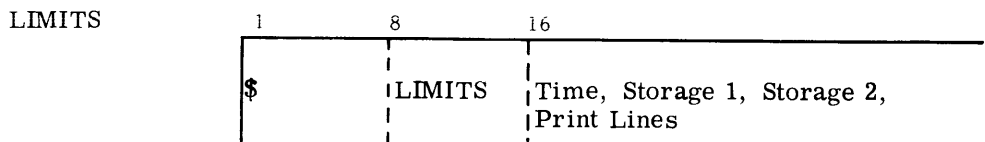
The LIMITS control card is used with each program to be executed and appears immediately behind the EXECUTE control card for that activity. The standard limits of system programs may also be modified using a LIMITS control card.

The operand field of the LIMITS control card contains four entries. The first entry specifies the maximum run time for the activity, beyond which the job is terminated. The unit of time is a decimal integer denoting hundredths of hours. If an activity calls upon a system program (such as, an object program calling SORT), this processing time must be included in the time estimate for the activity.

The second entry denotes the maximum storage requested for the running of the program. The units of storage are decimal digits representing the number of words desired. (Actual memory allocation is made in multiples of 1024 words.) The smallest request accepted by GECOS is 2048 words.

The third entry specifies the minimum storage which can accommodate the program if the maximum is unavailable at the time of memory allocation. If the minimum storage is equal to the maximum storage, the third entry may be omitted (however, the separating comma must be present).

The fourth entry specifies the maximum number of lines to be written on SYSOUT during program execution for later printing.

This control card is not required for system programs such as FORTRAN or COBOL, since their LIMITS are predefined.

In a "compile and go" or "assemble and go" operation, the LIMITS card defined for the run by the programmer should pertain only to the anticipated execution of the user's program and not to the compilation or assembly process. If an installation desires, it may define a standard set of limits which is supplied automatically by the Operating Supervisor when the LIMITS card is omitted.

ENDJOB

```
1        8        16
|        |        |
|        |        |
$       |ENDJOB  |
|        |        |
|        |        |
```
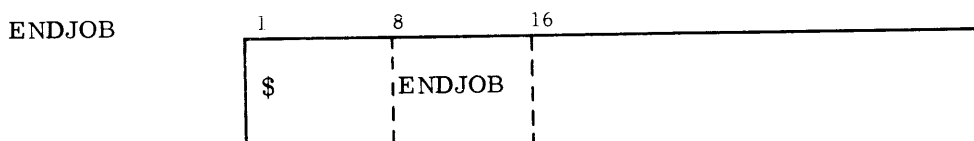
The ENDJOB control card is the last card of every job. When this card is encountered by GEIN, the job being processed becomes a candidate for allocation and execution, provided errors were not detected during processing by GEIN. If errors are detected, they are noted on the console typewriter as they occur. GEIN completes the processing and the entire job is deleted without allocation.

An example of a basic input deck is shown below:

```
$    SNUMB       00401
$    IDENT       00123, JOE SMITH, DEBUG, TEST FOR PAYROLL
$    OBJECT
     ------
     ------    }  object deck
     ------
$    DKEND
$    EXECUTE
$    LIMITS      10, 3000, , 40
$    ENDJOB
```

The LIMITS card specifies that the run will operate up to 10 hundredths of an hour, needs a maximum and minimum of 3000 decimal words of memory and has a maximum of 40 lines of printer output to be passed to SYSOUT. Note that, since the desired maximum and minimum memory are the same, the third field of the operand may be omitted so long as the field-defining comma remains.

Assembler and Compiler Call Cards

Each of the following compiler or assembler call cards offers several options pertaining to the output of either the assemble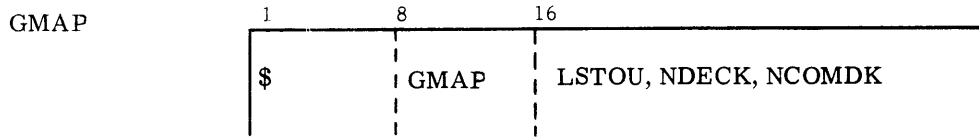r or the compilers. These options are specified with designators in the operand field of the call cards. If no designators are specified, the Operating Supervisor will assume certain standard options depending on which call card was used. The standard options may be changed by any installation. In the following discussion of each of these control cards, the standard options will be underlined.

```
GMAP              1         8        16
                  ┌─────────────────────────────────────────
                  │        │        │
                  │ $      │ GMAP   │ LSTOU, NDECK, NCOMDK
                  │        │        │
                  │        │        │
```

The GMAP control card is used to call the Macro Assembler. This control card must precede the source cards of each program or subprogram to be processed. The operand field specifies the system options and these may be listed in any desired order.

The options available with the Assembler are as follows:

LSTOU   A listing of the output will be prepared. (For a detailed discussion
             of the output listing, consult Chapter 3 of the Programming Reference
             Manual, CPB-1004A.)

NLSTOU   No listing of output will be prepared.

DECK   A binary object program deck will be prepared as output. (For a
             detailed discussion of the binary output deck, consult Chapter 3 of
             the Programming Reference Manual, CPB-1004A.)

NDECK   No binary object program deck will be prepared.

COMDK   A compressed deck of the source program will be prepared. (For a
             detailed discussion of compressed decks, consult Chapter 3 of the
             Programming Reference Manual, CPB-1004A.)

NCOMDK   No compressed source deck will be prepared.

```
FORTRAN           1         8        16
                  ┌─────────────────────────────────────────
                  │        │        │
                  │ $      │ FORTRAN│ LSTIN, NLSTOU, NDECK, NCOMDK, NSTAB
                  │        │        │
                  │        │        │
```
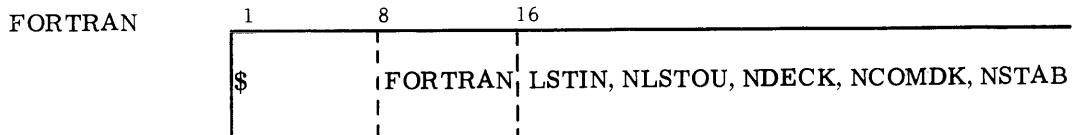
The FORTRAN control card is used to call the FORTRAN compiler. This control card must precede the source statements of each subprogram to be processed. The operand field specifies the system options. They may be listed in any desired order.

The options available with FORTRAN are as follows:

LSTIN   A listing of the input will be prepared. (For a detailed discussion of the input listing, consult the FORTRAN IV Reference Manual, CPB-1006.)

NLSTIN   No listing of the input will be prepared.

LSTOU   A listing of the output will be prepared. (For a detailed discussion of the output listing, consult the FORTRAN IV Reference Manual, CPB-1006.)

NLSTOU   No listing of output will be prepared.

DECK   A binary object program deck will be prepared. (For a detailed discussion of the binary object deck, consult Chapter 3 of the Programming Reference Manual, CPB-1004A.)

NDECK   No binary object program deck will be prepared.

COMDK   A compressed deck of the source program will be prepared. (For a detailed discussion of compressed decks, consult Chapter 3 of the Programming Reference Manual, CPB-1004A.)

NCOMDK   No compressed source deck will be prepared.

STAB   A symbol table to be used by GELOAD for DEBUG statements will be produced in the object deck. (For a detailed discussion of symbol tables, consult the General Loader Manual, CPB-1008A.)

NSTAB   No symbol table will be produced.

COBOL

1	8	16
$	COBOL	LSTIN, NLSTOU, NDECK, NCOMDK

The COBOL control card is used to call the COBOL compiler. This control card must precede the source statements of each subprogram to be processed. The operand field specifies the system options which may be listed in any desired order. The options available with COBOL are as follows:

LSTIN   A listing of input will be prepared.
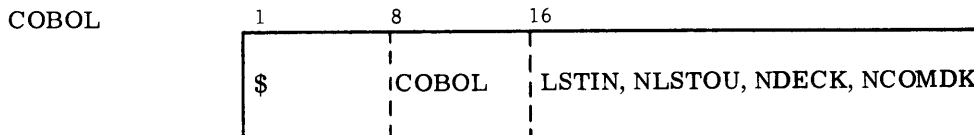
NLSTIN   No listing of input will be prepared.

LSTOU   A listing of output will be prepared. (For a detailed discussion of output listings, consult Chapter 3 of the Programming Reference Manual, CPB-1004A.)

NLSTOU   No listing of output will be prepared.

DECK	A binary object program deck will be prepared as output. (For a detailed discussion of binary decks, consult Chapter 3 of the Programming Reference Manual, CPB-1004.)
NDECK	No binary object program deck will be prepared.
COMDK	A compressed deck of the source program will be prepared. (For a detailed discussion of compressed decks, consult Chapter 3 of the Programming Reference Manual, CPB-1004.)
NCOMDK	No compressed deck of the source program will be prepared.

In the following example of an input deck, the GMAP control card does not specify any operand options. This means that the programmer is satisfied with the system standard options (an output listing only). However, on the FORTRAN control card, a listing of output, a compressed deck, and a symbol table are specified. From the STAB option, it can be assumed the FORTRAN programmer wishes to use the Loader DEBUG option at a later date.

```
$       SNUMB          00A12
$       IDENT          00174, JOE SMITH, COMPILE, PAYTEST
$       GMAP
        -----
        -----  } source cards
        -----
        -----
$       FORTRAN        LSTOU, COMDK, STAB
        -----
        -----  } source cards
        -----
$       EXECUTE
$       LIMITS         4, 2000, , 20
$       ENDJOB
```

NOTE: The LIMITS control card includes the time for the execution only, not for the assembly and compilation, since that time is predefined.

File Control Cards

File control cards define file information pertaining to a program to be executed. When calling upon a system program, such as FORTRAN or COBOL, file cards need not be included. In this situation, the file information is provided by GECOS. However, file substitution can be made in a system program for an individual run by the inclusion of a "file" card whose file code is identical to that for the file to be replaced.

Within a control sequence, file cards must follow the control card that defines the activity and precede any data cards associated with the activity. File cards associated with the execution of an object program must appear behind the EXECUTE control card for the activity.

The control field defines the <u>type</u> of unit involved.

The operand entries vary somewhat between file card types. The entries common to all file cards are described below.

<u>File Code</u> - A two character designation which is the code assigned by the programmer to uniquely identify a given file within his program. Refer to the GESERV section of this manual for a discussion of file codes.

<u>Logical Unit Designator</u> - All file control cards contain in their operand fields (in addition to a file code) a two or three character designation of the primary channel and unit assigned to the file. The first character is the symbolic channel letter. All files designated with the same type and letter are assigned to the same channel. The letter A is used to specify the first available channel of a peripheral type, the letter B for the next channel, etc. If only one type peripheral channel is present in any 625/635 system, the letter A must always be used.

