NBSIR 74-453

(See NBSIR 73-235, Instruction Manual, Volume II)

Field Service Test Model: Computer-Controlled U System. Operations Manual and Software Operating System Appendices for the Automated System. Volume I.

K. M. Gray
J. R. Ellis

Institute for Computer Sciences and Technology
National Bureau of Standards
Washington, D. C. 20234

January 1973

Instruction Manual

Prepared for
Department of the Air Force
HQ – USAF (AFTAC/TAP)
Patrick A.F.B., Florida 32925

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U.S. GOVERNMENT
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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

CONTENTS

1. INTRODUCTION
   1.1 General
   1.2 Requirements
   1.3 Hardware Description
   1.4 Basic Data Flow
   1.5 Basic Software Organization
   1.6 Operating System

2. E$INT - System Initialization Program
   2.1 Functional Description
      2.1.1 E:ANF - System Start/Restart Point
   2.2 Called Subroutine
   2.3 Input Parameter Descriptions
   2.4 Output Parameter Descriptions
   2.5 Internal Data Descriptions
   2.6 Program Flow Chart

3. E$SKD - System Scheduler
   3.1 Functional Description
      3.1.1 E:SKD - System Scheduler
      3.1.2 E:BSK - Background Task Scheduler
   3.2 Called Subroutines
   3.3 Data Formats
   3.4 Input Parameter Descriptions
   3.5 Output Parameter Descriptions
   3.6 Internal Data Descriptions
   3.7 Program Flow Chart

4. E$TSI - Time Slicing Interrupt Program
   4.1 Functional Description
      4.1.1 E:TSI - Time Slicing Interrupt Service Routine
      4.1.2 B:IOR - Background IO Request Routine
   4.2 Called Subroutines
   4.3 Input Parameter Descriptions
   4.4 Output Parameter Descriptions
   4.5 Program Flow Chart

5. E$CLK - System Clock
   5.1 Functional Descriptions
      5.1.1 E:SEC - One Second Timing Interrupt Service Routine
      5.1.2 E:MIN - One Minute Timing Interrupt Service Routine
   5.2 Called Subroutines
   5.3 Data Formats
   5.4 Input Parameter Descriptions
   5.5 Output Parameter Descriptions
   5.6 Internal Data Descriptions
   5.7 Program Flow Chart

6. E$UIN - U Data Input Program
    6.1 Functional Description
        6.1.1 E:ANL - AIS SI Interrupt Routine
        6.1.2 E:UIN - U Data Preprocessing Routine
        6.1.3 E:MIT - IOIS Digital Output Routine
    6.2 Data Formats
        6.2.1 AIS Input Data
        6.2.2 Sensor Parameter Control Output via IOIS
        6.2.3 DOY/TOD Input from WTC via IOIS
        6.2.4 Amplitude Values
        6.2.5 Phase Values
        6.2.6 Blanking Rate Values
    6.3 Input Parameter Descriptions
    6.4 Output Parameter Descriptions
    6.5 Internal Data Descriptions
    6.6 Program Flow Chart

7. E$SUB - System Monitor Subroutines
    7.1 Functional Description
        7.1.1 E:PWD - Power Loss Interrupt Service Routine
        7.1.2 E:PWU - Power Restored Interrupt Service Routine
        7.1.3 E:PAR - Memory Parity Error Interrupt Service Routine
        7.1.4 E:ABR - Console Interrupt Service Routine
        7.1.5 B:ORT - Background Task Abortion Routine
    7.2 Called Subroutines
    7.3 Input Parameter Descriptions
    7.4 Output Parameter Descriptions
    7.5 Internal Data Descriptions
    7.6 Program Flow Chart

FIELD SERVICE TEST MODEL: COMPUTER-CONTROLLED U SYSTEM

OPERATIONS MANUAL AND SOFTWARE OPERATING SYSTEM APPENDICES FOR THE AUTOMATED SYSTEM

VOLUME I

1. INTRODUCTION

Volume I of the "Automated U System" describes the software listings and the operator's manual. This volume is intended to instruct the station technician in the procedure to load programs and operate, under computer control, the automated U system. Other manuals describe the system and the technical design and are contained in the following manuals:

Volume II. Field Service Test Model: Computer-Controlled U System. Operations Manual and Software Operating System Appendices for the Automated System.

Field Service Test Model: Computer-Controlled U System. Manual for Receiver and ADACS Interface Chassis.

Field Service Test Model: Computer-Controlled U System. Manual for Test Unit.

Field Service Test Model: Computer-Controlled U System. Manual for Computer Subsystem.

Field Service Test Model: Computer-Controlled U System. Manual for System.

Certain commercial equipment and materials are identified in this paper in order to adequately specify the components used. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that the material or equipment identified is necessarily the best available for the purpose.

1.1 General.

The New-U Service Test Model is the termination of a development project aimed at automating the U sensor functions. IBM completed initial algorithm definition on the IBM Model 360/75 computer for batch mode operations in April 1968. These programs covered the three sensors of the proposed K technique; U, Z2, and H. In February 1969, a Scientific Control Corporation Model 660 computer was procured to permit the processing of data from the three sensors in real time. When the necessity to process data from all three sensors simultaneously was removed during the following year, a new Baseline Configuration was defined specifying simultaneous processing of the U and Z2 sensor data, but separate processing for the H sensor. In February 1970, the programs to implement this Baseline Configuration were completed and the system demonstrated. Post-baseline efforts concentrated on the U sensor alone. By September 1970, processing algorithms had been refined and experiments conducted to demonstrate the ability of the system to operate for extended periods of time without operator intervention. All efforts to that time had concentrated on the use of the current sensor

hardware. By December 1970, the National Bureau of Standards and Computer Science Corporation (under contract to the USAF) had developed an experimental sensor front end with response characteristics far surpassing those of the current equipment. The cost of using such new equipment was prohibitive, so effort was redirected toward modifying the existing equipment to permit faster response. By June 1971, this experiment was completed and alternative Service Test Model configurations were defined. Due to the higher cost involved with the greater processing load necessary for the faster response configuration, the decision was made to use the standard outputs of the current sensor. The test model would handle fourteen channels of U sensor data simultaneously with one processor. Procurement specifications for the digital computer to be used in the Operational Service Test were completed in May 1972. The contract was ultimately awarded to Modular Computer Systems Corporation for their MODCOMP III/5 digital computer with all necessary interface equipment and peripheral devices. The Processor was delivered to the Fort Belvoir experimental station in Virginia in mid-September, followed by the interface to the first two sensor channels within a few weeks. The software package, including both the Real-Time Operating System (ROS) and the applications programs (both foreground and background), was named NUSTAD (New U System of Totally Automated

Design). The skeleton of the ROS was on-line by mid-October. By the final week in November, the ROS was completed and the preliminary check-out of the applications programs was near completion. The system was then shipped to McClellan AFB, CA where the remaining twelve sensor channels were interfaced and the first part of the Operational Service Test would be performed. Program check-out by the programming staff was completed during the last week of January 1973, and the system was turned over to the 1155th TOS to begin formal system evaluation/prior to sending the system to a remote overseas location for a nine month evaluation of system performance under actual field conditions.

