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9 TECHNICAL REPORT T-2/342-3-10

6 SOFTWARE SUPPORT FOR A VIDEO-DIGITAL
DATA ACQUISITION SYSTEM

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Prepared for

U.S. Army Missile Command
Redstone Arsenal, Alabama 35809

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AUTHORIZATION

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I. INTRODUCTION

This manual describes the program called "SCAN" which provides software control for a Digital-Video Data Acquisition System.

SCAN is a selfcontained real-time program based on the basic instruction set provided by DGC** for the Nova-Line Computers. It was custom tailored to fit into a skeleton environment, doing its own storage, interrupt and INPUT/OUTPUT management, thereby releasing much of the core for data storage purposes. It uses none of the manufacturer's standard software, which would claim priority over parts of the core, and was built to be adaptable for a variety of acquisition modes. SCAN supports a configuration consisting of a Wang tape drive, an ASR-33 teletype equipped with a paper tape reader and punch, an EMR optical data acquisition unit and a PEP storage unit. (See Reference 2.)

Special attention was paid to the subject of user communication minimizing the need for a detailed understanding of the internal workings of the program.

**Data General Corporation.

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II. COMMUNICATION

LOGON PROCEDURE

Before the user can communicate with the computer, he must observe the following conditions:

1. The turnkey, situated in the upper left corner of the operator's console, must be in the locked position.
2. The power switch on the teletype (TTY) must be turned on.
3. The switch for the paper tape reader, situated on the left side of the teletype, must be in the off position.
4. The power switch to the computer, located in the rear, should be turned on.

After all four steps are met, in the order outlined, activating any key on the TTY will cause the program to prompt for the date, the hour and the minutes, all on a single line.

Each time a colon appears, the user should type in his answer followed by a carriage return (CR).

If, at any time, he wishes to cancel his input he should push the escape key (ESC).

The following example illustrates the format for the date. Assume that the date and time is: December 19, 1975 1:16 P.M. Note that the user's answers are underlined.

DATE: DEC 19'75 H:13 M:16

This procedure will initialize the computer clock.

Following the clock initialization, the computer will ask for the user's initials. Assume the initials are "RRI":

LOGON PLEASE:RRI

DEC 19'75 13:16 RRI

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The last line indicates that the user is now in control of the program.

LOG OFF PROCEDURE

When the user is finished with SCAN, he should type in the word 'OFF', followed by a (CR). SCAN will subsequently print out the elapsed time in seconds since his Logon. The program will then return to the idling mode and the power to the computer may be turned off.

Example:

* OFF

CPU TIME= 124 SECONDS

PROMPTING

The user communicates with the computer via the TTY. Whenever SCAN is in operation, it will issue a prompt character to indicate its readiness to accept an input. An input is defined as a character string terminated by a carriage return.

Various symbols are used by SCAN for prompting according to the mode of operation.

1. The primary prompt character is the symbol '*' and is issued when the computer is idling and ready for input. This symbol signifies that there are no pending operations, that all previous requests had been acknowledged and satisfied.

A request, following the symbol '*', will be termed a primary request.

2. The secondary prompt character is the symbol '/' and is used, primarily during the replay mode, to indicate that a primary request, which had only been partially satisfied, will be suspended until the completion of a secondary request. The new request may or may not cancel the primary one.

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At the completion of a secondary request the symbol '/' will reappear if the user's input was other than a carriage return or a TTY interrupt. (See 'Teletype Interrupt').

A TTY interrupt will cancel the primary request while a carriage return will cause its execution to be resumed.

3. A variety of other prompt symbols are used and their uses will become evident from the examples on the following pages.

In general all computer outputs followed by a colon (':') constitute prompts. For clarity, in all examples, user inputs will be underscored. Note that a (CR) is implied following each underscored entry.

Examples of prompts are:

```
* BACKUP CNT: 10
* LABEL: TEST
* REPLAY
TEST    100/REWIND/MEAN(20)=/(CR)
TEST    100/ERASE/SPLOT/#70
TEST    70/PLOT/(ESC)
* XINC(14)=12
*
```

COMMAND INPUTS

SCAN recognizes approximately 60 commands. A description of these is given in Table 1. In each command name, only the first four characters are significant but, for the purpose of clarity, any command may be extended up to 80 characters. Thus the following two statements have identical meanings:

```
* REWI
* REWIND THE TAPE.
```

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Commands will be referred to sometimes as functions or instructions.

NUMERICAL INPUTS

Whenever a numerical input is appropriate, the computer will prompt with a colon, or a label combination thereof, or it may prompt with a parenthesized number followed by an equal sign.

Numeric inputs are always considered decimal except when using the functions 'DEBUG' or 'JUMP' which, for core addresses and values representing instructions, must be octal numbers.

Numeric inputs are not checked for validity or type. Examples of some inputs are:

- * FORWARD CNT:20
- H: 12
- * JUMP: 5777
- * DELAY(200)=ZERO
- * DOCT ?19 23

VALID INPUTS

Except for interrupts, those inputs not followed by a carriage return will not be acknowledged. All command inputs are checked against the entries in Table 1 for a match. If a match is not found, the program will discard the input, report the error by ringing the bell and issue a new primary prompt. Whenever a numerical input is expected, any input will be interpreted as a valid number by SCAN. The word 'ZERO', for instance, will be interpreted as 0. (It just happens to be so.)

The computer will execute a function represented by a valid input, if there is no hardware obstacle present. In that case, it will report such an obstacle by ringing the bell and, in some cases, it will continue to do so until the obstacle is removed. The completion of a request is always reported by a new prompt. Note that a carriage return constitutes a valid input.

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TABLE - I DESCRIPTION OF FUNCTIONS

<u>NAME</u>	<u>DESCRIPTION</u>	<u>NO. OF ARGS.</u>	<u>TYPE</u>
ADD	Adds the background to the foreground. Destructive.	--	--
BACKUP	Tape control function; backspaces over a specified number of records.	1	I
BRANCH	Used in on-line programming; its argu- ment will be the user-built function name.	2	I,I
BUILD	Initiates on-line programming; its argu- ment will be the user-built function name.	1	A
CLOSE	Writes two EOF's on the tape. Must be used before removing a data tape. (EOF= End of File Mark.)	--	--
COMPLE- ment	Yields the complement of the foreground. Reversible.	--	--
DATE	Expects user to give the date and time of day; this function initializes the clock.	3	A,I,I
DEBUG	Utility function; examines and dumps core.	1	0
DOCT	Utility function; converts decimal values to octal.	1	I
DISABLE	Disables TTY interrupts. Used when Exe- cuting functions directly read from a paper tape.	--	--
DISPLAY	Displays the image in the PEP. **	--	--
ENABLE	Enables TTY interrupts.	--	--
ENHANCE	Adds the value of 'BIAS' to a selected band of intensities in the foreground. Destructive.	--	--
ERASE	Erases the image in the PEP and sets the erase flag for subsequent erasures.	--	--
EXPUNGE	Initializes the foreground to the value in 'CEXP'.	--	--
FAST	Will give continuous priming until a Vidicon related command is given.	--	--
FON	Turns on the Vidicon filament.	--	--