The second portion of the logical unit designator is numeric and is the unit identifier. The numerals have no specific meaning except that, for any one channel, the quantity of <u>different</u> numerals is equal to the number of units to be assigned to that channel. When using tape files, identical channel and unit characters within the same activity are assumed to be multifile units.

The last character of the logical unit designator is used to indicate the disposition of the unit following execution of the current activity. It is referred to as the disposition code. The disposition code conveys the intelligence to GECOS that it needs to accomplish such things as:

1. Assigning a physical device containing a file created in a prior activity to the proper input file for the current activity.

2. Insuring that a magnetic tape file to be removed from the computer is rewound with standby so that it may not be inadvertently reallocated and written upon.

3. Allowing a magnetic tape which has been written on to be temporarily dismounted and its "write inhibit" ring pulled, the tape to be then remounted and read.

4. Informing the system when a file is to be released for use by other activities/jobs.

The specific disposition codes for magnetic tape files are described below.

Code	Meaning	Action Taken at Activity Termination
S	Save	1. No specific termination action.
		2. Assign this unit to files with the same channel unit designator in subsequent activities of this job.
C	Continue	1. Rewind using "rewind and standby".

Code	Meaning	Action Taken at Activity Termination
C	Continue (cont)	3. Inform the operator to remove the "write inhibit" ring and remount the tape.
		4. Assign this unit to files with the same channel unit designator in subsequent activities of this job.
D	Dismount	1. Rewind using "rewind and standby".
		2. Issue dismounting instructions.
		3. Assign files with the same channel unit designator in subsequent activities to any available unit.
R	Utility	1. Rewind using "rewind" instruction.
		2. Do <u>not</u> issue dismounting instructions.
		3. Make available for assignment as utility tape.

Disposition codes for non-magnetic tape files are as follows:

Code	Meaning	Action Taken at Activity Termination
S	Save	1. Assign this device to files with the same channel unit designator in subsequent activities of this job.
C	Continue	1. Do not apply to nonmagnetic tape files.
D	Dismount	2. Are interpreted as U if present.
R	Utility	1. Make available for use by another activity/job.

TAPE

	1	8	16
Symbolic Example	$	TAPE	File Code, Logical Unit Designator, Secondary Logical Unit Designator, File Serial No. , Reel Sequence No. , File Name
Actual Example	$	TAPE	AB, A1S, , 24, 0001, BIGFILE

The operand field contains, besides the file code and logical unit designator, the following entries.

Secondary Logical Unit Designator - Any non-blank combination of six or less characters. When this entry is present, a secondary unit will be assigned to the file on the same channel as the primary logical unit.

File Serial Number - (Refer to the File and Record Control Manual).

Reel Sequence Number - (Refer to the File and Record Control Manual).

File Name - Any combination of twelve or less characters which represents the literal name given to this file for external identification.

PRINTER-CARD READER-CARD PUNCH-PERFORATED TAPE-CONSOLE TYPEWRITER

	1	8	16
Symbolic Example	$	PRINT	File Code, Logical Unit Designator
Actual Example	$	PRINT	BA, A1

The control field contains one of the following words, left-justified: PRINT (High-Speed Printer), READ (Card Reader), PUNCH (Card Punch), PPT (Perforated Tape Reader/Punch), TYPE (On-line Console Typewriter).

The operand field contains the file code and logical unit designator.

The file control card for the DISC or DRUM is different from the tape file control card in that the first character of the logical unit designator is the symbolic channel-unit designator. Therefore, for a GE-625/635 with a peripheral configuration consisting of one DSU controlling four file units, the letter A is used to specify the first available channel-unit, B the second, C the third, and D the fourth. For a configuration consisting of two DSU's each controlling four file units, the letters A-H would be used.

The second portion of the logical unit designator is numeric and is the file identifier. The numerals have no specific meaning other than, for any one channel-unit, the quantity of different numerals is equal to the number of files to be assigned to that channel-unit.

There is a restriction on the use of the logical unit designator for DSU or drum files. Once a specific file has been declared a "saved" file, the designator used for that file may not be used to designate another different file within a job.

DRUM--DISC

	1	8	16
Symbolic Example	$	DISC	File Code, Logical Unit Designator, Access, Label, Status
Actual Example	$	DISC	C1, A1, 4R

Access - Linked files are designated by the number 3840-word blocks allocated to the file followed by the letter L. Random files are designated by number of 3840-word blocks allocated to the file followed by the letter R.

See GESERV chapter, page 29, for a discussion of Linked and Random files.

If the programmer wishes to access a drum or DSU file that has been allocated and saved by a previous activity of the job, he is not permitted to alter the type--link/random--or the size of the allocated file from that which was specified on the "save" file card.

Multifile DSU and DRUM files are not permitted. The following is an example of this illegal combination, both files are requested in the same activity.

    Disc AB, A1, 5L
    Disc AC, A1, 3L

NTAPE

	1	8	16
Symbolic Example	$	NTAPE	File Code, Channel Designator, Number of Tapes
Actual Example	$	NTAPE	U1, A, 3

The $ NTAPE control card requests a number of utility tapes to be assigned to the tape channel specified. File codes are assigned by GECOS, beginning with the file code specified and increasing by one (binary addition) for each tape assigned.

File Code - The first tape assigned will be given this file code; each subsequent tape will be assigned a file code equal to one (1) plus the file code of the previous tape.

Channel Designator - This entry specifies the symbolic tape channel on which the tapes are to be allocated.

Number of Tapes - This entry specifies the number of utility tapes to be allocated.

An example of an input deck using file control cards is shown below:

```
$      SNUMB                10023
$      IDENT                3001B, JOE SMITH, UPDATE DEBUG
$      OBJECT
       ------ ⎫
       ------ ⎪
       ------ ⎪
       ------ ⎬  object deck
       ------ ⎪
       ------ ⎪
       ------ ⎪
       ------ ⎭
$      DKEND
$      EXECUTE
$      LIMITS               8, 6000, , 700
$      DRUM                 A1, B4S, R4
$      TAPE                 AB,A1R,,123,1, FILEA
$      TAPE                 AC,B1R,,143,1, FILEB
$      ENDJOB
```

This example shows an object program running 8 hundredths of an hour, using 6000 words of memory and 700 lines of printer output written on SYSOUT. The files used are a permanent drum file, and two utility tapes.

```
DATA        1          8          16
            ┌──────┬───────┬──────────────────────
            │      │       │
            │  $   │  DATA │  File Code
            │      │       │
            │      │       │
```
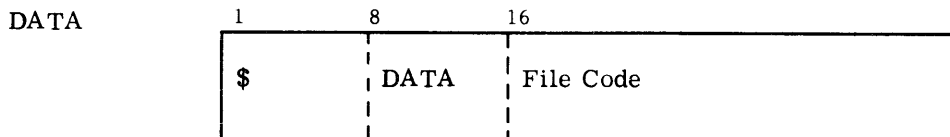
The $ DATA control card signifies that the cards or card images that follow constitute a file which will be referred to by the file code supplied in the operand field. All cards following the $ DATA control card up to the next $ control card are written onto a temporary linked drum file. Upon termination of the activity for which the file was created, the file and all references to it are removed from the computer.

The $ DATA control card may be used to place as many files as desired on the drum to be referenced at execution time. However, if the programmer does not wish to use the $ DATA control card he may let GEIN create a single data file for him by placing his data cards after all other cards of the activity. In this case the created file will be assigned file code I* automatically.

SYSOUT

```
        1        8        16
       ┌─────────┬─────────┬──────────────────────────
       │    │         │
    $  │  SYSOUT │  File Code
       │    │         │
       │    │         │
```
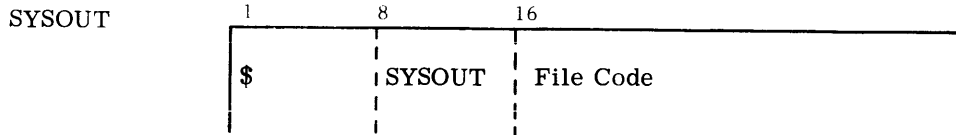
The SYSOUT control card is used to assign output files to the major system output unit
SYSOUT. This control card may be used only for files that are normally destined for printing
or punching as output files. The usual way to place output files on SYSOUT is by assigning
them to the P* file. However, for certain problems such as debugging when a normally long
output file contains only test output, the programmer may wish to avoid the time and expense
of mounting, dismounting and using additional tape handlers for short test runs. In this case
the programmer substitutes a SYSOUT control card for each file control card in his input
deck that he wishes to place on the SYSOUT unit.

An example of using $ SYSOUT and $ DATA control cards is shown below:

```
    $   SNUMB              0001A
    $   IDENT              00010, JOE SMITH, DEBUG
    $   OBJECT
        ------  ⎫
        ------  ⎬  object deck
        ------  ⎭
    $   DKEND
    $   EXECUTE
    $   LIMITS             6, 6000, , 700
    $   DATA               A2
        ------  ⎫
        ------  ⎬  data cards
        ------  ⎭
    $   SYSOUT             ZZ
    $   ENDJOB
```

The example shows a LIMITS of six hundredths of an hour, with 6000 words of core used and
700 lines of output to be written on SYSOUT. The data cards will be stored on the drum with
the file code of A2. The normal output file (ZZ) will appear on the SYSOUT file. After
debugging, the $ SYSOUT card will be replaced by a regular file control card.

Other Control Cards

SELECT

```
        1        8        16
       ┌─────────┬─────────┬──────────────────────────
       │    │         │
    $  │  SELECT │  Medium, Label
       │    │         │
       │    │         │
```
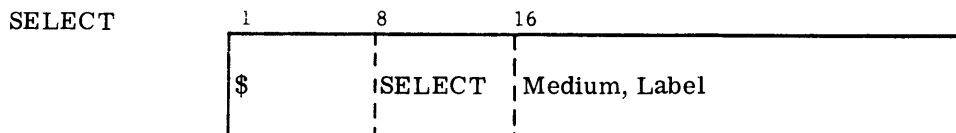
The SELECT control card is used to access programs, data and/or control cards that have
been stored on the disc or drum in standard system format. Upon detection of a SELECT

control card, GEIN (input media conversion) will immediately begin reading and interpreting card images from the file specified by the contents of the operand field. The selected file will be used in lieu of the normal input device until its end-of-file is encountered. The input source will then revert back to the normal input device and continue processing the input stream. The operand field contains two entries. The first entry is either the word DISC or DRUM. The second entry is the label identification attached to the disc or drum file when the catalog entry was made for this file by the disc or drum maintenance programs. The label operand is from one to twelve characters in length and must refer to a permanent file.