This document fully describes the programming associated with NUSTAD. The information contained herein should be sufficient to permit full understanding of the software operations and functions.

1.2 Requirements.

The primary goal of automating the U sensor functions was to reduce manpower. To meet this goal, NUSTAD was required to perform the following operations:

a. Read sensor data in real-time at a rate consistent with processing algorithm requirements.

b. Provide feedback control of the various parameters associated with the sensor as necessary to maintain sensor operations at an optimal level.

c. Perform waveform analysis of sensor data to recognize all signals of interest.

d. Monitor the status of sensor and interface equipment to recognize changes which affect processing operations and respond accordingly.

e. Maintain a station log of all status changes, parameter changes, and signals of interest, as well as periodic reports as required to evaluate sensor channel reliability. Also, generate report messages suitable for transmission over standard communications lines.

f. Provide display and format checking functions to validate or review data from the DRFUD (Digital Recorder For U Data) data tapes. This will permit the use of existing equipment for bulk data storage independent of processor operations.

In addition to reducing manpower, the New U system will permit standardization of reporting methods, more effective utilization of existing equipment, and an extended useful life for current sensor equipment.

1.3 Hardware Description.

The MODCOMP III/5 is the basic model of the MODCOMP III line. The III/5 used for the Service Test Model has the following characteristics:

a. Central Processing Unit

1. Fifteen general purpose registers, all available for use as accumulators, seven available as index registers.

2. 800 nanosecond cycle time.

3. 167 instructions including bit, byte, and word manipulation. (See Appendix V for complete instruction lists).

4. Hardware multiply/divide instructions.

5. Multi-level priority interrupt scheme.

b. Memory

1. 32, 768 words (16 bits) directly addressable, in four modules.

2. Memory parity (even parity) for each byte of memory.

c. Analog Input Subsystem

1. 48 channels multiplexed through a dedicated Direct Memory Processor (DMP) channel.

2. Input range of 0 to +10 volts.

3. Input in 11 bits plus sign.

d. Digital Input/Output Interface Subsystem

1. 15 basic (16 bit) digital input channels, plus 8 (16 bit) digital input channels on the channel extender.

2. 16 (16 bit) output channels.

3. 8 user defined external interrupts.

e. Peripheral devices

1. ASR 35 Teletype (ASCII).

2. ASR 28 Teletype (BAUDOT), configured for receive only operation.

3. Chalco 600 character/second paper tape reader.

4. Wang 45 ips magnetic tape unit.

The sensor is the standard EECO 881M Phase tracking receiver with modifications as described in an as yet unpublished NBS manual. The ADACS (Automatic Data Analysis and Control System) interface unit is described in another as yet unpublished manual. The following list includes documents useful in understanding the software development:

310-103000-000	MODCOMP III Reference Manual
310-600101	MODCOMP Assembler Reference Manual
220-600500-000	MODCOMP Program Descriptions-Utility Programs
210-600301-000	MODCOMP MAX I Reference Manual

220-341000	MODCOMP Tech Manual-Input/Output Interface Subsystem 1100
220-311000-001	MODCOMP Tech Manual-Analog Input Subsystem 1200/1500

1.4 Basic Data Flow

The essential elements of NUSTAD can be defined with respect to the systems hardware components through Figure 1.1. These elements are shown as they are related by the information flow among them.

Each U channel has the following input and output data for the processor:

a. Three analog input channels. One each for Amplitude, Phase, and Blanking Percentage.

b. One digital input channel to supply the processor with the channel's frequency and cardioid settings, and the channel's ADACS INE, Maintenance, and AUTO/MANUAL conditions.

c. One digital output channel supplying the receiver with the current RF gain, tracking rate, and blanking level data, and the phase shift control bit.

The World Time Clock (WTC) supplies the following timing information to the processor:

a. BCD (Binary Coded Decimal) time, with a three digit Day of Year (DOY) and a six digit Time of Day (TOD).

b. One per second and one per minute time pulses to drive the interrupts used by the system clock routine.

c. Ten per second timing pulses to drive the time slicing program used to segment time for background tasks.

The ASR 35 is used as the primary operator/system communications device. It is the means by which the operator requests the various program options and supplies information necessary for the processing of the DRFUD data tapes.

The ASR 28 is used to maintain the station log. All messages or reports of any historical value are printed here. A five-level paper tape is also punched, permitting the automatic preparation of data messages for later transmission over standard communications channels.

DRFUD tapes are recorded concurrent to on-line processing by a modified DRFUD unit for each eight U sensor channels. The tapes are played back into the system from the Wang tape drive, using background tasks requested by the operator.