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TABLE - I DESCRIPTION OF FUNCTIONS (cont'd)

<u>NAME</u>	<u>DESCRIPTION</u>	<u>NO. OF ARGS.</u>	<u>TYPE</u>
FOFF	Turns off the filament.	--	--
FOLD	Sets the fold flag for the inspection routines.	--	--
FORWARD	Spaces forward over a specified number of records on tape.	--	--
FTIME	Yields the recording time, i.e. the time when the accessed frame was recorded	--	--
INCRE- MENT	Used in on-line programming; adds the value of 'VARI' to the specified variable.	1	V
GOEND	Positions the magnetic tape to the end-of-file mark.	--	--
JUMP	Directs execution to a specified location in core. Utility.	1	0
LABEL	Requests the user to type in a label or comment for recording. Maximum size = 10 characters.	1	A
LOGON	Requests the user to give his initials. Only two characters will be retained.	1	A
MERGE	Merges background with foreground. Utility routine; Destructive.	--	--
MPEP	Moves image in foreground to PEP.	--	--
MTAPE	Moves the foreground to tape.	--	--
NEXT	Effects spacing to a new line on the TTY; used when using a chain of secondary commands.	--	--
NOERASE	Inhibits PEP erasure; resets the erase flag.	--	--
NOFOLD	Inhibits folding; resets the fold flag.	--	--
NOPEP	Disables PEP-WRITE.	--	--
NOPTR	Disables the paper tape reader.	--	--
ODEC	Converts octal numbers to their decimal equivalents.	1	0
OFF	Logs off the user and gives the elapsed time.	--	--
OUTPUT	Used in on-line programming; outputs the value of a variable.	1	V
PLOT	Gives a plot of the average intensities.	--	--
PMEM	Moves the image from PEP to core.	--	--

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TABLE - I DESCRIPTION OF FUNCTIONS (cont'd)

<u>NAME</u>	<u>DESCRIPTION</u>	<u>NO. OF ARGS.</u>	<u>TYPE</u>
PROMPT	Tabulates all variables and prompts for new assignments.	--	--
PTAPE	Moves the image from PEP directly to tape; similar to the 'PME' function.	--	--
PTR	Initiates the paper tape reader.	--	--
RNUMBER	Yields a random number.	--	--
RBIAS	Reverses the sign of the variable 'BIAS'.	--	--
RECORD	Initiates recording.	--	--
REPLAY	Initiates replay of taped data.	--	--
RESET	Resets the on-line program pointer to the beginning of the reserved area.	--	--
RESTORE	Moves background into foreground.	--	--
RETURN	Cancels all requests. Same as the escape interrupt.	--	--
REWIND	Rewinds the magnetic tape.	--	--
RPLOT	Replays the data in a plotted form.	--	--
SAVE	Moves foreground into background.	--	--
SEND	Sends user's message. Size unlimited.	--	--
SPLOT	Gives both scale and plot.	--	--
SUBTRACT	Subtracts background from foreground. Destructive.	--	--
TIME	Yields the date and time.	--	--
TOPEP	Sets the PEP-WRITE flag.	--	--
UZEN	Prompts for user's message subsequently output by the function 'SEND'.	1	A
VIDEO	Will perform a scan cycle moving data into core. If the 'TOPEP' option is specified, will also move it to the PEP.	--	--
WAIT	Puts computer into idle mode for a number of seconds specified by 'TWAIT'.	--	--

*A=Alpha-numeric, I=Integer, O=Octal, V=Variable

** PEP refers to the Princeton Electronic Product Model 400 Image Storage Device (Video Graphics Storage Terminal).

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INTERROGATION

There are a number of variables to which the user may assign values. A description of these is given in Table 2.

To display, and optionally modify, the value of a variable, the user simply types in its name and returns the carriage. SCAN will then respond by returning the last assigned value, enclosed in parenthesis, followed by an equal sign which indicates that a subsequent input is required.

If now the user simply returns the carriage, the parenthesized value will be retained or else, for a character string input, the input will be interpreted as a new assignment. Note that all this takes place on a single line and only the final carriage return will effect a spacing to a new line on the TTY.

Examples:

```
* DCINT(100)=51
* MEAN(250)=(CR)
*
```

A variation of this scheme is used by the 'PROMPT' option which tabulates all variables, along with their values parenthesized, and pauses for each to obtain possible new assignments. Once the table has thus been exhausted, a primary prompt will be issued. To prematurely terminate the tabulation, the escape interrupt should be used. (See 'TELETYPE INTERRUPT' below.)

Example:

```
* PROMPT
XINC(12)=14
YINC(14)=
XPTS(70)=200
XMID(2048)=
YMID(2048)= (ESC)
*
```

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Note that the escape option was used after the value for 'YMID' was printed.

TELETYPE INTERRUPT

When the interrupt flag is on and SCAN does not expect an input but receives one, it will regard it as an interrupt.

A TTY interrupt is interpreted to be the user's desire to prematurely terminate a function execution. This action may be enabled or disabled by SCAN.

There are two conditions under which TTY interrupt action is disabled:

1. When input is expected
and
2. During the data acquisition cycle when an unintentional interrupt could cause data to be lost.

Under these situations only the activation of the escape button can cause an interrupt. This may be used to cancel an erroneous input before its termination.

When a TTY interrupt is acknowledged, the program will abort all pending execution and return the primary prompt.

The user may overwrite TTY interrupt action, whenever it would be otherwise in effect, through the use of the options 'ENABLE' and 'DISABLE'.

DEVICE INTERRUPTS

In addition to the TTY interrupt capability, an important aspect of SCAN is its interruptibility on higher levels which enables it to perform some of the data acquisition functions in parallel. (This concept is further described under the heading 'TRANSFER TO TAPE'.)

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Devices that may cause an interrupt, under program control, are: the real-time clock, the tape transport and the TTY. All of these may cause independent interrupts and will be serviced with priorities in the order mentioned.

In addition there are two software interrupts latched onto the clock, one giving the time of day and the other servicing the 'WAIT' function.