The information called from the drum may consist of any legitimate program input, including control cards. However, the programmer may change any control card by including a replacement in the input deck after the SELECT card, GEIN replaces the $ control cards called from the drum with any $ control cards in the input deck that have identical file codes.

```
$   SNUMB          0001B                    Subprogram called from the drum:
$   IDENT          00141,JOE SMITH,RUN B
$   OBJECT                                     $   OBJECT
    ------  ⎫                                      ------  ⎫
    ------  ⎬ object deck                          ------  ⎬ object deck
    ------  ⎭                                      ------  ⎭
$   DKEND                                      $   DKEND
$   EXECUTE                                    $   EXECUTE
$   LIMITS         5,4000,,100                 $   LIMITS      5,1000,,40
$   TAPE           AB,A1S,,123,1,FILEB         $   TAPE       AB,A1D,,99999
                                               $   TAPE       BB,A2D,,99999
    ------  ⎫
    ------  ⎬ data cards
    ------  ⎭
$   SELECT         DRUM,RUNTB
$   TAPE           AB,A1D,,123,1,FILEB  ⎫ These file control cards will replace
$   TAPE           BB,A2D,234,1,ENDB    ⎭ those on the drum for files AB and BB.
$   ENDJOB
```
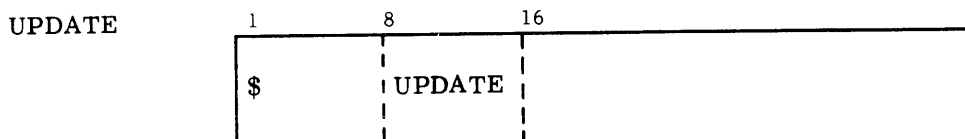
In this example, the object subprogram saves an output tape (AB) which the subprogram (RUNTB) from the drum uses as input. Output from the selected drum program (RUNTB) is saved on tape ENDB.

```
UPDATE            1        8        16
                  ┌────────┬────────┬──────────────────────────
                  │        ┆        ┆
                  │  $     ┆ UPDATE ┆
                  │        ┆        ┆
                  │        ┆        ┆
```

The UPDATE control card is used when supplying alter input to a compiler or assembler. In the input sequence for a job, the UPDATE control card and associated alter statements must follow and be contiguous to the source program to which the alter statements apply.

For a complete description of the program alteration function consult the General File and Record Control Manual, CPB-1003B.

GE-600 SERIES

An example of using the UPDATE control card follows:

```
$    SNUMB
$    IDENT
$    GMAP              LSTOU, COMDK
     ------ ⎫
     ------ ⎬
     ------ ⎬  compressed source deck
     ------ ⎬
     ------ ⎭
$    UPDATE
$    ALTER             n₁, m₁
     ------
$    ALTER             n₂, m₂
     ------
$    ALTER             n₃, m₃
     ------
$    EXECUTE
$    LIMITS
$    ENDJOB
```

The programmer may call for an updated object deck and an updated compressed source deck incorporating alter statements. This function is accomplished by specifying the DECK and COMDK options when an assembly or compilation is being processed using associated alter statements.

COMMENT

1	8	16
$	COMMENT	Any Comments

The COMMENT control card is used by the programmer to communicate to the operator through the on-line typewriter. The entire contents of columns 16-72 will be typed by GECOS immediately preceding execution of the activity in which the COMMENT cards occur. Note: This card should be used with caution. The time to type the comment could exceed the execution time of the activity. If this happened frequently the entire system could be waiting on the typewriter.

INCODE

	1	8	16	
	$	INCODE	BCD Card Code	
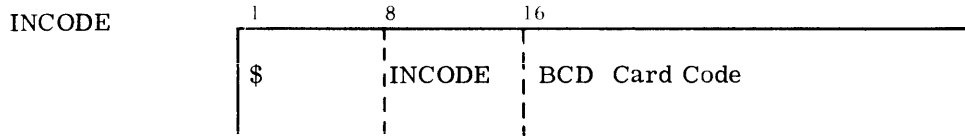
The INCODE control card indicates that the following BCD input cards must undergo character transliteration from the character set specified on the INCODE card to the internal binary representation of the GE-635 Standard Character Set. All BCD cards following the INCODE card and preceding the next control card will undergo transliteration. (See Figure 6, page 77.)

The operand field contains the mnemonic which identifies the character set used in punching the input cards. The mnemonic IBMF designates the IBM FORTRAN character set, while the mnemonic GE225 designates the GE-225 character set. The IBM Business (or EAM) character set is a subset of the GE Standard Set and hence is not an operand option.

An example of the use of the INCODE control card follows.

```
$      SNUMB
$      IDENT
$      FORTRAN
$      INCODE            IBMF
       ------  ⎫
       ------  ⎪
       ------  ⎬  source cards in IBM FORTRAN character set
       ------  ⎪
       ------  ⎭
$      EXECUTE
$      LIMITS
$      ENDJOB
```

GE·600 SERIES ———————————————————————————————— GECOS

Control Cards Used by the General Loader (GELOAD)

Many $ control cards after being recognized by GEIN as control cards are passed on in the input stream for Loader use. These Loader control cards are listed as follows:

$ OPTION
$ USE
$ ENTRY
$ EQUATE
$ LOWLOAD
$ LIBRARY
$ OBJECT
$ DKEND
$ DUMP
$ LINK

LINK

1	8	16
$	LINK	NAME
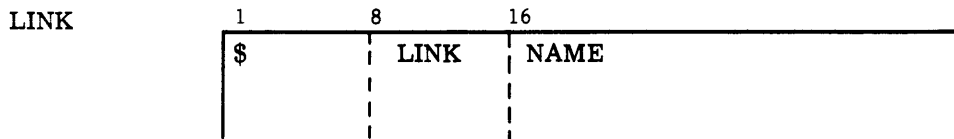
The $ LINK control card is used by the programmer for specifying overlay segments to programs. Upon recognizing a $ LINK control card, GEIN will assign a file (file code H*) upon which the Loader will save the overlay segments specified by the control card. The $ LINK control card is then passed on to the Loader input file (file code R*). The Loader uses the $ LINK cards and the overlay segment file during its execution.

A complete discussion of the Loader $ control cards and their formats may be found in the General Loader Manual, CPB-1008A.

APPENDIX

MAJOR STATUS AND SUBSTATUS CODES

With Explanations and Error Recovery Procedures

INTRODUCTION

The Status Return Pointer field of the Return Word (see page 38) indicates to the programmer the address of the two status return words which carry back information supplied by GEIOS on the termination of the current input/output request. The first of these status return words contains a Major Status field (bits 2-5) and a Substatus field (bits 6-11), which serve to identify the nature of the termination of the request.

Those status returns listed with an * in this Appendix are the only ones that a user program can expect to see in the status return words, unless it issues a Request Status (REQS) or a Reset Status (RESS) command. If the program issues an REQS or an RESS command, it must be prepared to receive any of the status/substatus conditions listed herein. No error recovery action is performed when either an REQS or an RESS is issued.

In all cases when error recovery action is taken, appropriate error statistics are typed and written on SYSOUT for later processing and statistical analysis.

Throughout this Appendix, wherever it states under "Action Taken by GEEPR" that the operator is given the option of aborting the program, this implies that he will also take any applicable action necessary to initiate servicing of the malfunctioning hardware.

CARD READER

Major Status: *Channel Ready (0000)   Substatus: None (000000)

Meaning of Status Return:

> If this status is received as an initiation interrupt in response to REQS or RESS, the card reader is ready to accept a new command.

> If this status is received as a termination interrupt, it indicates the command execution was error free and the card reader is ready to accept a new command.

Action taken by GEEPR:

> On Initiation   and Termination: Status returns are passed back to user program.

Major Status: Attention (0010)   Substatus: Hopper/Stacker Alert (XXXXX1)

Meaning of Status Return

> a) Input card hopper is empty.

> b) Output card stacker is full.

> c) Both a) and b) exist.

Action taken by GEEPR:

> On Initiation: A message is typed to the operator instructing him to place more cards in the input hopper or remove cards from the output stacker. When the attention condition has been corrected and the card reader is in "ready," the previously rejected command will be reissued.

> On Termination: The first word of the card image (columns 1-6) is scanned in memory. If this word contains the Standard End-of-File card format (***EOF in columns 1-6) an End-of-File major status (0100) is returned to the user. If the word in memory is not of this format, a Channel Ready major status (0000) is returned. If the last card read was not an End-of-File card and the program gives another card read command, this will result in an initiation interrupt. The operator will then be able to either refill the input hopper with the remainder of the input deck, or place the End-of-File card, which he previously forgot, in the input hopper resulting in an End-of-File major status being returned to the user.

CARD READER (Continued)

Major Status: Attention (0010)   Substatus: Feed Alert (XX1XXX)

Meaning of Status Return:

   A new card failed to feed from the input hopper within the prescribed time.

Action taken by GEEPR:

   On Termination: No manual backspacing is required. A message is typed to the operator giving him the following options:

   a) Take corrective action and then retry the command, or

   b) Call in a hardware test routine, or

   c) Abort the program, or initiate a rollback procedure.

Major Status: Attention (0010)   Substatus: Manual Halt (XXXX1X)

Meaning of Status Return:

   The operator has depressed the HALT switch. He must depress the OPERATE/RESET to resume normal operations.

Action taken by GEEPR:

   On Initiation: The initiation of the command will be deferred. It will be executed when a special interrupt is received as a result of the operator depressing the OPERATE/RESET switch.

CARD READER (Continued)

Major Status: Attention (0010)   Substatus: Last Batch (XXX1XX)

Meaning of Status Return:

This substatus will never be seen by the user program when GEEPR is used. It arises from one of the following conditions:

a) The input card hopper has gone empty while the LAST BATCH switch was on, or

b) While the HOPPER/STACKER ALERT switch was on, the operator depressed the LAST BATCH switch and a REQS/RESS command was issued.

Action taken by GEEPR:

On Initiation and Termination: This substatus is treated exactly as if a Hopper/Stacker Alert substatus had been received.

Major Status: Attention (0010)   Substatus: Card Jam (X1XXXX)

Meaning of Status Return:

A card's trailing edge did not arrive at a photocell within the prescribed time period after its leading edge had passed this photocell. (After about 2 seconds following detection of this condition, the C/R will begin to cycle down and power will be removed from the device.)