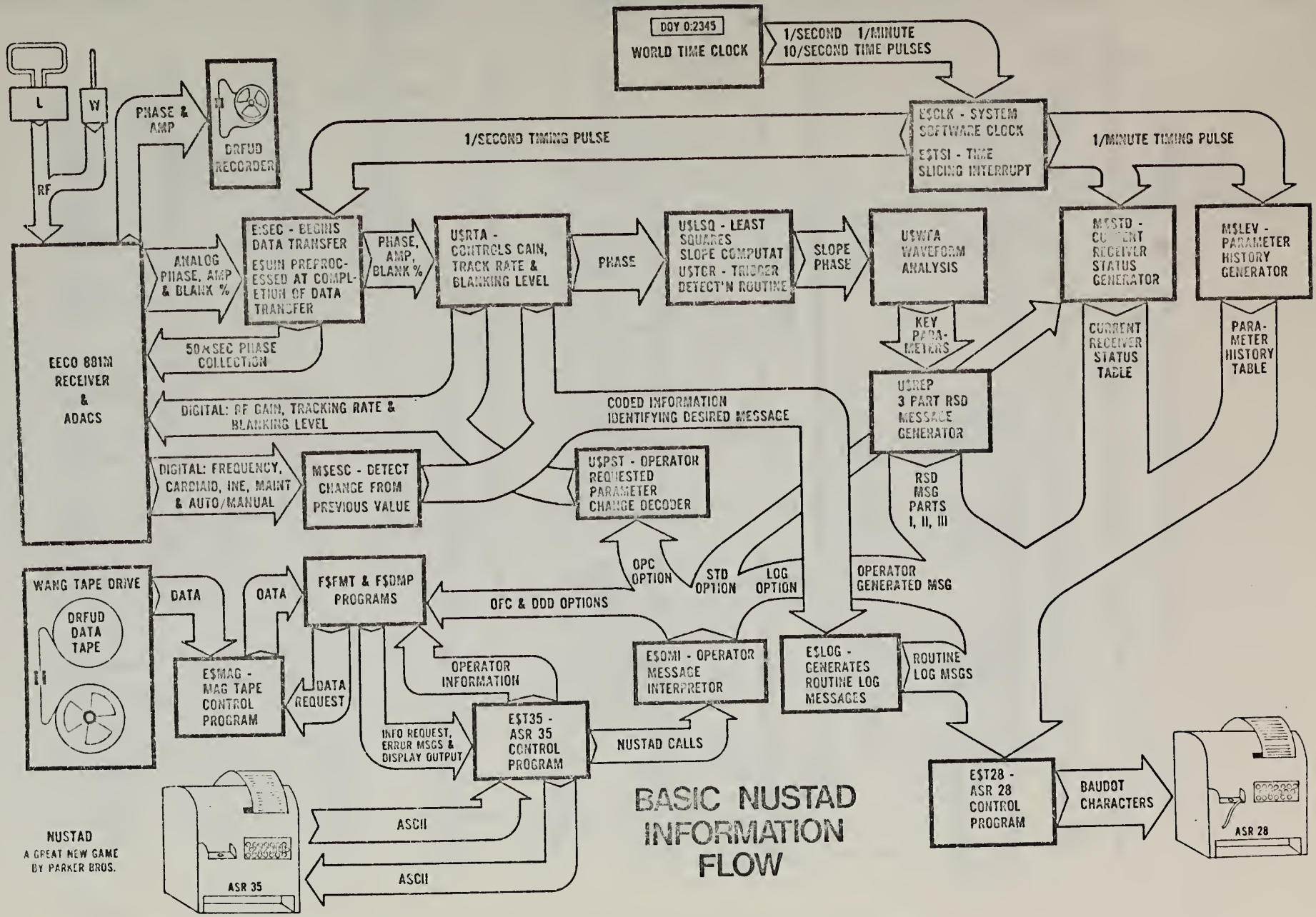

DOY 0:2345
WORLD TIME CLOCK
1/SECOND 1/MINUTE
10/SECOND TIME PULSES
L
W
RF
PHASE & AMP
DRFUD RECORDER
1/SECOND TIMING PULSE
E$CLK - SYSTEM SOFTWARE CLOCK
E$TSI - TIME SLICING INTERRUPT
1/MINUTE TIMING PULSE
EECO 881M RECEIVER & ADACS
ANALOG PHASE, AMP & BLANK %
E:SEC - BEGINS DATA TRANSFER
E$UIN PREPROC-ESSED AT COMPL-ETION OF DATA TRANSFER
PHASE, AMP, BLANK %
U$RTA - CONTROLS GAIN, TRACK RATE & BLANKING LEVEL
PHASE
U$LSQ - LEAST SQUARES SLOPE COMPUTAT U$TCR - TRIGGER DETECT'N ROUTINE
SLOPE PHASE
U$WFA WAVEFORM ANALYSIS
M$STD - CURRENT RECEIVER STATUS GENERATOR
M$LEV - PARAMETER HISTORY GENERATOR
50 μSEC PHASE COLLECTION
KEY PARA-METERS
CURRENT RECEIVER STATUS TABLE
PARA-METER HISTORY TABLE
DIGITAL: RF GAIN, TRACKING RATE & BLANKING LEVEL
CODED INFORMATION IDENTIFYING DESIRED MESSAGE
U$REP 3 PART RSD MESSAGE GENERATOR
DIGITAL: FREQUENCY, CARDIAID, INE, MAINT & AUTO/MANUAL
M$ESC - DETECT CHANGE FROM PREVIOUS VALUE
U$PST - OPERATOR REQUESTED PARAMETER CHANGE DECODER
RSD MSG PARTS I, II, III
OPC OPTION
STD OPTION
LOG OPTION
OPERATOR GENERATED MSG
WANG TAPE DRIVE
DRFUD DATA TAPE
DATA
OATA
F$FMT & F$DMP PROGRAMS
OFC & DDD OPTIONS
E$MAG - MAG TAPE CONTROL PROGRAM
DATA REQUEST
OPERATOR INFORMATION
E$OMI - OPERATOR MESSAGE INTERPRETOR
E$LOG - GENERATES ROUTINE LOG MESSAGES
ROUTINE LOG MSGS
INFO REQUEST, ERROR MSGS & DISPLAY OUTPUT
E$T35 - ASR 35 CONTROL PROGRAM
NUSTAD CALLS
E$T28 - ASR 28 CONTROL PROGRAM
BAUDOT CHARACTERS
ASR 28
ASR 35
ASCII
ASCII
NUSTAD
A GREAT NEW GAME BY PARKER BROS.
BASIC NUSTAD INFORMATION FLOW

Figure 1.1 displays the relationship among the various IO signals and the individual programs using them. This diagram shows the relationship among programs on the basis of data flow, while Figure 1.2 shows how the programs are related by transfer of program control.

1.5 Basic Software Organization.

Linkages among the various programs are more easily understood by recognizing the naming conventions used for symbolic labels.

a. First character - The first character of a symbolic label tells to which basic function that particular label is associated:

1. E - used to identify operating system and executive support functions.

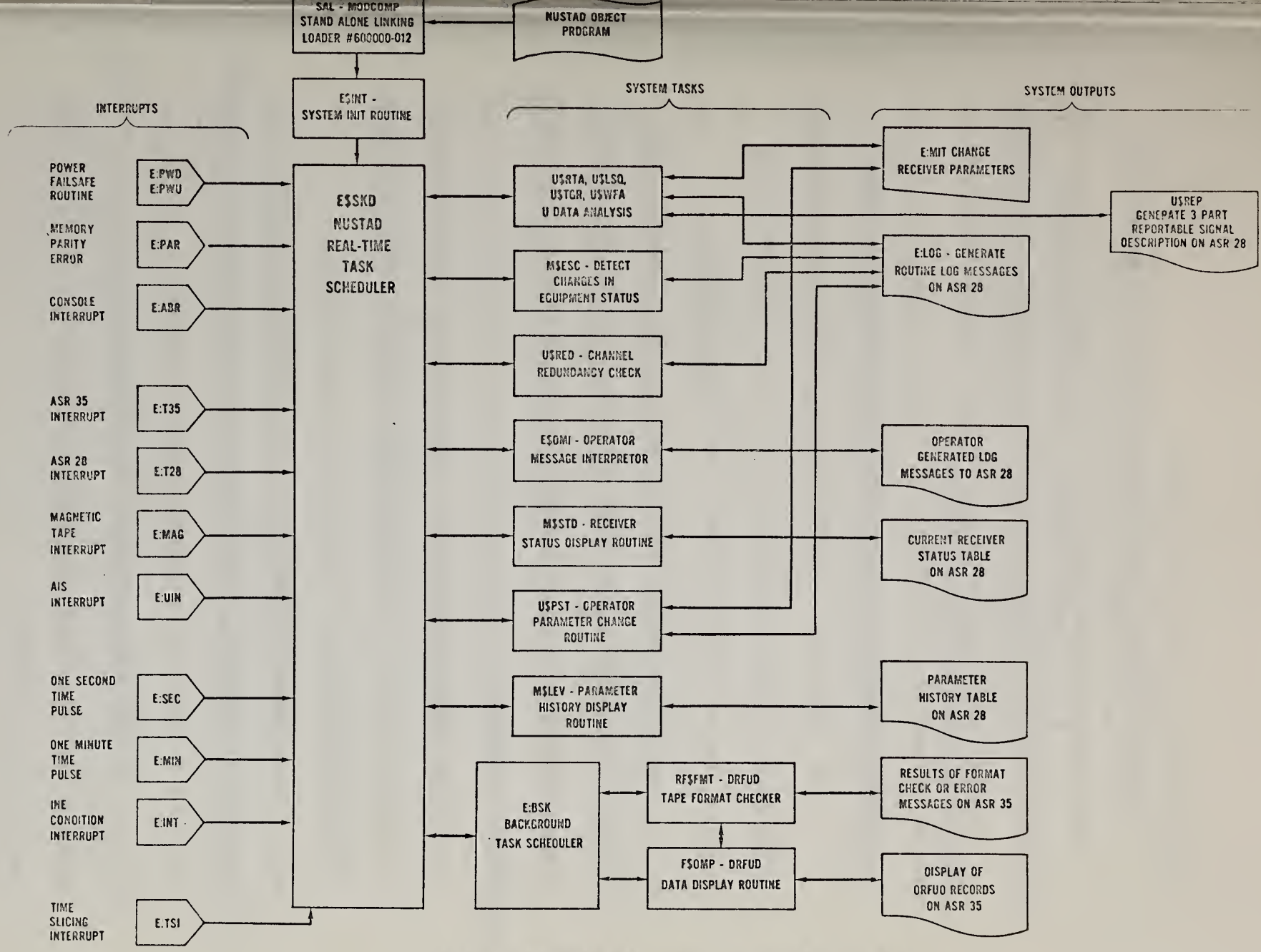
2. B - used to identify functions associated with background tasks other than DRFUD routines.

3. M - used to identify functions related to system status monitoring.

4. U and W - used to denote functions directly related to the U data analysis functions.

5. F - used to identify functions associated with background DRFUD operations.

b. Second character - The second character of the label



BASIC NUSTAD ORGANIZATION

indicates how the label is to be used:

1. $ - used to denote a program name.

2. : - used to indicate a program entry point.

3. . - used to specify a parameter location used in another program (an external linkage).

NUSTAD programs may be considered of five basic types:

a. Real-Time Operating System (ROS) - those programs which control system resources; e.g., the interrupt servicing routines, the peripheral handlers, and the schedulers.

b. Executive Support Programs - which perform utility functions generally needed by the applications programs, such as reformatting time or phase values into output format, computing the square root, etc.

c. Monitor Programs - which sense and report changes in hardware status and provide historic records needed to evaluate channel reliability.

d. U Analysis Programs - the primary applications programs of NUSTAD. These programs provide automatic parameter control and real-time waveform analysis of U data.

e. DRFUD Programs - These applications programs execute in the background level to provide some analysis of off-line U data recorded by the DRFUD.

The interaction among the programs of NUSTAD is shown schematically in Figure 1.2. The various tasks associated with the system's mission are scheduled in response to external interrupts. As these tasks execute, they use executive support functions to generate the system's output. The scheduler is the heart of the ROS and NUSTAD as all program control is made through this program, including entry into the background state.

1.6 Operating System.

All NUSTAD programs are coded in the assembly language of the MODCOMP III computer, and are assembled under the manufacturer's MAX I batch oriented operating system. The programs are loaded using the manufacturer's Stand Alone Linking Loader (SAL, MODCOMP No. 600000-012). After loading, control is assumed by NUSTAD's ROS. NUSTAD runs in two basic levels:

a. FOREGROUND FUNCTIONS: These are the primary mission associated tasks which are scheduled in response to system interrupts. These tasks are configured to execute to completion before returning control to the operating system.

b. BACKGROUND FUNCTIONS: These tasks are requested by the operator and execute subordinate to the foreground functions.

Background tasks are interrupted frequently to give the foreground functions priority access to the system's resources. These functions relinquish control to the operating system during all IO actions. Only one background task is permitted to execute at a time.

2. E$INT.

2.1 Functional Description.

E$INT is the NUSTAD system initialization routine. At load time (see Appendix III for loading procedures), it specifies the contents of low-core locations necessary for interrupt and IO operations. Table 2.1 lists these locations and the values stored in them. Those specified as "DFC" contain the address of the symbolic label given.

2.1.1 E:ANF (System Start/Restart Point).

E:ANF (location 010016) is the program execution start-up point. Transferring control to NUSTAD from SAL by means of the GO command will cause execution to begin here. Also, depressing the MASTER CLEAR switch on the console panel will cause a system restart at this point.

When execution begins, E$INT performs the following tasks:

a. Reset the start-up flag for the U data acquisition program (E$UIN).

b. Transmit the current GAIN, TRACKING RATE, and BLANKING LEVEL values to the sensor.

c. Clear and activate all interrupts to be used.

d. Reset to initial values all processing flags, counters, parameters, etc., used by the applications programs.

e. Clear the channels to the ASR 35 and the ASR 28.

f. Schedule M$STD in scheduler.

g. Send the system restart messages to the teleprinters; a LF/CR to the ASR 35 and a "SYSTEM RESTART" message with the restart time to the ASR 28.

h. Establish initial values for background processing.

i. Transfer control to the system scheduler (E:SKD in (E$SKD).