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TABLE - II VARIABLES AND THEIR USES

<u>NAME</u>	<u>DISCRIPTION</u>
XINC	Sampling increment in the horizontal direction
YINC	Sampling increment in the vertical direction.
XPTS	The number of points in a horizontal line.
YPTS	The number of points in a vertical line.
XMID	The horizontal mid-point of the matrix.
YMID	The vertical mid-point of the matrix.
	The theoretical midpoints on the Vidicon face are 2048 in both directions.
FRAM	Frame counter; designates the number of frames to be processed. During 'REPLAY' it assumes the frame number of the accessed frame.
RCNT	Gives the number of records in a frame.
TEXP	Exposure time.
TPRI	Priming time.
DCIN	Designates the 'DARK' current interval. A value of 51, for example, will cause SCAN to omit the shutter-open pulse, i.e. it will take a frame without exposure, every 50-th frame. It should always have a value one higher than the desired interval.
TERA	PEP erasure time.
YML	The vertical midpoint during a 'CALIBRATION' SCAN. A 'CALIBRATION' frame is taken right after a 'DARK' current frame and the geometry of the matrix is momentarily changed, in the vertical direction, to obtain a full range of intensities and to avoid foldover. During this time, the shutter remains closed and the filament is turned off. In the experiments, an octal value of 5750 was used.
TREP	Replay pause time; the viewing time for replayed frames.
TPAU	The pause time; important for shutter and relay operation.
DELA	The number of acquisitions necessary before recording. Established experimentally.
TWAI	Waiting time, in seconds, used in conjunction with the 'WAIT' function.
OLIM	The lower limit of the band of intensities when using the 'CONTOUR' and the 'ENHANCE' functions.
NLIM	The upper limit of the band of intensities when using the 'CONTOUR' and 'ENHANCE' functions.

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TABLE - II VARIABLES AND THEIR USES (cont'd)

<u>NAME</u>	<u>DISCRIPTION</u>										
BIAS	The bias used for enhancing.										
HERZ	Designates the frequency of the real-time clock. 'HERZ' may have four possible values:										
	<table> <tr> <th>VALUE</th><th>FREQUENCY</th></tr> <tr> <td>0</td><td>AC Line Frequency</td></tr> <tr> <td>1</td><td>10 Hz</td></tr> <tr> <td>2</td><td>100 Hz</td></tr> <tr> <td>3</td><td>1000 Hz</td></tr> </table>	VALUE	FREQUENCY	0	AC Line Frequency	1	10 Hz	2	100 Hz	3	1000 Hz
VALUE	FREQUENCY										
0	AC Line Frequency										
1	10 Hz										
2	100 Hz										
3	1000 Hz										
	In SCAN, AC Line Frequency is used.										
PWAI	Plot-Wait time; the number of seconds for viewing a plot.										
MEAN	The mean intensity of a frame; this value is updated after each plot.										
MIAV	The smallest horizontal average found in a frame; a new value is obtained after each plot.										
MXAV	The largest horizontal average found in a frame; will be updated after each plot.										
CEXP	The expunge constat; when used in conjunction with the function 'EXPUNGE', the foreground will be initialized to this value.										
YPL	The value of 'YPTS' during 'CALIBRATION'. In the experiments 200 was used.										
VARI	The increment variable; used in on-line programming, this value will be added to a specified variable when using the 'INCR' function. Its value may be negated through the use of the 'RVAR' function.										
YIL	The value of 'YINC' when taking a 'CALIBRATION' frame. In the experiments a value of 10 was used.										
SATV	Designates the intensity value considered to be the saturated value. It is used during plotting.										

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III. DIGITAL DATA ACQUISITION

As stated before, SCAN's primary purpose is to assist in the acquisition of digital data in a fairly complicated hardware environment. A detailed description of this environment is given in Reference 2.

As far as the program's operation is concerned, the following aspects of the system are of special interest.

1. Communication between SCAN and the various devices.
2. Modes of accessing and/or transmitting data.
3. Inspection and disposal of acquired data.
and
4. The coordination of these operations in a real-time environment.

The computer communicates with the hardware devices via data channels. The software in turn communicates the programmer's intentions through the use of standard instructions provided by DGC. Thus SCAN maintains a link and control over, for example, the movement of the electron beam in the Vidicon tube, or it may issue a command to turn off the filament or to initiate analog to digital conversion, etc..

Two questions arise when issuing a command to a device:

- a. Is the device ready to receive a command?; and
- b. Is the completion of a previous command a desired precondition to the issuance of a new one?

For this purpose special instructions are available which, when invoked, will return information regarding device status.

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BASIC ACQUISITION CYCLE

The following list describes the functions performed during the data acquisition cycle in chronological order. The reader is referred to Table-2 for descriptions of the names of the variables.

PRIMING

Prior to exposure, the target must be primed to erase any residual charges left behind on the Vidicon face. The time duration for priming is specified, in MSEC, by the variable 'TPRIME'.

Although the time required for a full priming cycle is only about 40 MSEC, 'TPRIME' is usually assigned a value in the neighborhood of 200. This is because 'TPRIME' is the major contributor to the repetition period when a number of frames are scanned consecutively. Also, 'TPRIME' is the dominant viewing time. That is the time during which the monitor will display intensity data acquired during the previous SCAN cycle.

Priming is initiated by the computer by issuing a single command and from then on is free-running until a new command is issued. It is monitored when a command to stop priming is issued so that the action is terminated only after an integral number of cycles.

PEP ERASURE

Next the PEP image is erased by issuing a single computer command (NIOP 36).

The action starts at the beginning of the next complete TV field and ends after two complete fields (one frame). The time allowed for this, given by 'TERASE', must be at least 50 MSEC. (See the "ERASE" option.)

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EXPOSURE

Following PEP erasure, the Vidicon target is exposed for a time duration dependent on the type of shutter used and on the variable 'TEXPOSE', using a 'DOC 34' type instruction to both initiate and terminate the process.

A slightly different sequence is used when obtaining 'DARK' frames and/or 'CALIBRATION' frames. In these two cases the shutter is kept in the closed position and in the latter case the filament will be turned off during the time specified by 'TEXPOSE'.

PAUSE

A so-called relay command determines whether the intensity input to the PEP is from the camera or the computer memory. Immediately following the shutter-close pulse, the appropriate relay command is issued and the computer will pause for a given number of MSEC, specified by 'TPAUSE', to allow for the full recovery of both the shutter mechanism and the relay.

SAMPLING

Next the computer will direct the sampling mechanism to interrogate the Vidicon face, over an area specified by the parameters 'XPTS', 'YPTS', 'XINC' and 'YINC', for intensity data which will be digitized and then transferred to core.

The sampling follows the conventional reading fashion, that is from left to right and from top to bottom, the spacings between the interrogated points being determined by the variables 'XINC' and 'YINC'.