Action taken by GEEPR:

On Initiation: No manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

On Termination: Manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action, manually backspace the device, and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

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CARD READER (Continued)

Major Status: Attention (0010)   Substatus: Read Alert (1XXXXX)

Meaning of Status Return:

The actual time required for the card to pass through the read station was not within the acceptable time range.

Action taken by GEEPR:

On Termination: No manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

Major Status: Data Alert (0011)   Substatus: Transfer Timing Alert (00000X)

Meaning of Status Return:

The IOC did not receive (read) data characters at a rate compatible with the transfer rate of the system.

Action taken by GEEPR:

On Termination: Manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action, manually backspace the device, and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

CARD READER (Continued)

<u>Major Status:</u> *Data Alert (0011)   <u>Substatus:</u> Validity Check (000010)

Meaning of Status Return:

During a Read Card Hollerith command a character was recognized as not being a valid character (See Figure 6, General Electric Character Set). An ignore character (octal 17) is automatically stored in the memory position of the invalid character. The remainder of the card is read and stored normally.

Action taken by GEEPR:

On Termination: Data Alert major status (0011) with Validity Check substatus (000010) is passed back to the user program.

<u>Major Status:</u> End of File (0100)   <u>Substatus:</u> None (000000)

Meaning of Status Return:

The input hopper has gone empty and the last card read was an END OF FILE card. This card has the following format:

    Col. 1 2 3 4 5 6
         * * * E O F

Action taken by GEEPR:
On Termination: The End of File major status (0100) is passed back to user.

CARD READER (Continued)

Major Status: Command Reject (0101)   Substatus: None (000000)

Meaning of Status Return:

    The received command is being rejected because it is of an unacceptable configuration or has a parity error.

Action taken by GEEPR:

    On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an **EQU** card, will be 3. If recovery is not successful, the operator is given the following options:

    a)   Reissue N more times, or

    b)   Call for a hardware test routine, or

    c)   Initiate a rollback procedure, or

    d)   Abort the program.

Standard Character Set	GE-Internal Machine Code	Octal Code	Hollerith Card Code	Standard Character Set	GE-Internal Machine Code	Octal Code	Hollerith Card Code
0	00 0000	00	0	↑	10 0000	40	11-0
1	00 0001	01	1	J	10 0001	41	11-1
2	00 0010	02	2	K	10 0010	42	11-2
3	00 0011	03	3	L	10 0011	43	11-3
4	00 0100	04	4	M	10 0100	44	11-4
5	00 0101	05	5	N	10 0101	45	11-5
6	00 0110	06	6	O	10 0110	46	11-6
7	00 0111	07	7	P	10 0111	47	11-7
8	00 1000	10	8	Q	10 1000	50	11-8
9	00 1001	11	9	R	10 1001	51	11-9
Γ	00 1010	12	2-8	-	10 1010	52	11
#	00 1011	13	3-8	$	10 1011	53	11-3-8
@	00 1100	14	4-8	*	10 1100	54	11-4-8
:	00 1101	15	5-8	)	10 1101	55	11-5-8
>	00 1110	16	6-8	;	10 1110	56	11-6-8
?	00 1111	17	7-8	'	10 1111	57	11-7-8
ƀ	01 0000	20	(blank)	+	11 0000	60	12-0
A	01 0001	21	12-1	/	11 0001	61	0-1
B	01 0010	22	12-2	S	11 0010	62	0-2
C	01 0011	23	12-3	T	11 0011	63	0-3
D	01 0100	24	12-4	U	11 0100	64	0-4
E	01 0101	25	12-5	V	11 0101	65	0-5
F	01 0110	26	12-6	W	11 0110	66	0-6
G	01 0111	27	12-7	X	11 0111	67	0-7
H	01 1000	30	12-8	Y	11 1000	70	0-8
I	01 1001	31	12-9	Z	11 1001	71	0-9
&	01 1010	32	12	←	11 1010	72	0-2-8
.	01 1011	33	12-3-8	,	11 1011	73	0-3-8
]	01 1100	34	12-4-8	%	11 1100	74	0-4-8
(	01 1101	35	12-5-8	=	11 1101	75	0-5-8
<	01 1110	36	12-6-8	"	11 1110	76	0-6-8
\	01 1111	37	12-7-8	!	11 1111	77	0-7-8

Figure 6. Standard Character Set

CARD PUNCH

Major Status:* Channel Ready (0000)   Substatus: None (000000)

Meaning of Status Return:

If this status is received as an initiation interrupt in response to REQS or RESS, the card punch is ready to accept a new command.

If this status is received as a termination interrupt, it indicates the command execution was error free and the card punch is ready to accept a new command.

Action taken by GEEPR:

On Initiation   and Termination: Status Returns are passed back to user program.

Major Status: Attention (0010)   Substatus: Hopper/Stacker Alert (0XXXX1)

Meaning of Status Return:

a) Input card hopper is empty.

b) Output card stacker is full.

c) Both a) and b) exist.

Action taken by GEEPR:

On Initiation: No manual backspacing is required. A message is typed to the operator informing him of the condition. The interrupted command will be reissued as soon as the attention condition is cleared.

On Termination: This condition is ignored and GEEPR returns a Channel Ready status to the user because this I/O operation was completed normally. This attention condition will be detected as an initiation interrupt on the next I/O request to this device.

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CARD PUNCH (Continued)

Major Status: Attention (0010)   Substatus: Manual Halt (0XXX1X)

Meaning of Status Return:

The operator has depressed the "HALT" switch. He must depress the OPERATE/RESET
to resume normal operations.

Action taken by GEEPR:

On Initiation: GEEPR will resume normal operation when the attention condition is cleared.

On Termination: This condition is ignored and GEEPR returns a Channel Ready
status to the user because this I/O operation was completed normally. This attention
condition will be detected as an initiation interrupt on the next I/O request to this device.

- -

Major Status: Attention (0010)   Substatus: Chadbox Full (0XX1XX)

Meaning of Status Return:

Chad is the waste material resulting from a card being punched. When the receptacle for
these pieces of chad is full, this status is returned and the operator must empty the
chadbox before normal punching can be resumed.

Action taken by GEEPR:

On Initiation: No manual backspacing is required. A message is typed to the operator
informing him of the condition. The interrupted command will be reissued as soon
as the attention condition is cleared.

On Termination: This condition is ignored and GEEPR returns a Channel Ready
status to the user because this I/O operation was completed normally. This attention
condition will be detected as an initiation interrupt on the next I/O request to this
device.

- -

CARD PUNCH (Continued)

Major Status: Attention (0010)   Substatus: Feed Alert (0X1XXX)

Meaning of Status Return:

A card has failed to feed from the input hopper into the card punch mechanism. The card currently being punched is completed normally.

Action taken by GEEPR:

On Initiation: No manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

On Termination: This condition is ignored and GEEPR returns a Channel Ready status to the user because this I/O operation was completed normally. This attention condition will be detected as an initiation interrupt on the next I/O request to this device.

CARD PUNCH (Continued)

Major Status: Attention (0010)   Substatus: Card Jam (01XXXX)

Meaning of Status Return:

One or more cards were improperly loaded in the input hopper or a card has failed to feed at the proper time from one station to another. The card currently being punched will immediately be terminated and will not be completed normally. (After about 2 seconds following detection of this condition, the C/P will begin to cycle down and power will be removed from this peripheral.)

Action taken by GEEPR:

On Initiation: No manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

On Termination: Manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action, manually backspace the device, and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

Major Status: Data Alert (0011)   Substatus: Transfer Timing Alert (000000) or (000XX1)

Meaning of Status Return:

The IOC did not send (write) data characters at a rate compatible with the transfer rate of the system.

Action taken by GEEPR:

On Termination: Manual backspacing is required. A message is typed to the operator giving him the following options:

a) Take corrective action, manually backspace the device, and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

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CARD PUNCH (Continued)

<u>Major Status:</u> Data Alert (0011)   <u>Substatus:</u> Transmission Parity Alert (000X1X)

Meaning of Status Return:

    Incorrect parity was detected on a data character received from the IOC. This can occur
only during a "write" operation.

Action taken by GEEPR:

    On Termination: Manual backspacing is required. A message is typed to the operator
giving him the following options:

    a) Take corrective action, manually backspace the device, and then retry the command, or

    b) Call in a hardware test routine, or

    c) Abort the program, or initiate a rollback procedure.

<u>Major Status:</u> *Data Alert (0011)   <u>Substatus:</u> Punch Alert (0001XX)

Meaning of Status Return:

    A hole count of what is actually punched on the card is compared with the calculated hole
count. This status indicates the two counts do not agree.

    NOTE: Since this check is made as the card passes from the first post-punch station to
the second post-punch station at the time this error is detected, a subsequent
card will be undergoing punching.

Action taken by GEEPR:

    Data Alert status (0011) with punch alert substatus (0001XX) is returned to the user
program. The user may use his own recovery action--such as tell the operator to discard
the last two cards that were punched and then reissue the two commands or he may choose
to ignore the punch alert substatus. (See NOTE under Meaning of Status Return.)

CARD PUNCH (Continued)

<u>Major Status:</u> Command Reject (0101)   <u>Substatus:</u> None (000000)

Meaning of Status Return:

The received command is being rejected because it is of an unacceptable configuration or has a parity error.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

PERFORATED TAPE READER/PUNCH

Major Status: *Channel Ready (0000)   Substatus: Reader Plugboard No. (XXXXXX)

Meaning of Status Return:

When Channel Ready status is returned for any command addressed to the Perforated Tape Reader/Punch, the substatus field will contain the 6 bit number which has been wired into the Reader Plugboard. If no Reader Plugboard is present a $(77)_8$ substatus is sent from the peripheral.

Action taken by GEEPR:

On Initiation   and Termination: Status returns are passed back to user program.

Major Status: *Attention (0010)   Substatus: Out of Tape (0000X1)

Meaning of Status Return:

Either the punch or the reader has run out of tape, or the tape has broken. This condition can also occur if the tension is too tight between the punch head and the supply reel.

Action taken by GEEPR:

On Initiation   and Termination: Status returns are passed back to user program.

Major Status: Attention (0010)   Substatus: Manual Halt (00001X)

Meaning of Status Return:
One or more of the following switches has been actuated:
a) Manual HALT switch (both punch and reader are inoperable).
b) READER TAPE LOAD switch (only the reader is inoperable).
c) PUNCH TAPE LOAD switch (only the punch is inoperable).
d) ON/OFF LINE switch set to OFF LINE.

Action taken by GEEPR:

On Initiation and Termination: GEEPR will resume normal operation when the attention condition is cleared.