2.2 Called Subroutines.

Subroutine	Program	Function
E:MIT	E$UIN	Transmit GAIN, TRACKING RATE, and BLANKING LEVEL values to sensor channel given in R3.
E:FRT	E$FRT	Converts BCD DOY/TOD to ASCII characters for output.
E:035	E$T35	Transfers output message to buffer before transmission to the ASR 35.
E:028	E$T28	Translates output message to BAUDOT code and stores in buffer before transmission to the ASR 28

2.3 Input Parameter Descriptions.

Parameter	Program	Description
E.SF1	E$UIN	Bit Ø set for first AIS record, reset thereafter.
U.CCN	U$DAT	Accumulated effect of cycle shifts.
U.CPC	U$DAT	Channel Compressed Point Counter.
U.CST	U$DAT	Channel Status, set to 4 indicating channel down.
U.RTY	U$DAT	Channel Recovery Tally, counts ten-second-periods before channel can come up.
U.IHB	U$DAT	Bit Ø set to inhibit processing on channel if INE or Maintenance set on the channel.
U.TM1	E$CLK	Minute counter for scheduling U$RED.
U.TM3	U$RTA	Gain Clock, counts ten-second-periods for entry to gain control section of U$RTA.
U.TM4	U$RTA	Track Clock, counts ten-second-periods for entry to tracking rate control section of U$RTA.
E.035	E$T35	ASR 35 status word.
E.028	E$T28	ASR 28 status word.
E.TØ8	E$SKD	Scheduler task table entry for M$STD.
E.IOF	E$T35	Parameter word used in calling E:035.
E.28F	E$T28	Parameter word used in calling E:028.

Parameter	Program	Description
U.AST	U$DAT	Channel waveform analysis status, indicates point in signal to which processing has progressed, initially Ø.
F.MTP	F$FMT	Character pointer for Mag Tape data in input buffer.
B.STT	E$SKD	Background Status Flag, set to Ø for no task in progress.
E.TSF	E$SKD	Time Slicing Flag, Bit Ø set to Ø to inhibit time-slice processing, set to 1 to indicate background task in execution and time-slicing needed.
E:SKD	E$SKD	Entry to system scheduler.

2.4 Output Parameter Descriptions.

Parameter	Size	Description
E:ANF		Entry point for system start/restart.
F:ANL		Dummy background task; to be replaced by a background program to perform waveform analysis on data from DRFUD tapes.

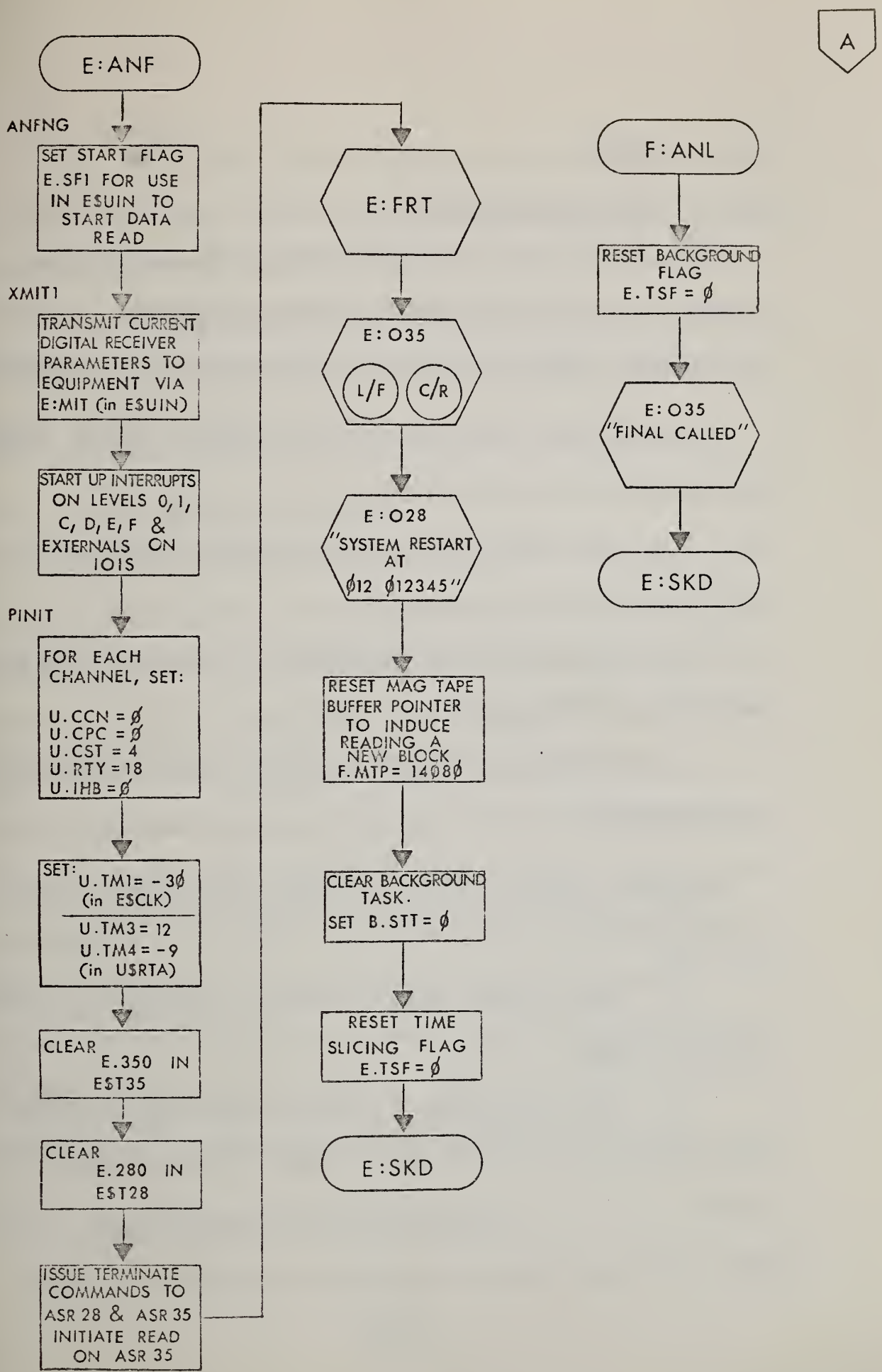
2.5 Internal Data Descriptions.

Parameter	Size	Description
MSGØ	39	System restart message: "......SYSTEM RESTART AT 123 123456......"
STIME		Location of DOY/TOD group in MSGØ.
MSG1		LF/CR from MSGØ.