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The rectangular matrix thus scanned is always centered at 'XMID', 'YMID', and its overall physical dimensions are 'XPTS*-XINC' by 'YPTS*YINC', while its element dimensions are 'XPTS' by 'YPTS'.

Prior to sampling a data point, SCAN will examine the status indicator of the X and Y deflection circuits and will commence sampling only after a non-busy status is returned. After a similar status check of the intensity A/D converters the digital samples, ranging in values from 0 to 255, are subsequently packed into 16-BIT computer words and stored sequentially in core.

This process requires approximately from 10 to 15 USEC per data point.

TRANSFER TO PEP

The analog intensity values accessed during sampling will be transferred simultaneously to the PEP storage unit if so requested by the user. (See the 'TOPEP' and 'NOPEP' options.).

The same parameters describing the geometry of the scanned matrix on the Vidicon face are also used to describe the gray-scale matrix on the target. Thus there is a point-by-point mapping of intensity from one device to the other. Since PEP prohibits reading and writing simultaneously, display on the monitor is postponed during this time and will take place while priming the Vidicon in preparation for a subsequent frame.

If a higher data transfer rate is desirable, and if PEP storage is of no importance, 'TERASE' may be eliminated and the user may then use the 'NOPEP' option which will inhibit data transfer to PEP.

* Symbol for Multiplication

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TRANSFER TO TAPE

Data accumulated in core will be transferred to the magnetic tape during the scanning action. That is, at a crucial point, when the core is just being replenished with fresh data, the recording action will be initiated and from then on data will be moved to tape at a constant rate from consecutive core locations.

The tape will trigger its own interrupt each time a record is written and SCAN will service the interrupt as follows:

A. It will momentarily disable the interrupt-capability of the transport, check if there is more data to be moved and, if so, point to the first location of that data, enable tape interrupt and restart the tape action.

Otherwise;

B. Tape action will remain inhibited until the next cycle.

The parallel mode of recording affords a significantly higher rate of acquisition than the sequential mode. It requires, however, a more detailed supervision, for it is possible to initiate the recording action too soon or too late. For this reason a special delay parameter was incorporated into SCAN, the value of which is established experimentally and depends on a number of parameters such as: the rate of recording, the exposure time, the geometry of the matrix, etc..

'DELAY' is a software counter specifying the number of acquisitions necessary before recording may begin.

RECORDING

Real-time recording is accomplished through the use of the 'RECORD' option. As described under the heading 'TRANSFER TO TAPE', frames are transferred to tape during the scanning action. The variable, 'FRAMES', specifying the number of frames to be recorded, is decremented after each cycle and its value becomes

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an item of the label record. See the 'RECORD FORMAT'. It is important to reinitialize the variable 'FRAMES' before each recording. Recording will halt automatically when the frame count is exhausted or it may be terminated at any time through the use of the escape option. When recording is finished the tape will remain at a position at which subsequent recording may be resumed, with perhaps a different label.

If the user issues a 'BACKSPACE' or a 'REWIND' instruction for inspection purposes, he must play back the last recorded frame, i.e. frame number 1, before further recording or else he will erase parts of the data. (An alternate way would be to issue a 'CLOSE' command and subsequently a 'GOEND' command which will result in an 'EOF' mark separating the two data blocks.) For compatibility with other systems, a 'CLOSE' command must always be issued after the final recording on a data tape.

See the 'MTAPE' function for sequential recording.

Example:

```
* LABEL:TEST1
* FRAMES (1)=500
* RECORD

12:30
*
```

TRANSFER RATE

The following parameters play a role in establishing the transfer rate:

1. The dimensions of the scanned matrix.
2. The priming time 'TPRIME'.
3. The erasure time 'TERASE'.
4. The exposure time 'TEXPOSE', and finally,
5. The pause time 'TPAUSE'.

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Usually all of these will be assigned their lowest possible values, as described earlier, except for 'TPRIME' which, by varying its value from 40 MSEC upward, is instrumental in achieving different frame rates. Assuming the frame dimensions to be 70 by 200, the total sampling time will be, approximately, 200 MSEC. If all parameters are assigned their lowest value, the frame rate will be about 3 frames/sec.

When figuring the transfer rate, there is an additional factor involved namely, the physical limitation of the transport device itself. The user has no control over this factor. According to specifications, the time required to process a data word is 56 USEC. Additional times are needed for writing interrecord gaps, which become quite significant when frames consisting of more than one record are transmitted. Also, the transport, being a physical device, requires time to gain momentum.

It is desirable, therefore, to maintain a continuous flow of data to the tape and to this end, the variable 'DELAY' must have a suitable value. This value, however, must be established experimentally.

If the need arises, it is possible to achieve transfer rates of up to 10 frames/sec, if suitable adjustments are made within the program. In that case, however, a frame is restricted to consist of a single record. Because a data word holds two intensity values, the number of data points that may be transferred this way is 8192.

SEQUENTIAL RECORDING

The memory-to-tape option, 'MTAPE', provides a convenient way for sequential recording when used in a user-built program.

'MTAPE' moves a single frame to the tape, without modifying the frame counter or other parameters present in the label record. To effect sequential operation, with a variable frame

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count in either direction, a program function, such as the one given below, may be used. See 'ON-LINE PROGRAMMING'.

Example:

```
* FRAMES(100)=1
* LABEL: TEST
* BUILD: SRECORD
1 INS: VIDEO CNT:1
2 INS: MTAPE CNT:1
3 INS: INCR PAR:FRAMES
4 INS: BRAN LBL:1 CNT:100
5 INS: (ESC)
*
* SRECORD
```

This program will transmit 100 frames to the tape with increasing frame numbers all having the label 'TEST'.

REPLAY OF TAPED DATA

Data recorded on tape may be replayed and viewed on the monitor in various ways. The user may opt to view the frames sequentially or he may choose to replay them in a plotted form. (See 'DATA PLOTTING'.). He may address individual frames, change the replay mode, analyze the data, modify it for display purposes and so on. He may call upon SCAN to perform any function while still in the replay mode and he may access information regarding individual frames.

There are two basic replay modes represented by the functions 'REPLAY' and 'RLOT' respectively.

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THE 'REPLAY' FUNCTION

This function operates as follows: when the user types in 'REPLAY', SCAN will read into core a data frame from tape and display it on the monitor. At the same time, it will print the associated label and frame number on the TTY followed by the secondary prompt '/'. It then will pause awaiting user input. The user may now direct SCAN to perform any function at the completion of which a new secondary prompt will appear allowing him to call upon yet another function. Indeed, the user may request the execution of any number of functions and SCAN will still remain in the replay mode.