PERFORATED TAPE READER/PUNCH (Continued)

Major Status: *Data Alert (0011)   Substatus: Transfer Timing Alert (00000X)

Meaning of Status Return:

   The IOC did not send (write) or receive (read) data characters at a rate compatible with
   the transfer rate of the system.

Action taken by GEEPR:

   On Termination: Since there is no programmed method of backspacing the perforated
   tape reader/punch and since any Data Alert is a termination interrupt and has resulted in
   the movement of perforated tape, GEEPR is unable to perform any recovery for Data Alert
   conditions. GEEPR will return the status to the user program and allow him to initiate
   his own recovery action.

Major Status: *Data Alert (0011)   Substatus: Parity Alert (000X10)

Meaning of Status Return:

   A parity error has been detected on a data character being read according to the wiring
   of the PARITY HUB on the plugboard. The use of the PARITY HUB will indicate whether
   or not parity is to be checked, and whether parity is to be odd or even.

   While punching, this indicates a parity error is detected on a data character received from
   the IOC. The character in error is not punched.

Action taken by GEEPR:

   On Termination: Since there is no programmed method of backspacing the perforated
   tape reader/punch and since any Data Alert is a termination interrupt and has resulted
   in the movement of perforated tape, GEEPR is unable to perform any recovery for Data
   Alert conditions. GEEPR will return the status to the user program and allow him to
   initiate his own recovery action.

PERFORATED TAPE READER/PUNCH (Continued)

Major Status: *Data Alert (0011)   Substatus: Punch Tape Warning (0001X0)

Meaning of Status Return:

The take-up reel on the punch is full, or the input reel on the punch has about N feet of unused tape remaining. N is variable depending upon the adjustment of a sensing arm. The punch tape trailer length (N) should be standardized depending upon the maximum record length at an installation, but should never be less than 25 feet.

Action taken by GEEPR:

On Termination: Since there is no programmed method of backspacing the perforated tape reader/punch and since any Data Alert is a termination interrupt and has resulted in the movement of perforated tape, GEEPR is unable to perform any recovery for Data Alert conditions. GEEPR will return the status to the user program and allow him to initiate his own recovery action.

Major Status: *End of File (0100)   Substatus: None (000000)

Meaning of Status Return:

A character wired into the END OF FILE HUB on the reader plugboard has been detected. This character will be sent to the IOC unless it has also been wired into the DELETE HUB.

Action taken by GEEPR:

On Termination: Status Returns are passed back to user program.

PERFORATED TAPE READER/PUNCH (Continued)

Major Status: Command Reject (0101)   Substatus: Invalid Operation Code (0000X1)

Meaning of Status Return:

Either the operation code is unrecognizable or a parity error exists on the operation code.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

Major Status: Command Reject (0101)   Substatus: Invalid Device Code (00001X)

Meaning of Status Return:

Either the device code is unrecognizable (refers to the punch while the physical system contains only a reader) or there is a parity error detected on an otherwise legitimate device code.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

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PRINTER

<u>Major Status:</u> *Channel Ready (0000)   <u>Substatus:</u> None (000000)

Meaning of Status Return:

    If this status is received as an initiation interrupt in response to an REQS or RESS, the printer is ready to accept a new command.

    If this status is received as a termination interrupt, it indicates the command execution was error free and the printer is ready to accept a new command.

Action taken by GEEPR:

    On Initiation   and Termination: Status returns are passed back to user program.

<u>Major Status:</u> Attention (0010)   <u>Substatus:</u> Out of Paper (00XXX1)

Meaning of Status Return:

    This status may be caused by either the detection of torn paper or at the first top of page after the paper low condition is detected.

Action taken by GEEPR:

    On Initiation: Status returns are passed back to user program. (See page 41.)

    On Termination: This condition is ignored and GEEPR returns a Channel Ready status to the user, because this I/O operation was completed normally. This attention condition will be detected as an initiation interrupt on the next I/O request to this device.

PRINTER (Continued)

Major Status: Attention (0010)   Substatus: Manual Halt (00XX1X)

Meaning of Status Return:

    Either:

    a) The manual HALT switch has been actuated, or

    b) The POWER ON has been actuated while the printer was not in the Power On state, or

    c) The printer yoke has been raised from the print hammers.

    This condition is reset manually actuating the "OPERATE/RESET" switch.

Action taken by GEEPR:

    On Initiation   and Termination: Status returns are passed back to user program.

Major Status: Attention (0010)   Substatus: VFU Tape Alert (00X1XX)

Meaning of Status Return:

    One of the following has occurred:

    a) VFU tape horizontal parity error.

    b) VFU tape is not present.

    c) VFU tape is not properly installed.

    d) Holes are punched in both channel 5 (start automatic slew) and channel 6 (stop automatic slew) of the same vertical line position on the VFU tape.

Action taken by GEEPR:

    On Termination: Status returns are passed back to user program.

PRINTER (Continued)

Major Status: Attention (0010)   Substatus: Check (001XXX)

Meaning of Status Return:

One or more of the following has occurred:

a) Hammer driver fuse failures

b) Paper slew fuse failure

c) Incomplete printout detected because not all characters received from IOC have been printed

d) Print wheel out of sequence

Action taken by GEEPR:

On Initiation   and Termination: Status returns are passed back to user program.
(See page 41.)

Major Status: Data Alert (0011)   Substatus: Transfer Timing Alert (000011)

Meaning of Status Return:

The IOC did not send (write) data characters at a rate compatible with the transfer rate of the system. Since data transfer occurs before printing starts, transfer timing alert will always be sent with "Alert before printing began" substatus.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

PRINTER (Continued)

Major Status: Data Alert (0011)   Substatus: Alert before printing began (XXXX1X)

Meaning of Status Return:

This condition is detected when

a) Parity error is detected on a print line data character sent from the IOC.

b) Printer buffer overflow is sensed when more than 136 printable characters (including spaces) are received from the IOC before either a slew character or an end data transfer signal is received by the printer.

c) Internal parity error is detected on a character within the internal storage buffer of the printer.

d) A transfer timing alert condition exists.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

Major Status: *Data Alert (0011)   Substatus: Alert after printing began (XXX1XX)

Meaning of Status Return:

This substatus is sent when a parity error has been detected on a data character within the printer buffer and physical printing has actually been started.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program. (See page 41.)

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PRINTER (Continued)

Major Status: Data Alert (0011)   Substatus: Paper Low (XX1XXX)

Meaning of Status Return:

A program that uses GEEPR need not concern itself with this return. This substatus is sent when the printer is about to run out of paper. When this condition is sensed, between 22 and 26 inches of unused paper still remain.

Action taken by GEEPR:

On Termination: This condition is ignored and GEEPR returns a Channel Ready status to the user. At the first top of page, after the paper low condition is detected, a Device Attention - out of paper - status is detected and is passed back to the user program.

Major Status: Data Alert (0011)   Substatus: Slew Alert (X1XXXX)

Meaning of Status Return:

This substatus is sent when two top of page indications (a punch in channel 7 of the VFU tape) are sensed within a single slew operation.

Action taken by GEEPR:

On Termination: A message is typed providing the operator with the following options:

a)   Take corrective action and then retry the command, or

b)   Call for a hardware test routine, or

c)   Initiate a rollback procedure, or

d)   Abort the program.

PRINTER (Continued)

Major Status: *Data Alert (0011)　　　Substatus: Top of Page (1XXXXX)

Meaning of Status Return:

Paper is slewed to the top of page as a result of a slew command other than an explicit slew-to-top-of-page command. This is often used by a programmer to initiate the printing of page headings.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program.

Major Status: Command Reject (0101)　　Substatus: Invalid Operation Code (XXXXX1)

Meaning of Status Return:

Either the operation code is unrecognizable or a parity error exists on an otherwise legitimate operation code.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

PRINTER (Continued)

Major Status: Command Reject (0101)   Substatus: Slew Alert on last slew operation (X1XXXX)

Meaning of Status Return:

The last command resulted in a termination interrupt with Data Alert status and Slew Alert substatus.

Action taken by GEEPR:

On Termination: A message is typed informing the operator of the Alert condition, then status and substatus are returned to the user.

Major Status: * Command Reject (0101)   Substatus: Top-of-page Echo on last slew operation (1XXXXX)

Meaning of Status Return:

The last command resulted in a termination interrupt with Data Alert status and Top-of-Page substatus.

Action taken by GEEPR:

On Initiation: Status returns are passed back to user program.

MAGNETIC TAPE

Major Status: *Channel Ready (0000)   Substatus: None (000000)

Meaning of Status Return:

    If this status is received as an initiation interrupt in response to an REQS or RESS, the
    magnetic tape subsystem is ready to accept a new command.

    If this status is received as a termination interrupt, it indicates the command execution
    was error free and the magnetic tape subsystem is ready to accept a new command.

    Channel Ready major status may have no substatus or may have 1 or both of the following
    substatus conditions accompany it.

Action taken by GEEPR:

    On Initiation   and Termination: Status returns are passed back to user program.

Major Status: *Channel Ready (0000)   Substatus: Last tape handler Write Inhibited (0000X1)

Meaning of Status Return:

    The tape on the last tape unit addressed has had the "write enable" ring removed from it.

Action taken by GEEPR:

    On Initiation   and Termination: Status returns are passed back to user program.

Major Status: *Channel Ready (0000)   Substatus: Last tape handler on Load Point (00001X)

Meaning of Status Return:

    The tape on the last tape unit addressed is currently positioned at the load point (it is
    ready to read or write the first physical record on tape).

Action taken by GEEPR:

    On Initiation   and Termination: Status returns are passed back to user program.

MAGNETIC TAPE (Continued)

Major Status: Device Busy (0001)   Substatus: None (000000)

Meaning of Status Return:

This status will never be seen by a program using GEIOS. The addressed tape unit is
rewinding or, if this is a cross-barred tape system, the addressed tape unit is executing
a command from the second controller.

Action taken by GEEPR:

On Initiation: GEEPR will reinitiate the I/O action after all other requests queued for
that channel have been handled.

Major Status: Attention (0010)   Substatus: Tape Write Inhibited (0XXXX1)

Meaning of Status Return:

A write command has been addressed to a tape unit on which the tape reel does not have a
"write enable" ring.

Action taken by GEEPR:

On Initiation: No manual backspacing is required. A message is typed to the operator
giving him the following options:

a) Take corrective action and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

MAGNETIC TAPE (Continued)

<u>Major Status:</u> Attention (0010)   <u>Substatus:</u> No Such MTU (0XXX1X)

Meaning of Status Return:

    A command has been addressed to a tape unit that does not exist within the system.