Parameter	Size	Description
MSG8	9	Message generated by F:ANL -- "F:ANL CALLED"

Loc	Content	Function	Program
ØØØØ ØØØ1	BRU E:ANF	Program restart point	E$INT
ØØ21	DFC E:PWD	Power Down/Up Interrupt Location	E$SUB
ØØ23	DFC E:PAR	Memory Parity Error Interrupt Location	E$SUB
ØØ3D	DFC E:ABR	CONSOLE Interrupt Location	E$SUB
ØØ3F	DFC E:TSI	Time Slicing Interrupt Location	E$TSI
ØØ63	-42	Transfer Count for AIS DMP	E$UIN
ØØ64	-14Ø8Ø	Transfer Count for Mag Tape DMP	E$MAG
ØØ73	DFC E. UBU	Transfer Address for AIS DMP	E$UIN
ØØ74	6176_{16}	Transfer Address for Mag Tape DMP	E$MAG
ØØ8A	DFC E:I35	Data Interrupt Location for ASR 35	E$T35
ØØ98	DFC E:I28	Data Interrupt Location for ASR 28	E$T28
ØØ99	DFC E:I28	Data Interrupt Location for ASR 28	E$T28
ØØAØ	DFC E:SEC	1 per Second Interrupt Location	E$CLK
ØØA1	DFC E:MIN	1 per Minute Interrupt Location	E$CLK
ØØA2	DFC M:INT	INE Interrupt Location (from ADACS)	M$ESC
ØØA7	DFC M:INT	Common Alarm Board Interrupt Location	M$ESC
ØØC4	DFC E:MTI	Service Interrupt Location for Mag Tape	E$MAG
ØØCA	DFC E:35S	Service Interrupt Location for ASR 35	E$T35
ØØD1	DFC E:ANL	Service Interrupt Location for AIS	E$UIN
Ø1ØØ		Program Execution Starting Point	E$INT

TABLE 2.1 Dedicated Memory Locations Established in E$INT


A
E:ANF
ANFNG
SET START FLAG E.SF1 FOR USE IN ESUIN TO START DATA READ
XMIT1
TRANSMIT CURRENT DIGITAL RECEIVER PARAMETERS TO EQUIPMENT VIA E:MIT (in ESUIN)
START UP INTERRUPTS ON LEVELS 0, 1, C, D, E, F & EXTERNALS ON IOIS
PINIT
FOR EACH CHANNEL, SET:
U.CCN = Ø
U.CPC = Ø
U.CST = 4
U.RTY = 18
U.IHB = Ø
SET: U.TM1 = -3Ø (in ESCLK)
U.TM3 = 12
U.TM4 = -9 (in USRTA)
CLEAR E.350 IN EST35
CLEAR E.280 IN EST28
ISSUE TERMINATE COMMANDS TO ASR 28 & ASR 35 INITIATE READ ON ASR 35
E:FRT
E:O35
L/F
C/R
E:O28 "SYSTEM RESTART AT Ø12 Ø12345"
RESET MAG TAPE BUFFER POINTER TO INDUCE READING A NEW BLOCK F.MTP = 14Ø8Ø
CLEAR BACKGROUND TASK. SET B.STT = Ø
RESET TIME SLICING FLAG E.TSF = Ø
E:SKD
F:ANL
RESET BACKGROUND FLAG E.TSF = Ø
E:O35 "FINAL CALLED"
E:SKD

3. E$SKD.

3.1 Functional Description.

E$SKD is the heart of ROS. The tasks in its task table are scheduled in response to the various external interrupts. Through the task table, entry is then made to the various tasks in the system.

E$SKD consists of two subprograms; E:SKD and E:BSK. E:SKD performs three primary functions:

a. Control direct entry to the real-time tasks listed in the task table (priorities 1 through 14).

b. Monitor CPU activity (primarily through interrupt actions) and log loss of ROS control.

c. Control entry into the background level via priority 15 in the task table.

Control is passed to the system scheduler at E:SKD in one of four ways:

a. After a system restart, E$INT unconditionally transfers control to E:SKD.

b. After each dedicated real-time task listed in the task table completes execution, it returns control to the scheduler at E:SKD.

c. When a time slicing interrupt occurs during the execution of a background task, E$TSI retains the information needed to continue that task and returns control to E:SKD.

d. When a background task requests an IO action, B:IOR (in E$TSI) retains the information needed to continue the task, and returns control to E:SKD until the IO action is completed.

3.1.1 E:SKD (System Scheduler).

At E:SKD, the scheduler begins a scan of the task table to look for tasks which require servicing. If one is found, the task flag bit is reset and control is passed to that task via the address stored as that task's entry in the task table. The tasks in the task table, and the program in which they may be found, are listed in Table 3.1. Should no task be flagged during the pass through the task table, a counter is decremented. Should the counter reach Ø, indicating that approximately five seconds had elapsed without a scheduled task, the system is considered dead, and E$LOG is called to generate a "T SD" message for the station log. A system restart is then attempted by passing control to E:ANF in E$INT. Each time a task is entered, then completed, control is returned at E:SKD and the counter is reset.

3.1.2 E:BSK (Background Task Scheduler).

When the flagged task is priority 15, control is passed to E:BSK,

the background task scheduler. The status of the background task is stored in a word called B. STT (the Background Status). When the operator requests a background task, via E$OMI (the Operator Message Interpretor), B. STT is set to a value corresponding to that task and E:BSK is flagged in the task table. Thus, the first time E:BSK is entered for a given task, it will find B. STT equal to 1, 2, or 3, and will transfer control to the desired task, as listed in Table 3. 2. Thereafter, entry to E:BSK will be to continue a task previously interrupted. In this case, either E:TSI or B:IOR will have set B. STT to 4 to indicate that a background task is in progress, and will have retained the location counter and the register contents so as to continue processing at that point where the interrupt occurred. Therefore, when E:BSK finds B. STT = 4, it restores the registers to the values retained in holding buffers at B. RS1 (for registers 1 through 7) and B. RS2 (for registers 1Ø through 15), and returns control to the next instruction of the background task at the location saved in B. RET. Should the operator wish to abort his background task, the console interrupt routine (B:ORT in E$SUB) resets B. STT to Ø. When E:BSK finds B. STT = Ø, it simply returns control to E:SKD without executing any background task or rescheduling the background level. Therefore, B. STT will normally be Ø when no background task is being processed.

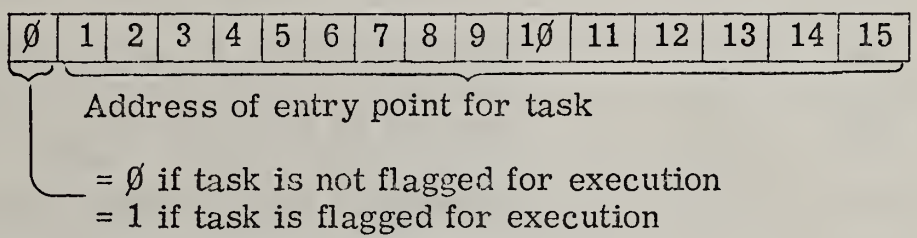
3.2 Called Subroutines.

Subroutine	Program	Function
E:LOG	E$LOG	Generate coded log message for ASR 28.