If the reply to the secondary prompt is a carriage return, SCAN will pull in the next frame, display it and prompt anew. To effect a continuous uninterrupted replay, the user should type in a semicolon and from then on, until an escape interrupt or an end-of-file hit, SCAN will sequentially display each frame, without printout or request for user input. While in this mode, the parameter 'TREP' should have a suitable value for it dictates the rate of replay.

If the user wishes to access a particular frame, he must type in a number sign (#) followed by the frame number. SCAN will retrieve the frame, display it and prompt for input. Note that frames on the tape are numbered in descending order and trying to access an earlier frame this way will cause SCAN to search, without success, until an end-of-file hit. To retrieve a frame already passed during replay, the 'BACKSPACE' option should be used.

If more than one label was used on a data tape, naming a particular label will cause the program to search for it. Any input not recognized as a function name or the symbol '#', followed by a number, will be considered as a label.

In the following example, it is assumed that two blocks of data, with labels TEST 1 and TEST 2 respectively, were recorded.

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The first one consisting of 500 frames and the second of 100.

* REPLAY

TEST1 500/(CR)

TEST1 499/ERASE/SLOT/FORWARD CNT:996/ (CR)

TEST1 1/TOPEP/ (CR)

TEST2 100/PLOT/#50

TEST2 50/ (ESC)

* REPLAY

TEST2 49/REWIND/;

..END

*

THE 'RLOT' FUNCTION

This function is identical in every respect to the 'REPLAY' function except that instead of a gray-scale display an intensity plot is given on the monitor. See 'DATA PLOTTING'.

It is possible to obtain both a gray-scale picture and its average intensity plot simultaneously by specifying the 'TOPEP' option.

Examples:

* REWIND

* NOPEP

* RLOT

TEST1 500/TREP(1)=2/;

..END

*

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DATA PLOTTING

To facilitate on-the-spot analysis of data, a plot routine had been incorporated into SCAN. This routine may be invoked during actual data acquisition, during the replay of data from the tape or for setup purposes. The plot routine displays a calibrated X-Y scale and a plot, each point having an abscissa corresponding to a line number and an ordinate proportional to the average intensity of that line. Thus, in the one-dimensional display, the point closest to the ordinate represents the average intensity found over the upper-most line of the frame, the next point that of the next line, and so on.

In addition to a graphic display, the routine returns the smallest and the largest of these averages through the variables 'MIAV' and 'MXAV' respectively, and also the mean of the intensities, over the entire frame, through the variable 'MEAN'. See 'INTERROGATION'.

If at any time a predetermined number of consecutive points have a saturated value, the plot routine will alert the user by ringing the bell on the TTY.

There are two modes of assessing the plot routine.

1. 'SPLOT'

This version will return both a scale and a plot and is used when doing the 'RPLOT' version of replay. Of course, it may be used anytime separately.

2. 'PLOT'

'PLOT' returns a plot without a scale. This version is used when making comparisons between two or more plots and the scale is already displayed on the monitor.

To superimpose more plots, the 'NOERASE' option should be specified.

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Examples:

* VIDEO

* SLOT

* NOPEP

* VIDEO

* PLOT

Note that these functions operate on data already in core.

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IV. MAGNETIC TAPE CONTROL

With one exception (ERASE), a full complement of tape control capabilities has been provided. These are:

REWIND
BACKSPACE
FORWARD
REPLAY
RECORD
CLOSE
and
GOEND

Some of these functions had been described earlier. A brief description for the remainder is given below.

REWIND

A REWIND command causes the tape-head to be positioned immediately behind the BOT mark (Beginning-of-Tape Mark). This action is not interruptable and is purely under mechanical control. The rewind speed is 150 inches per second; rewinding an entire reel takes about three minutes. While rewinding a tape, tape-oriented commands will not be honored by SCAN.

Example:

* REWIND
* VIDEO

BACKSPACE

This function allows the user to BACKSPACE over a given number of records on the MAG tape.

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Example:

* REPLAY

TEST1 50/RCNT(2)=/BACKSPACE CNT:4/(CR)

TEST1 48/(ESC)

*

As explained in the section 'RECORD FORMAT', the variable 'RCNT' contains the record count for a frame. The user should use this number as a multiplier when referencing frames in this way.

FORWARD

This command is identical to the 'BACKSPACE' command except it works in the forward direction. It may be used to access frames or to pass over an EOF (End-Of-File) mark.

Example:

* FORWARD CNT:20

*

CLOSE

'CLOSE' will write two EOF marks on the tape. It may be used to separate data blocks and it must be used before releasing a data tape for consistency with other systems.

Example:

* CLOSE

* REWIND

*

GOEND

When issuing a 'GOEND' command, SCAN will search through the tape for an EOF mark. If none is found, the tape will entirely unwind itself; I.E. It will go beyond the end-of-tape

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mark, and it will have to be restarted manually.

If an EOF mark is found, tape action will stop there and, following that, the user may choose to erase the mark and continue to record beyond it. ERASURE is accomplished by simply backspacing over the file mark and proceeding from there.

Example:

- * GOEND
- * RECORD
- *

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V. ON-LINE PROGRAMMING

One of the strongest features of SCAN is that it allows the user to name and build programs which then become executable functions. In this way the user may direct SCAN to perform any group of functions in any desired order and number of times. Multiply nested loops are possible and there are no exit or entry restrictions. The only limitation is that imposed by core size. Since there are more than fifty functions, it is clear that arrangements can be made in a great many different ways.

An on-line program consists of one or more program lines preceded by line numbers. The line numbers are assigned by SCAN. There are five different line constructs possible and, to guide the user, SCAN uses special prompt symbols identifying the type of input expected.

In the descriptions that follow, the symbol 'INS' stands for instruction, 'CNT' for count, 'LBL' for label, 'VAR' for variable, 'PAR' for parameter and 'VLU' for value.

Note that all user inputs are underscored.

1. A FUNCTION LINE

The user names an executable function and specifies the number of times he wishes that function to be performed.

Example:

1 INS: VIDEO CNT: 5

This example is interpreted to mean: Perform the function 'VIDEO' five times then continue to the next line.

A user built function may not appear on a function line.

2. AN ASSIGNMENT LINE

The user types in the name of the variable and the value he wishes to assign to it. Any variable from Table 2 may

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thus be assigned a value in a program.

Example:

2 INS: XINC VLU: 12

In this example the value 12 has been assigned to the variable 'XINC'.

3. AN INCREMENT LINE

The value of any variable in Table 2 may be incremented by the amount specified in 'VARI'. If the option 'RVAR' (Reverse Variable) is used, the 'INCR' function becomes a decrement function.