    Valid logical tape unit numbers are from 0 through 15; any physical unit may be set
to any unique logical tape unit number.

Action taken by GEEPR:

    On Initiation: No manual backspacing is required. A message is typed to the operator
giving him the following options:

    a) Take corrective action and then retry the command, or

    b) Call in a hardware test routine, or

    c) Abort the program, or initiate a rollback procedure.

<u>Major Status:</u> Attention (0010)   <u>Substatus:</u> MTU Standby (0XX1XX)

Meaning of Status Return:

    The addressed tape unit is physically present but is not in the Ready state - it is in
Standby. This can be caused by:

    a) A rewind/standby command.

    b) The operator has manually put the unit in standby.

    c) A previous write operation resulted in the   Blank tape on Write   - Device Attention
        being set.

Action taken by GEEPR:

    On Initiation: No manual backspacing is required. A message is typed to the operator
giving him the following options:

    a) Take corrective action and then retry the command, or

    b) Call in a hardware test routine, or

    c) Abort the program, or initiate a rollback procedure.

    On Termination: This unrecoverable error is due to either operator error or hardware
malfunction. GEEPR will give the operator the option of calling in a hardware test routine
or aborting the program.

MAGNETIC TAPE (Continued)

Major Status: Attention (0010)   Substatus: MTU Check (0X1XXX)

Meaning of Status Return:

Some malfunction (such as broken tape) within the addressed tape unit has resulted in an inoperable condition that makes further operation physically impossible.

Action taken by GEEPR:

On Initiation: A message is typed to the operator giving him the following options:

a) Take corrective action and then retry the command, or

b) Call in a hardware test routine, or

c) Abort the program, or initiate a rollback procedure.

On Termination: This inoperable condition is caused by some hardware malfunction-- recovery is not possible. GEEPR will give the operator the option of calling in a test routine or aborting the program.

Major Status: Attention (0010)   Substatus: Blank Tape on Write (01XXXX)

Meaning of Status Return:

A write operation had actually been started on the addressed handler but the read after write check was unable to detect any characters.

Action taken by GEEPR:

On Termination: This inoperable condition is caused by some hardware malfunction-- recovery is not possible. GEEPR will give the operator the option of calling in a test routine or aborting the program.

Major Status:*Data Alert (0011)   Substatus: Transfer Timing Alert (00000X)

Meaning of Status Return:

   The IOC did not send (write) or receive (read) data characters at a rate compatible with
   the transfer rate of the system.

Action taken by GEEPR:

   On Initiation: The rejected command will be reissued N times by GEEPR. N, which is
   easily changed by an EQU card, will be 3. If recovery is not successful, the operator is
   given the following options:

   a)   Reissue N more times, or

   b)   Call for a hardware test routine, or

   c)   Initiate a rollback procedure, or

   d)   Abort the program.

Major Status:*Data Alert (0011)   Substatus: Blank Tape on Read (XXXX10)

Meaning of Status Return:

   After the receipt of a read command, 30 inches of tape has been passed over without the
   detection of any character previously being written on the tape.

Action taken by GEEPR:

   On Termination: Since this condition may be the result of either a hardware failure or
   of trying to read a new tape that has never been written on, this status/substatus is
   returned to the user program so that he may take whatever action is appropriate to his
   specific needs.

MAGNETIC TAPE (Continued)

Major Status: Data Alert (0011)   Substatus: Transmission Parity Alert (XXX1X0)

Meaning of Status Return:

   Incorrect parity was detected on a data character received from the IOC. This can occur
   only during a "write" operation.

Action taken by GEEPR:

   On Initiation: The rejected command will be reissued N times by GEEPR. N, which is
   easily changed by an EQU card, will be 3. If recovery is not successful, the operator is
   given the following options:

   a)   Reissue N more times, or

   b)   Call for a hardware test routine, or

   c)   Initiate a rollback procedure, or

   d)   Abort the program.

Major Status: *Data Alert (0011)   Substatus: Lateral Parity Alert (XX1XX0)

Meaning of Status Return:

   During a write or a read operation either a missing character is detected or lateral
   (character) parity is detected.

Action taken by GEEPR:

   See action taken for Longitudinal Parity Alert (next page).

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Major Status: *Data Alert (0011)   Substatus: Longitudinal Parity Alert (X1XXX0)

Meaning of Status Return:

   During a write or a read operation, the recorded check character does not agree with the
   calculated check character.

Action taken by GEEPR:

   On Termination:

   For Reading: When GEEPR encounters a parity error while reading, the tape is backspaced
   and the read is tried again. If after trying the read N times (N will be 10, but may be
   changed by an EQU card), a parity alert is still detected, the tape is backspaced once more
   and the record is reread with a GEEPR-created instruction having a word count of 3. If
   the DCW residue contains a number X (X ≠ 0), then the record just read was noise.

   The noise record is ignored, and with the tape now positioned beyond the noise record the
   read tape command is reissued and the following physical record is read.

   If the DCW residue contains a zero then the record just read was not noise but is a valid
   data record with parity. The tape is backspaced and the read command reissued. If
   parity still exists, after repeating the cycle N times, the operator is given the option of
   retrying another N times, or of having the status/substatus returned to the user program.
   The user program may now ignore the record or initiate his own recovery action.

   For Writing: When GEEPR encounters a parity error while writing, the tape is backspaced
   and the write is retried. This cycle is repeated N times (N will be 10, but may be changed
   by an EQU card), if still unsuccessful the tape is erased (about 9 inches) and the cycle
   retried N times. If still unsuccessful the erase is repeated for a total of 3 erases (or
   about 27 inches of tape) and the write is retried another N times. If parity still exists the
   operator is given the option of calling in a hardware test routine or aborting the program.

Major Status: *Data Alert (0011)   Substatus: End Tape Mark (1XXXX0)

Meaning of Status Return:

   During a write operation, the tape handler has detected the end-of-tape reflective foil.
   This write operation will proceed to its normal termination and any subsequent write
   commands will be executed normally. The portion of tape beyond the end-of-tape foil
   should be used only for end-of-tape labels and checkpoint memory dumps.

Action taken by GEEPR:

   On Termination: Status returns are passed back to user program.

MAGNETIC TAPE (Continued)

Major Status: Data Alert (0011)   Substatus: Bit detected during erase (XXXX11)

Meaning of Status Return:

This status is sent when a bit is detected in that portion of tape that should have been erased as the result of either an erase or a write-end-of-file command.

Action taken by GEEPR:

On Termination: The Data Alert—Bit detected during erase status/substatus is changed to a   Channel Ready   status and it is returned to the user. If there is truly a noise bit on the tape, this will be successfully handled when the tape is read (see action for Longitudinal Parity Alert).

- -

Major Status:* End of File (0100)   Substatus: Single data character ($\neq 77_8$) (XXXXXX) but not (111111)

Meaning of Status Return:

During the execution of a read, backspace or forwardspace command, a single character record accompanied by its longitudinal check character was detected. If the operation was completed with no Data Alert condition, the substatus character will be the bit configuration of the single character end-of-file record for a file written in the binary mode, or an octal 17 for a file written in the decimal mode.

NOTE: The write single character record (WFM-write file mark) can be used with files written and read only in the binary mode.

The write end-of-file (WEF) may be used with either BCD or binary files.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program.

- -

MAGNETIC TAPE (Continued)

Major Status: *End of File (0100)   Substatus: Data Alert (=77_8) (111111) |

Meaning of Status Return:

A data alert condition was detected during the reading of an end-of-file record.

NOTE: If a programmer specifies 77 as a legitimate end-of-file character, he will have no way of knowing whether a data alert condition exists or whether this is truly his special end-of-file character for files written in the binary mode.

If a file is written in the BCD mode, and the programmer uses WFM to write a special single character record, when reading his file and the end-of-file is encountered, the End-of-File major status will always be sent with an octal 77 substatus.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program.

Major Status: Command Reject (0101)   Substatus: Invalid Operation Code (0XXXX1)

Meaning of Status Return:

The operation code, although having correct parity, is not of a recognizable configuration.

Action taken by GEEPR:

On Initiation: This unrecoverable error is in the user program. There is no possible recovery action that GEEPR can take. The program is aborted and an error message is typed to inform the operator of the error condition and the action taken.

Major Status: Command Reject (0101)   Substatus: Invalid Device Code (0XXX1X)

Meaning of Status Return:

The device code, although having correct parity, is not of a recognizable configuration.

Action taken by GEEPR:

On Initiation: This error is due to a hardware malfunction. There is no possible recovery action that GEEPR can take. The program is aborted and an error message is typed to inform the operator of the error condition and the action taken.

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Major Status: Command Reject (0101)   Substatus: Parity Alert on Operation Device Code
(0XX1XX)

Meaning of Status Return:

A parity error is detected on either the operation code, the device code, or both.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

Major Status: *Command Reject (0101)   Substatus: Magnetic Tape on Load Point (0X1XXX)

Meaning of Status Return:

A backspace, write end-of-file or Erase command was issued while the tape was positioned at the load point.

NOTE: An end-of-file can be written while the tape is at load point by using a Write Single Character Record command.

Action taken by GEEPR:

On Initiation: Status returns are passed back to user program.

MAGNETIC TAPE (Continued)

Major Status: Command Reject (0101)   Substatus: Attempted Read after Write (01XXXX)

Meaning of Status Return:

A program issued a read or forwardspace instruction after a write instruction had just been issued to this tape unit with no intervening instructions.

Action taken by GEEPR:

On Initiation: This unrecoverable error is in the user program. There is no possible recovery action that GEEPR can take. The program is aborted and an error message is typed to inform the operator of the error condition and the action taken.

MAGNETIC DRUM

<u>Major Status:</u>*Channel Ready (0000)   <u>Substatus:</u> Block Address (0XXXXX)

Meaning of Status Return:

    If this status is received as an initiation interrupt in response to an REQS or RESS,   the magnetic drum is ready to accept a new command.

    If this status is received as a termination interrupt, it indicates the command execution was error free and the magnetic drum is ready to accept a new command.

    The substatus will always contain the 5 low-order bits of the block address which is a measure of the actual angular position of the drum at the instant the command was executed.

Action taken by GEEPR:

    On Initiation   and Termination: Status returns are passed back to user program.

<u>Major Status:</u> Attention (0010)   <u>Substatus:</u> None (000000)

Meaning of Status Return:

    This status indicates the magnetic drum is unable to accept an instruction because of some inoperable condition.