(Also see Tables 3.1 and 3.2 for tasks called by E:SKD and E:BSK)

3.3 Data Formats.

The primary data entity in the scheduler is the task table entry, which is of the form:



3.4 Input Parameter Descriptions.

Parameter	Program	Description
E:ANF	E$INT	Entry point for a system restart

3.5 Output Parameter Descriptions.

Parameter	Size	Description
E. TSK	1	Base of task table
E:SKD		Entry to ROS scheduler
E:BSK		Entry to background level scheduler

Parameter	Size	Description
E. TØ1	1	Priority 1 task table entry (see Table 3. 1)
E. TØ2	1	Priority 2 task table entry (see Table 3. 1)
E. TØ3	1	Priority 3 task table entry (see Table 3. 1)
E. TØ4	1	Priority 4 task table entry (see Table 3. 1)
E. TØ5	1	Priority 5 task table entry (see Table 3. 1)
E. TØ6	1	Priority 6 task table entry (see Table 3. 1)
E. TØ7	1	Priority 7 task table entry (see Table 3. 1)
E. TØ8	1	Priority 8 task table entry (see Table 3. 1)
E. TØ9	1	Priority 9 task table entry (see Table 3. 1)
E. T1Ø	1	Priority 1Ø task table entry (see Table 3. 1)
E. T11	1	Priority 11 task table entry (see Table 3. 1)
E. T12	1	Priority 12 task table entry (see Table 3. 1)
E. T13	1	Priority 13 task table entry (see Table 3. 1)
E. T14	1	Priority 14 task table entry (see Table 3. 1)
E. T15	1	Priority 15 task table entry (see Table 3. 1)
B. STT	1	Background Status (see Table 3. 2)
E. TSF	1	Time Slicing Flag: (see Section 4. 1) = Ø to inhibit processing of time slice interrupt = 1 to permit processing of time slice interrupt
B. RS1	7	Holding buffer for registers 1-7 of interrupted background task

Parameter	Size	Description
B. RS2	6	Holding buffer for registers 1Ø-15 of interrupted background task
B. RET	1	Return location for interrupted background task

3.6 Internal Data Descriptions.

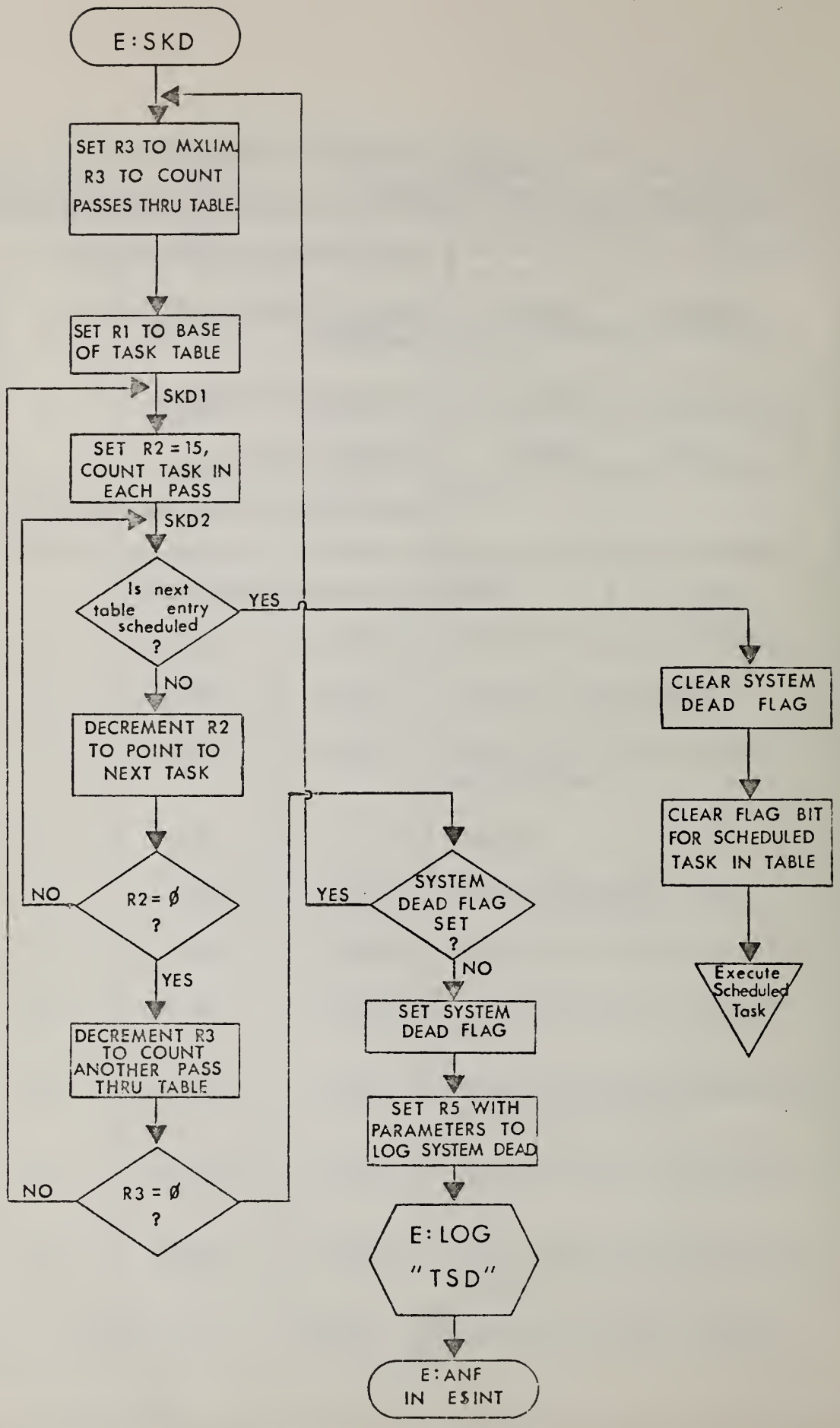
Parameter	Size	Description
BTABL	5	Table of background task entry points