For example:

3 INS: VARI VLU: 50

4 INS: INCR PAR: XMID

5 INS: RVAR CNT: 1

6 INS: INCR PAR: YMID

In this example the increment variable 'VARI' was assigned the value 50 in Line 3, 'XMID' became 'XMID' + 50 in Line 4, 'VAR' was reversed to -50 in Line 5 and 'YMID' became 'YMID' - 50 in Line 6.

4. AN OUTPUT LINE

The value of any variable may be output on TTY while executing a program.

Example:

7 INS: OUTP PAR: MEAN

The value of the parameter 'MEAN' will be output each time Line 7 is encountered during program execution. Note, however, that this value must be established through a PLOT - type function in a previous program line.

5. A BRANCH LINE

The 'BRANCH' instruction allows the user to execute program lines in groups. If a 'BRANCH' instruction points to

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a lower line number than that assigned to its own line, execution will be diverted to the line pointed to, each time the BRANCH line is encountered. The flow of execution will then again proceed towards the BRANCH line and this process will continue until the count specified is exhausted.

If, on the other hand, the user identified a higher branch target, all instructions lying between the two line numbers will be bypassed after encountering the branch line. This then is an unconditional branch to the target line regardless of the count specified. The maximum allowed value for a branch count is 255, but since multiple looping is allowed this is not a

Example:

```
7 INS: BRAN LBL: 3 CNT: 255
```

This example states: Branch to Label (or line number) 3 255 times.

A few practical examples are given below.

Example 1 :

```
*BUILD:CPLOT  
1 INS: NOPEP CNT:1  
2 INS: FON CNT:1  
3 INS: VIDEO CNT:1  
4 INS: NOERA CNT:1  
5 INS: SPLOT CNT:1  
6 INS: VIDEO CNT:1  
7 INS: PLOT CNT:1  
8 INS: OUTP PAR: MEAN  
9 INS: ERASE CNT:2  
10 INS: BRANCH LBL:3 CNT:255  
11 INS: BRAN LBL:10 CNT:255  
12 INS: (ESC)  
*  
* CPLOT
```

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This program, when invoked as a function, will do 'VIDEO' 65025 times and will display as many plots, two superimposed at a time. It also prints out the mean of each frame.

Note that the escape option was used to exit from the programming mode.

Example 2

```
* BUILD:CVIDEO
1 INS: TOPEP CNT:1
2 INS: FON CNT:1
3 INS: ERASE CNT:1
4 INS: VIDEO CNT:1
5 INS: WAIT CNT:2
6 INS: BRANCH LBL:3 CNT:100
7 INS: TIME CNT:1
8 INS: (ESC)
```

*

```
* CVIDEO
```

```
Jan 24'75 15:30
```

*

'CVIDEO' is now a function doing 100 'GRAY-SCALE' displays, at a moderate rate for convenient viewing, and, following that, prints out the time.

Example 3

```
* UZEN: THE MONITOR IS FRAMED.
* BUILD:SQUARE
1 INS: VARI VLU:50
2 INS: XPTS VLU:10
3 INS: YPTS VLU:10
4 INS: XMID VLU:700
5 INS: YMID VLU:500
6 INS: INCR PAR: YMID
7 INS: VIDEO CNT:1
```

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Example 3 (cont'd)

```
8 INS: BRAN LBL:6 CNT:68
9 INS: INCR PARL XMID
10 INS: VIDEO CNT:1
11 INS: BRAN LBL:9 CNT:64
12 INS: RVAR CNT:1
13 INS: BRAN LBL:6 CNT:2
14 INS: SEND CNT:1
15 INS: (ESC)
```

*

* SQUARE

The monitor is framed..

Example 3 demonstrates the flexibility provided by the on-line programming option. 'SQUARE' traces the periphery of a rectangle on the Vidicon and displays the intensities so obtained on the monitor.

In fact, a scheme such as this could be used to track a target through a relatively simple modification of SCAN.

Because of limited core size, the user may have no more than five such functions at any one time.

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VI. UTILITY FUNCTIONS

DEBUG

The 'DEBUG' function provides direct access to core, for modification and/or display purposes, and was intended primarily to assist the programmer. This function may be used, on the programming level, to insert breakpoints, to modify otherwise inaccessible data items, to insert patches, to dump core segments and so on.

'DEBUG' expects octal inputs.

For Example:

* DEBUG

2040(401)=(CR)

2041(777)=63077

*

JUMP

'JUMP' is another programming level function and should be used with caution. It directs execution to a specified core location and, if the address given contains a non-executable instruction, core damage will result. It can be used to force SCAN to start execution in an abnormal mode or to exit.

Example:

* JUMP ?56540

!

DOCT

This function is a decimal-to-octal conversion function.

Example:

* DOCT ?100 144

*

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ODEC

The function 'ODEC' will convert octal values to their decimal equivalents.

Example:

* ODEC ?144 100

*

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VII. INSPECTION ROUTINES

MPEP

There are a number of functions which permit data modification for inspection purposes.

The modified data may be moved to the PEP and displayed on the monitor through the 'MPEP' (Memory-To-PEP) option.

This function will unpack the 16-BIT data words in core and for each BYTE so obtained initiate digital to analog conversion, and subsequently deposit the converted data into PEP.

Since data values in core assume a position reflecting the geometry used in scanning, this geometry will be faithfully reproduced on the PEP. Therefore, if used without data modification, the sequence of instructions, 'NOPEP'-'VIDEO'-'MPEP', would essentially be the same as the sequence, 'TOPEP'-'VIDEO' except for the possible noise introduced during the additional conversion step.

The option may be used to retain multiple images on the PEP by alternately modifying the values of 'XMID' and/or 'YMID'.

To spread or to elongate an image on the PEP, or to obtain a denser image, the parameters 'XINC', 'YINC' may be changed.

Example:

```
* BUILD:DOUBLE
1 INS: NOPEP CNT:1
2 INS: XMID VLU:2048
3 INS: NOERASE CNT:1
4 INS: VIDEO CNT:1
5 INS: MPEP CNT:1
```

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Example: (cont'd)

```
6 INS: VIDEO CNT:1
7 INS: INCR PAR: XMID
8 INS: MPEP CNT:1
9 INS: WAIT CNT:3
10 INS: ERASE CNT:2
11 INS: BRANCH LBL:2 CNT:100
12 INS: (ESC)
*
* VARI(1)=500
* DOUBLE
```

This function will transfer 100 pairs of frames, all taken from the theoretical center of the Vidicon, but separated by 500 binary units on the PEP.

Note that 'VARI' was not included into the program so that it may be changed at will.