Action taken by GEEPR:

    On Initiation and Termination: A message is typed to the operator giving him the following options:

    a) Take corrective action and then retry the command, or

    b) Call in a hardware test routine, or

    c) Abort the program, or initiate a rollback procedure.

MAGNETIC DRUM (Continued)

Major Status: Data Alert (0011)   Substatus: Transfer Timing Alert (00000X)

Meaning of Status Return:

The IOC did not send (write) or receive (read) data characters at a rate compatible with the transfer rate of the system.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a)   Reissue N more times, or

b)   Call for a hardware test routine, or

c)   Initiate a rollback procedure, or

d)   Abort the program.

Major Status: Data Alert (0011)   Substatus: Transmission Parity Alert (0X0X10)

Meaning of Status Return:

Incorrect parity was detected on a data character received from the IOC. This can occur only during a write operation.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a)   Reissue N more times, or

b)   Call for a hardware test routine, or

c)   Initiate a rollback procedure, or

d)   Abort the program.

MAGNETIC DRUM (Continued)

Major Status: Data Alert (0011)   Substatus: Invalid Select Data (0X01X0)

Meaning of Status Return:

The start address received during the Select command operation was invalid because it specified a non-existent address.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. (N, which is easily changed by an EQU card, will be 3.) If recovery is not successful, the program will be aborted.

Major Status:*Data Alert (0011)   Substatus: Check Character Alert (010XX0)

Meaning of Status Return:

During the reading of a data block from drum, the calculated check character does not agree with the previously recorded check character.

Action taken by GEEPR:

The last command execution performed on the addressed drum resulted in an attempt to access data outside the allowable limit of the referenced file.

Major Status:*End-of-File (0100)   Substatus: None (000000)

Meaning of Status Return:

The last command execution performed on the addressed drum resulted in an attempt to access data outside the allowable limit of the referenced file.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program.

MAGNETIC DRUM (Continued)

Major Status:*End of Logical File (1111)   Substatus: None (000000)

Meaning of Status Return:

This status is not sent by hardware but is rather a GEIOS implemented return.   An
attempt was made to read past the written portion of a linked drum file.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program.

Major Status: Command Reject (0101)   Substatus: Invalid Operation Code (00XXX1)

Meaning of Status Return:

The received command is being rejected because the operation code is of an unac-
ceptable configuration.

Action taken by GEEPR:

On Initiation: This unrecoverable error is in the user program.   There is no possible
recovery action that GEEPR can take.   The program is aborted and an error message is
typed to inform the operator of the error condition and the action taken.

Major Status: Command Reject (0101)   Substatus: Invalid Device Code (00XX1X)

Meaning of Status Return:

The received command is being rejected because the device code is of an unacceptable
configuration.

Action taken by GEEPR:

On Initiation: This error is due to a hardware malfunction.   There is no possible
recovery action that GEEPR can take.   The program is aborted and an error message is
typed to inform the operator of the error condition and the action taken.

MAGNETIC DRUM (Continued)

Major Status: Command Reject (0101) Substatus: Parity Alert on Operation/Device Code
                                                (00X1XX)

Meaning of Status Return:

The received command is being rejected because a parity error has been detected on
either the operation or device code of an otherwise acceptable command.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is
easily changed by an EQU card, will be 3. If recovery is not successful, the operator is
given the following options:

a)   Reissue N more times, or

b)   Call for a hardware test routine, or

c)   Initiate a rollback procedure, or

d)   Abort the program.

Major Status: Command Reject (0101)   Substatus: Invalid Command Sequence (001XXX)

Meaning of Status Return:

The previously issued Select Drum command has not been successfully completed but a
Read Drum, Write Drum, Write Drum and Verify, or Drum Compare and Verify command
has been received that requires the successful completion of the Select Drum.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is
easily changed by an EQU card, will be 3. If recovery is not successful, the operator is
given the following options:

a)   Reissue N more times, or

b)   Call for a hardware test routine, or

c)   Initiate a rollback procedure, or

d)   Abort the program.

DISC STORAGE UNIT

__Major Status:__ *Channel Ready (0000)   __Substatus:__ None (000000)

Meaning of Status Return:

   If this status is received as an initiation interrupt in response to an REQS or RESS, the
   Disc Storage Unit is ready to accept a new command.

   If this status is received as a termination interrupt, it indicates that the command
   execution was error free and the Disc Storage Unit is ready to accept a new command.

Action taken by GEEPR:

   On Initiation   and Termination: Status returns are passed back to user program.

- -

__Major Status:__ Device Busy (0001)   __Substatus:__ Overridable (000000)

Meaning of Status Return:

   This status and the following overridable/not overridable substatuses will never be seen
   by a program using GEIOS. However, the status does mean that the addressed unit is in
   the process of executing an off-line operation.

   The Overridable substatus indicates that a Seek File command is being executed and
   this command execution may be overridden by the reception of any other Seek command.
   This substatus can only be sensed in response to an REQS or RESS.

Action taken by GEEPR:

   On Initiation: GEIOS will reinitiate the I/O action after all other requests queued for
   that channel have been handled.

- -

__Major Status:__ Device Busy (0001)   __Substatus:__ Not Overridable (000001)

Meaning of Status Return:

   The Not Overridable substatus indicates an off-line command other than a Seek is being
   executed by the addressed file unit. This command cannot be overridden by any other
   Seek command.

Action taken by GEEPR:

   See Overridable, above.
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DISC STORAGE UNIT (Continued)

<u>Major Status</u>: Attention (0010)   <u>Substatus</u>: None (000000)

Meaning of Status Return:

    The Disc Storage Unit is unable to accept an instruction because of some inoperable condition.

Action taken by GEEPR:

    On Initiation and Termination: A message is typed to the operator giving him the following options:

    a) Take corrective action and then retry the command, or

    b) Call in a hardware test routine, or

    c) Abort the program, or initiate a rollback procedure.

<u>Major Status</u>: Data Alert   (0011)   <u>Substatus</u>: Transfer Timing Alert (00000X)

Meaning of Status Return:

    The IOC did not send (write) or receive (read) data characters at a rate compatible with the transfer rate of the system.

Action taken by GEEPR:

    On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

    a) Reissue N more times, or

    b) Call for a hardware test routine, or

    c) Initiate a rollback procedure, or

    d) Abort the program.

DISC STORAGE UNIT (Continued)

Major Status: Data Alert   (0011)   Substatus: Transmission Parity Alert (0XXX10)

Meaning of Status Return:

   Incorrect parity was detected on a data character received from the IOC.   This can occur
   only during a write operation.

Action taken by GEEPR:

   On Initiation: The rejected command will be reissued N times by GEEPR. N, which is
   easily changed by an EQU card, will be 3. If recovery is not successful, the operator is
   given the following options:

   a)   Reissue N more times, or

   b)   Call for a hardware test routine, or

   c)   Initiate a rollback procedure, or

   d)   Abort the program.

Major Status: Data Alert   (0011)   Substatus: Invalid Control Character (0XX1X0)

Meaning of Status Return:

   Control characters are used to transmit the physical device address of the data to be read
   or written on disc.   Before all six control characters have been received, an end data
   transfer signal is sent by the IOC to the Disc Storage Unit.

Action taken by GEEPR:

   On Termination: This unrecoverable error is in the user program.   There is no
   possible recovery action that GEEPR can take.   The program is aborted and an error
   message is typed to inform the operator of the error condition and the action taken.

DISC STORAGE UNIT (Continued)

Major Status: Data Alert   (0011)   Substatus: Internal Alert (0X1XX0)

Meaning of Status Return:

Any one of the following can result in this substatus:

a) Parity error on character read from buffer.

b) An inconsistency in control characters.

c) An error condition is detected within one of the file units.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

Major Status: Data Alert   (0011)   Substatus: Check Character Alert (01XXX0)

Meaning of Status Return:

During the reading of a data block from disc, the calculated check character does not agree with the previously recorded check character.

Action taken by GEEPR:

On Termination: GEEPR will retry the sequence (both the seek and the following read or write) N times. N, easily changed by an EQU card, will be 3. If the alert persists, the status/substatus will be returned to the user program.

DISC STORAGE UNIT (Continued)

Major Status:* End of File (0100)   Substatus: None (000000)

Meaning of Status Return:

    The last command execution performed by the addressed Disc Storage Unit resulted in the last consecutive block being accessed.

Action taken by GEEPR:

    On Termination: Status returns are passed back to user program.

Major Status:* End of Logical File (1111)   Substatus: None (000000)

Meaning of Status Return:

    This status is not sent by hardware but is rather a GEIOS implemented return. An attempt was made to read past the written portion of a linked file unit.

Action taken by GEEPR:

    On Termination: Status returns are passed back to user program.

Major Status: Command Reject   (0101)   Substatus: Invalid Operation Code (0000X1)

Meaning of Status Return:

    The received command is being rejected because either the operation code is of an unacceptable configuration or a parity error was detected on an otherwise acceptable operation code.

Action taken by GEEPR:

    On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

    a)   Reissue N more times, or

    b)   Call for a hardware test routine, or

    c)   Initiate a rollback procedure, or

    d)   Abort the program.

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DISC STORAGE UNIT (Continued)

Major Status: Command Reject   (0101)   Substatus: Invalid Device Code (00001X)

Meaning of Status Return:

The received command is being rejected because either the device code is of an unacceptable configuration or a parity error was detected on an otherwise acceptable device code.

Action taken by GEEPR:

On Initiation: The rejected command will be reissued N times by GEEPR. N, which is easily changed by an EQU card, will be 3. If recovery is not successful, the operator is given the following options:

a) Reissue N more times, or

b) Call for a hardware test routine, or

c) Initiate a rollback procedure, or

d) Abort the program.

CONSOLE TYPEWRITER

Major Status:* Channel Ready (0000)   Substatus: None (000000)

Meaning of Status Return:

   If this status is received as an initiation interrupt in response to an REQS or RESS,
   the typewriter is ready to accept a new command.

   If this status is received as a termination interrupt, it indicates the command execution
   was error free and the card reader is ready to accept a new command.

Action taken by GEEPR:

   On Initiation   and Termination: Status returns are passed back to user program.

Major Status: Attention (0010)   Substatus: None (000000)

Meaning of Status Return:

   This status indicates the typewriter is unable to accept an instruction because of some
   inoperable condition.

Action taken by GEEPR:

   On Initiation   and Termination: The typewriter is inoperable. GEIOS will initiate
   a "Write Alarm" to the console which will cause the sounding of an audio alarm. The
   sounding of this alarm notifies the operator of the inoperable state of the typewriter.

Major Status: Data Alert (0011)   Substatus: Transfer Timing Alert (00000X)

Meaning of Status Return:

   The IOC did not receive (read) data characters at a rate compatible with the transfer
   rate of the system.

Action taken by GEEPR:

   On Termination: The command is reissued by GEEPR until it is accepted. Since the
   cause of this condition is due to a timing problem, retry will eventually correct the alert.

CONSOLE TYPEWRITER (Continued)

Major Status: Data Alert (0011)   Substatus: Transmission Parity Alert (0XXX10)

Meaning of Status Return:

    Incorrect parity was detected on a data character received from the IOC. This can
occur only during a "write" operation.

Action taken by GEEPR:

    On Termination: The command will be reissued N times. (N, easily changed by an
EQU card, will be 3). Each time the command is retried an exclamation point (!) will be
typed for that character that has a parity error and the message will be terminated. If
the situation persists, the operator can recognize that a hardware problem exists by the
frequency of exclamation points.

    If recovery is not successful, a write alarm (audio alarm) will be issued to inform the
operator of a malfunction somewhere between the IOC and the console.

Major Status: Data Alert (0011)   Substatus: Operator Input Alert (0XX1X0)

Meaning of Status Return:

    While typing a message, the operator realizes that what he has typed is in error. He
wishes to have the message ignored. By depressing the OPERATOR INPUT ERROR
button, the operator causes this status/substatus to be returned to GEEPR.

Action taken by GEEPR:

    On Termination: GEEPR will reissue the read command.

CONSOLE TYPEWRITER (Continued)

Major Status:* Data Alert (0011)   Substatus: Operator Distracted (0X1XX0)

Meaning of Status Return:

An interval of 30 seconds has elapsed between the receipt of a Read command and the first data character, or between successive characters, or between the last character to be typed and the actuation of the END OF MESSAGE button.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program.

Major Status:* Data Alert (0011)   Substatus: Incorrect Format (01XXX0)

Meaning of Status Return:

An escape character(s) is followed by a non-permissible character in a message received from the IOC to be typed; or a control character (17_8= (?), or 77_8= (!)) is not preceded by the proper number of escapes (77_8).

NOTE: In order to type a (?) or a (!) it is necessary to precede that character with two escapes.

Action taken by GEEPR:

On Termination: Status returns are passed back to user program.

Major Status: Data Alert (0011)   Substatus: Message Length Alert (100000)

Meaning of Status Return:

The operator has typed more than the number of characters specified by the DCW s referred to by the READ command.

Action taken by GEEPR:

On Termination: GEEPR will type a message to the operator requesting him to retype the message.

CONSOLE TYPEWRITER (Continued)

Major Status: Command Reject (0101)   Substatus: Invalid Operation/Device Code (000001)

Meaning of Status Return:

   The received command is being rejected because either the operation code or the device
   code (or both) is of an unacceptable configuration.

Action taken by GEEPR:

   On Initiation: This error may be in the user program.   There is no recovery action that
   GEEPR can take.   The program is aborted and a message so stating is typed to the
   operator.

Major Status: Command Reject (0101)   Substatus: Parity Alert on Operation Code (000011)

Meaning of Status Return:

   The received command is being rejected because a parity error has been detected on an
   otherwise acceptable operation code.

Action taken by GEEPR:

   On Initiation: The command is reissued N times (N, easily changed by an EQU card,
   will be 3). If recovery is not successful, a write alarm (audio alarm) will be issued
   to inform the operator of a malfunction somewhere between the IOC and the console.

GE-600 SERIES ——— GECOS

I N D E X

MME SUBROUTINES AND SYSTEM CONTROL CARDS

GENERAL ⊙ ELECTRIC
COMPUTER DEPARTMENT

GE-600 SERIES
TECHNICAL INFORMATION BULLETIN

DATE
July 1965

NO. 24

SUBJECT: Checkpoint Dump (GECHEK)

REF. GECOS
CPB-1002A

INITIALLY. C(Q) required:

0	17 18	35
L(Checkpoint File Control Block)	MBZ	
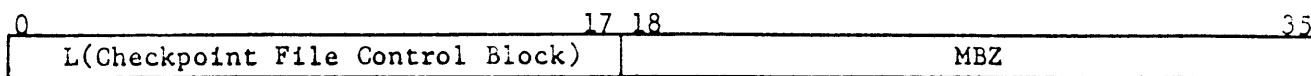
CALLING SEQUENCE

Entry	L	MME GECHEK
	L+1	TRA 1,QU
Return	L+2	Next Instruction

DESCRIPTION. A checkpoint dump is written onto the file identified by the $C(Q)_{0-17}$. This file must have previously been opened via GEFRC. When the peripheral type is magnetic tape, any number of checkpoint dumps may be written on the file along with other data. When the file specified is disc or drum, its use must be restricted to the sole purpose of checkpoint dumps. No other data may appear. Again, any number of checkpoints may be taken on a disc or drum file as each newest one will overlay any preceding dumps. Each checkpoint dump will contain sufficient information for restarting of the activity at a later time from the point at which the checkpoint occurred.

RESERVATIONS. Both the restart procedure and the rollback procedure provide file position·ing capabilities only for those files which were "open" at the time of the checkpoint and have GEFRC file control blocks associated with them. Any file which has been closed be-tween the checkpoint request and the rollback request will not be repositioned.

If a file is closed and reopened, a new checkpoint dump should be taken to maintain a complete rollback capability. A MME GECHEK may not be performed in a courtesy call.

GEFRC provides an automatic checkpoint dump at the beginning of a reel after switching tape on a multireel file. A connection exists, in this instance, with the instruction TRA 1,QU. Checkpoint and rollback will provide the address +1 of the last MME GECHEK in the upper half of the Q-Register. Upon return to the slave after rollback, this will insure a correct entry point, even if an automatic checkpoint was taken by GEFRC.

The user also has the option of providing an additional routine in the event special slave processing is required as a result of a rollback. This routine will automatically be entered if prior to the first MME GECHEK, the entry location is placed in the upper half of word 14 in the slave memory area. This location may be referenced thusly:

1	8	16
WRD14	BOOL	15

where the tag WRD14 may be used as an operand.

When using this option, the user then has the responsibility of reentering the main body of his program as he sees fit. The upper half of the Q-Register will still contain the location +1 of the last MME GECHEK taken.

RETURN CODES. After entry to the checkpoint program, certain logical checks are made. The results of these checks are passed back to the slave program in the lower half of the Q-Register.

The codes are as follows:

    Contents of lower half of Q = 0 Successful checkpoint taken

    Contents of lower half of Q = 1 File specified for checkpoint not open. No checkpoint
                       taken.

    Contents of lower half of Q = 2 Checkpoint attempted on illegal peripheral type or
                       on SYSOUT file. No checkpoint taken.

    Contents of lower half of Q = 5 Bad status return on attempted write. An incomplete
                       checkpoint dump may exist and a new checkpoint should
                       be taken.

All other registers will be set to the state they had immediately prior to the MME GECHEK, with the possible exception of AR, Index 0 and 1, and QR.

CALLING SEQUENCE

        Entry   L   MME GEROLL

DESCRIPTION. Entry to GEROLL results in an output message to the operator, requesting the operator to initiate a restart of the program. If the operator's response is <u>restart</u>, the program is restarted at the last checkpoint within the current activity if such a checkpoint exists.

The user is advised to place a checkpoint (MME GECHEK) at the start of his program; otherwise, if no checkpoint exists, the program is aborted (since GELOAD releases any library files as well as memory itself prior to any possible reinitiation of an activity).

If the operator's response is <u>no restart</u>, the program is also aborted.

When restart is attempted, positioning of magnetic tape files is accomplished using information available within the user's file control blocks at the time of the checkpoint. The positioning of linked drum and disc files is accomplished using information contained in the user's peripheral assignment table at the time of the checkpoint.

After the checkpoint recovery has taken place, control is returned to the address specified by the contents of the address field of location 14 within the user's assigned memory. If at the time a checkpoint is taken (via GECHEK) the address field of this location is zero, the checkpoint routine will place the address of the MME GECHECK plus one into this location.

Note: Following any file switch, file release, or memory release procedures, the user should issue a MME GECHEK. This will ensure that peripheral unit assignments have not been disturbed between current instruction and last checkpoint.

Any tapes or files assigned to SYSOUT (file code of P*) will not be repositioned. All other files on tape should have a standard system label. Any non-standard labeled tape files will not be repositioned and a 4 will appear in the QR after the GEROLL return to the slave program. All other rollback functions will have taken place at this point.

The rollback capability does not extend to any file not under control of GEFRC or to any unopened file.

The contents of the machine registers will be restored to the point immediately prior to the last checkpoint dump. Rollback will always take the positioning information given in the last checkpoint dump and passover to selected dumps is not possible.

If a rollback abort and slave dump occurs with the value 3 in the QR, the indication is that no checkpoint dump was taken because of an invalid File Control Block Address as input to the checkpoint program.

The attached chart refers to the Data Control Word (DCW) residue as it is

returned by the IOC at the conclusion of an I/O operation.

This chart supplements the discussion of the Status Return Word found on Pages 38-39

of GE-625/635 Comprehensive Operating Supervisor (GECOS) Reference Manual, CPB-1002A.

CONDITIONS I/O TERMINATION	DCW TYPE			WAS LAST CHARACTER TRANSMITTED PART OF LAST WORD SPECIFIED BY DCW?	WAS LAST CHARACTER TRANSMITTED THE SIXTH CHARACTER OF WORD?	IOC STATUS	DCW RESIDUE	
	IOTD	IOTP IONTP	TDCW				ADDRESS FIELD	WORD COUNT FIELD
Command not accepted by peripheral	X	X	NA	NA	NA	00	Specified address	Specified Word Count - 1
DCW word count exhausted	X	NA	NA	YES	YES	00	Last full word transferred + 1	Zero
Peripheral recognizes physical end of record or error	X			YES	YES	00	Last full word transferred + 1	Zero
		X		YES	YES	00	Specified address in next DCW (other than TDCW)	Specified word count in next DCW (other than TDCW)
	X	X		YES	NO	00	Last partial word transferred + 1	Zero
	X	X		NO	YES	00	Last full word transferred + 1	Residual word count
	X	X	NA	NO	NO	00	Last partial word transferred + 1	Residual word count (partial word counted as full word)
DCW limit check (high or low speed write, or low speed read)	X	X	X	NA	NA	60 or 70	Specified address	Specified word word count
DCW limit check (high speed read)	X	X	X	NA	NA	60 or 70	Specified address	Specified word word count - 1

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