The following inspection routines are available:

CONTOUR

This function will mark the positions of a selected band of intensities in a frame. Whenever an intensity falls within specified limits, given by the parameters 'OLIM' and 'NLIM', its position will be marked by a 'WHITE' value while the background remains dark.

The function operates in the step mode, i.e., adjoining bands of intensity values will be processed successively.

After each step, 'CONT' pauses for a secondary input using the slash prompt character.

After a (CR) input, the function will proceed to the next band.

If the 'NOERASE' option is specified, one can observe how the various bands build up.

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Example:

```
* OLIM(1)= (CR)  
* NLIM(1)=20  
* CONT/(CR)/MEAN(35)=/NOERASE/(CR)/(ESC)  
*
```

In this example, three bands were displayed and the second one had a mean of 35 (its range was 20-40).

It was also specified not to erase the last two bands.

ENHANCE

The enhance function operates in a similar fashion to the contour function except, instead of a dark background, the original intensities are retained and those which fall within the band will be intensified.

The value of the variable 'BIAS' will be used for intensification.

'BIAS' may be reversed by using the function 'RBIAS'.

Example:

```
* BIAS(1)=20  
* ENHANCE/(CR)/(CR)/RBIAS/(CR)/(ESC)  
*
```

Note that both 'CONT' and 'ENHA' are destructive functions. See the 'SAVE' and 'RESTORE' options below.

SAVE

A frame may be saved in the background for later recall. Thus, there may be two images present at any one time in the core. The 'ADD' and 'SUBTRACT' functions, described later, require two frames to operate on.

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Similarly, when using a destructive function, it is advisable to retain the original through the 'SAVE' option.

Because of limited core, only frames consisting of less than 20000 points may be saved.

RESTORE

The restore function will move the data from the 'SAVE' area into the foreground.

SCAN operates only on 'FOREGROUND' data, always leaving the saved data intact, and each time the 'RESTORE' option is specified, there will be two like images present in core.

Note that, along with the intensity data, the 'SAVE' and 'RESTORE' options also move the label record.

Example:

```
* EXPUNGE VLU:50
* SAVE
* VIDEO
* ADD
*
```

In this example a bias of 50, saved in the background, was added to each point of a newly acquired frame.

See the 'EXPUNGE' and 'ADD' functions.

COMPLEMENT

The 'COMP' function returns the binary complement of each data point in a frame. It is useful, for example, in detecting small variations between two frames and in data plotting.

This is not a destructive function.

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Example:

```
* VIDEO  
* SAVE  
* VIDEO  
* COMP  
* ADD  
*
```

ADD

This function adds the frame in the background to that in the foreground. It is a word-by-word addition, that is 16 bits at a time.

The function is destructive, but if the 'FOLD' option is specified, a subsequent 'SUBTRACT' will restore the original image.

Note that the background remains intact.

'ADD' may be used, for example, to bias frames, or for calibration purposes.

SUBTRACT

'SUBT' is identical to 'ADD' except it subtracts the background from the foreground.

Both of these functions are reversible if the 'FOLD' option is specified. In that case, if a resultant intensity is not within the expressable range, it will be folded module 255. Using then the parent function, the original image will be restored.

When in the 'NOFOLD' mode, the intensities out of range will receive a saturated value, i.e., 0 or 255.

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MERGE

This function merges background and foreground the following way:

Each BYTE from the save-area will be compared to its parent BYTE in the foreground. The one with the 'DARKER' value will replace the foreground BYTE.

The function may be used, for example, to reconstruct the path of a moving target. Note that 'MERGE' is destructive.

Example:

```
* BUILD:TRACE
1 INS: VIDEO CNT:1
2 INS: SAVE CNT:1
3 INS: VIDEO CNT:1
4 INS: MERGE CNT:1
5 INS: BRANCH LBL:2 CNT:50
6 INS: (ESC)
*
* TRACE
```

The function 'TRACE' will merge 50 frames, each frame adding additional information to the saved area.

A subsequent 'RESTORE' will yield the composite result. A 'WAIT' function could be used for a different 'TRACE'-rate.

PMEM

The PEP-TO-MEMORY function remains for the moment a software complement, but once the necessary hardware adjustments are made, its usefulness will be significant.

It is programmed to work as follows:

The PEP storage area is interrogated, over a given geometry, for intensity values and these values will be first passed through an A/D converter and then packed into 16-BIT data words in core.

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The process is, therefore, identical to the one used in scanning with the PEP playing the role of the Vidicon.

Since the PEP has a relatively large storage surface, 'PMEM', in conjunction with 'MPEP', offers a convenient way for storing.

In addition, it allows data to be processed, which may have been acquired through means other than through the Vidicon.

As a software unit, the 'PMEM' function was tested and is operational.

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VIII. PAPER TAPE OPERATION

Provisions were made in SCAN for loading of programs from paper tapes. The user is referred to Reference 1 for information concerning the TTY reader and punch.

On-line programs may be pre-punched on a paper tape and later read into core for execution by SCAN through the use of the 'PTR' option.

A program so built may contain only user inputs separated by carriage returns.

Once the program is read in , it may be accessed by its function name.

The last instruction, on a paper tape, should be the 'NOPTR' instruction to inhibit the reader after the program is loaded.

Example 1, from the section 'ON-LINE PROGRAMMING', for instance, would look like this on a paper tape:

```
BUILD  
CPLOT  
NOPEP  
1  
FON  
1  
VIDEO  
1  
NOERA  
1  
SPLOT  
1  
VIDEO  
1  
PLOT  
1  
OUTP  
MEAN  
ERASE
```

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```
2  
BRANCH  
3  
255  
BRAN  
10  
255  
(ESC)  
NOPEP
```

Specifying 'PTR', with the tape properly mounted, will cause SCAN to read in all words, including the 'NOPEP' instruction, which will turn off the reader. The function 'CPLOT' is then in CORE ready for use.

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IX. RECORD FORMAT

Dependent on its size, each frame may contain up to ten records. The first 44 words of the first record contain user supplied information and constitute the 'LABEL RECORD'. The rest of the frame contains intensity data, each BYTE representing a count ranging in value from 0 to 255.

The number of BYTES in a frame, representing data, is equal to the product of the parameters 'XPTS' and 'YPTS'.

In a frame with N records, the first record, if it is not also the last, consists of 4096 words which is the largest possible size for any record.

The remaining N-1 records will have a size of 4052 words, and the last record will vary in size.

Note that a 'WORD' here means 16 BITS.

The following table describes the items in the 'LABEL RECORD'. Under the designation 'TYPE', a means alphanumeric and I means integer. Places left blank are for future expansion.

<u>WORD #</u>	<u>ITEM</u>	<u>DESCRIPTION</u>	<u>TYPE</u>
1-8	—	Label or Comment	A
9	XINC	Horizontal Increment	I
10	YINC	Vertical Increment	I
11	XPTS	The Number of Horizontal Points	I
12	YPTS	The Number of Vertical Points	I
13	FRAM	Frame Count	I
14	TEXP	Exposure Time	I

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RECORD FORMAT (cont'd)

<u>WORD #</u>	<u>ITEM</u>	<u>DESCRIPTION</u>	<u>TYPE</u>
15	TPRI	Priming Time	I
16	XMID	Horizontal Mid-Point	I
17	YMID	Vertical Mid-Point	I
18	DCIN	Dark Current Interval	I
19	RCNT	The Number of Records in a a Frame	I
20	—	Hour when Frame was Recorded	I
21	—	Minutes when Frame was Recorded	I
22-27	—	—	—
28-35	FTIM	Frame Time and Date	A
36	—	Users Initials	A
37-44	—	—	—

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X. THE EXECUTIVE

Because the DGC utility routines are large and operate on a dedicated basis, for the configuration available, a special executive program had been written to save and retrieve programs from a magnetic tape.

Under most circumstances, the executive may reside in core and may be accessed, via the 'JUMP' function, by SCAN.

The executive provides the following capabilities:

1. Saving of core images on tape.
2. Moving saved programs into core for execution.
3. Listing of saved programs.
and
4. Deleting of saved programs.

SAVING

The user specifies the name, the starting address in core, the size and the entry point.

Example:

!SAVE SCAN

ADDR:0

CNT:5777

ENTRY:75

Note that the prompt character for the executive is the exclamation mark.

RESTORING

To move a program into core for execution, the user types in the word 'RUN' followed by the name of the program.

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Example:

!RUN SCAN

*

The program will then start execution at the designated entry point.

LISTING

To list saved programs, the user types in the word 'LIST' followed by a carriage return. (To list a specified program, the word should be followed by the programs name).

The executive will print a heading and underneath that the associated information established during a previous save. In the example, it is assumed that two programs were saved on the program tape.

Example:

!LIST

<u>NAME</u>	<u>ADDR</u>	<u>CNT</u>	<u>ENTRY</u>
SCAN	0	5777	75
RRI	20	7777	3

DELETE

To delete a saved program, the user specifies 'DELETE' followed by the program name.

Example:

!DELETE SCAN

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XI. MEMORY LAYOUT

The total core available is 24K. SCAN occupies the first six K and it has fixed boundaries.

The remainder of the core is subdivided into segments as depicted in Fig. 1.

Segments, designated as dynamic, have variable boundaries each lower section having priority preference over the remainder of the core. The 'ON-LINE PROGRAMS' segment, for instance, may extend into the foreground, the foreground into the save area and, the save area into the executive and loader.

Before core damage could result, however, SCAN will alert the user by sending the message: 'SZER..' (Size Error..), except when using a utility function.

FIG. 1 CORE LAYOUT

SCAN PROGRAM STATIC	ON-LINE PROGRAMS DYNAMIC	FORE- GROUND DYNAMIC	SAVE AREA DYNAMIC	EXECUTIVE & UTILITY STATIC	DGC LOADER STATIC
6K	16K			2K	
—LOW END OF CORE					
HIGH END OF CORE—					

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XII. PROGRAM LOADING

Since the NOVA-820 for which SCAN was written does not have the hardware memory protection feature, SCAN must carry the burden of protecting all core segments containing programs, I.E. the segments designated as 'STATIC' in FIG. 1. Such a 'SOFTWARE-PROTECTION' is never fool-proof and, on rare occasions, due to a sequence of inputs not anticipated by the programmer, CORE damage may result. (see the 'UTILITY FUNCTIONS'). CORE damage will manifest itself in erratic responses to inputs and, in general, SCAN will not be able to recover and will, therefore, have to be reloaded. If the user does not reload SCAN when damage is first evidenced, the damage may further extend into the executive and the loader in which case those programs too will have to be reloaded. (The EXECUTIVE and SCAN are saved on separate magnetic tapes marked 'EXEC' and 'SCAN' respectively. The Binary Loader is on a paper tape marked 'EXEC-LOAD'.)

To reload SCAN from the magnetic tape, follow these steps:

1. Press Stop.
2. Turn the turnkey to the on position.
3. Mount the magnetic tape marked 'SCAN'.
4. Set the data switches to 056540 (OCTAL).
5. Press Start.

An exclamation mark (!) should now appear on the TTY provided that the executive was intact. If so, reload SCAN according to the steps outlined under the heading 'RESTORING' in the section: 'THE EXECUTIVE'.

If the prompt character does not appear, follow the steps below:

6. Place the paper tape marked 'EXEC-LOAD' in the TTY reader and turn the reader on.
7. Press Reset.
8. Set the data switches to 000010 (OCTAL).
9. Press Program Load.

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This procedure will reload the DGC loader and a special program needed to reload the executive from the magnetic tape.

To reload the executive, follow this procedure:

10. Replace the tape marked 'SCAN' by one marked 'EXEC'.
11. Press Reset.
12. Set the data switches to 023000 (OCTAL).
13. Press Start.

An exclamation mark will now appear, indicating that the executive is in core. Remount the tape marked 'SCAN' and follow the steps described in the section: 'THE EXECUTIVE'.

REMARKS

The SCAN routine is operational and has served in the collection of large amounts of data.

Certain features, however, though quite useful as they stand, have not been developed to their fullest extent.

The 'ON-LINE PROGRAMING' function, for instance, could be extended to allow relational and logical expressions as well as logical and arithmetic if statements.

The basic SCAN too, could be modified to allow for real-time decision making and feedback.

The program was structured with a view to such possible extensions.

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XII. REFERENCES

1. "How to Use the Nova Computers," Data General Corporation.
2. D. Porter, "Digital Acquisition System for Image Data,"
RRI Technical Report T-3/342-3-10, June 1976.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This manual describes the program called "SCAN" which provides software control for a Digital-Video Acquisition System. SCAN is a selfcontained real-time program based on the basic instruction set provided by DGC** for the Nova-Line Computers. It was custom tailored to fit into a skeleton envi- (over)		

ronment, doing its own storage, interrupt and INPUT/OUTPUT management, thereby releasing much of the core for data storage purposes. It uses none of the manufacturer's standard software, which would claim priority over parts of the core, and was built to be adaptable for a variety of acquisition modes. SCAN supports a configuration consisting of a Wang tape drive, an ASR-33 teletype equipped with a paper tape reader and punch, an EMR optical data acquisition unit and a PEP storage unit. (See Reference 2.)

Special attention was paid to the subject of user communication minimizing the need for a detailed understanding of the internal workings of the program.