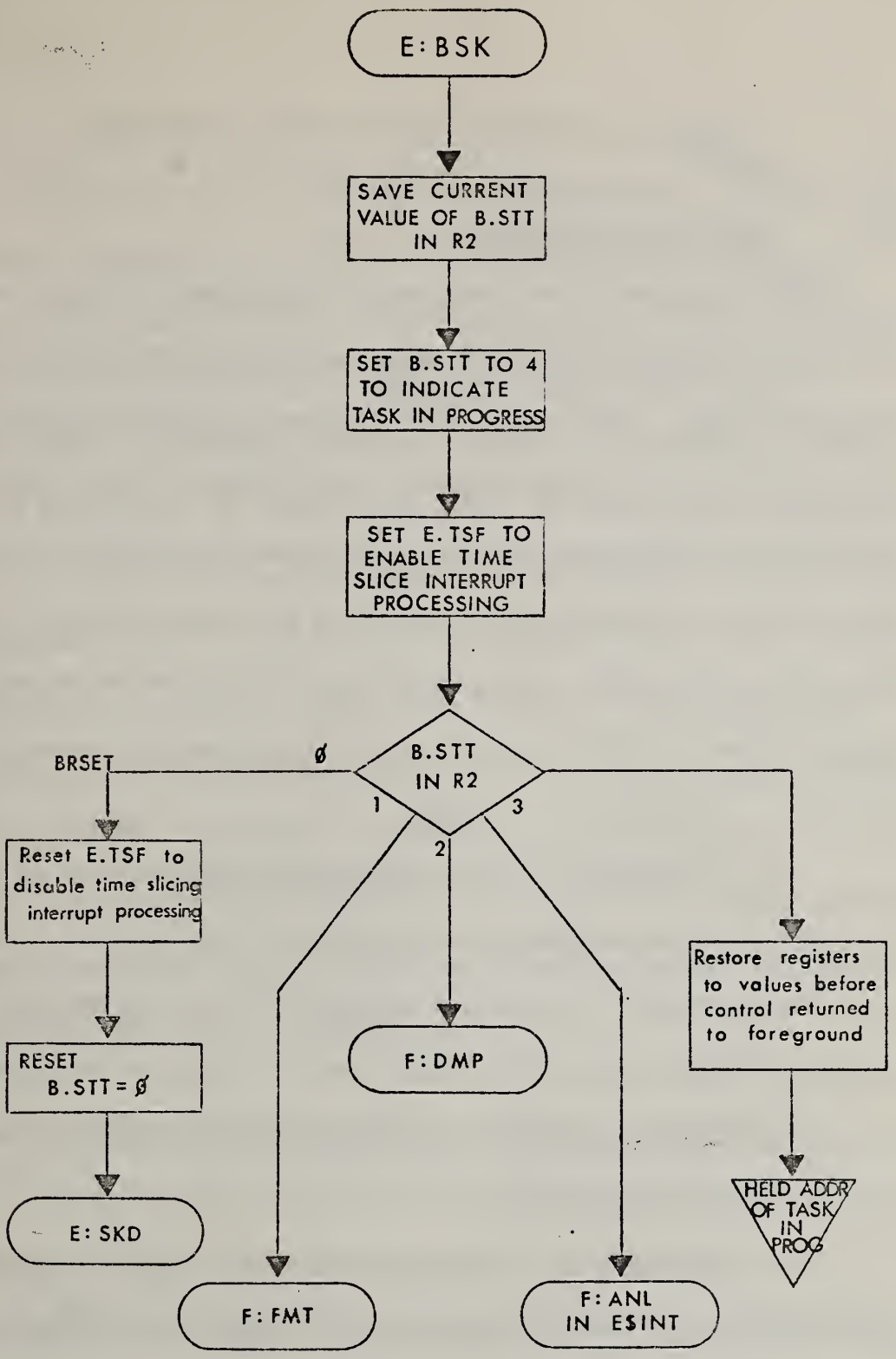
Priority	Program Entry	Program Name	Task
1	U:RTA	U$RTA	U Data Real Time & Waveform Analysis
2	M:ESC	M$ESC	Scan for Equipment Status Change
3	E:UIN	E$UIN	Preprocess last U Data Input
4	U:RED	U$RED	Perform Channel Redundancy Check
5	E:T28	E$T28	ASR 28 Character Transfer Ready
6	E:OMI	E$OMI	Interpret Operator Message
7	U:RP3	U$REP	Generate Part III RSD
8	M:STD	M$STD	Generate Current Receiver Status Table
9	------	------	Unused
1Ø	B:ORT	E$SUB	Abort Background Task
11	E:MAG	E$MAG	Mag Tape Transfer Complete
12	E:T35	E$T35	ASR 35 Character Transfer Ready
13	U:PST	U$PST	Process Operator Requested Parameter Change
14	M:LEV	M$LEV	Generate Parameter History Table
15	E:BSK	E$SKD	Enter Background Task Thru E:BSK

TABLE 3.1 NUSTAD SCHEDULER TASK TABLE

B. STT Code	Program Entry	Program Name	Task
ø			Abort Background Processing
1	F:FMT	F$FMT	DRFUD Tape Format Check Program
2	F:DMP	F$DMP	DRFUD Data Display
3	F:ANL	E$INT	(Dummy Task)
4			Continuation of Task in Progress

TABLE 3.2 NUSTAD BACKGROUND TASKS


E:SKD
SET R3 TO MXLIM. R3 TO COUNT PASSES THRU TABLE.
SET R1 TO BASE OF TASK TABLE
SKD1
SET R2 = 15, COUNT TASK IN EACH PASS
SKD2
Is next table entry scheduled ?
YES
NO
DECREMENT R2 TO POINT TO NEXT TASK
R2 = Ø ?
NO
YES
DECREMENT R3 TO COUNT ANOTHER PASS THRU TABLE
R3 = Ø ?
NO
SYSTEM DEAD FLAG SET ?
YES
NO
SET SYSTEM DEAD FLAG
SET R5 WITH PARAMETERS TO LOG SYSTEM DEAD
E:LOG "TSD"
E:ANF IN E$INT
CLEAR SYSTEM DEAD FLAG
CLEAR FLAG BIT FOR SCHEDULED TASK IN TABLE
Execute Scheduled Task


E: BSK
SAVE CURRENT VALUE OF B.STT IN R2
SET B.STT TO 4 TO INDICATE TASK IN PROGRESS
SET E.TSF TO ENABLE TIME SLICE INTERRUPT PROCESSING
B.STT IN R2
BRSET
Ø
1
2
3
Reset E.TSF to disable time slicing interrupt processing
RESET B.STT = Ø
E: SKD
F: FMT
F: DMP
F: ANL IN ESINT
Restore registers to values before control returned to foreground
HELD ADDR OF TASK IN PROG

4. E$TSI.

4.1 Functional Description.

E$TSI contains the two programs which permit programs to operate on the background level while not inhibiting the processing of real-time tasks. Since background tasks will generally require some IO support and execute for relatively long periods of time, ROS must ensure that a background task not be permitted to hold the CPU to the point where priority tasks executed in the foreground are delayed from timely execution. Background tasks will therefore relinquish control to the real time tasks via the system scheduler in one of two ways:

a. Voluntarily. When a background task requires an IO operation (such as additional information from the operator, or data from the mag tape), the program will make its request through B:IOR (in E$TSI), which will initiate the IO through the necessary peripheral handler, and then return control to the foreground until that IO action is completed.

b. Involuntarily. If a background task is executing when the time slicing interrupt occurs (ten per second), E:TSI returns control to the foreground until any pending real-time tasks are serviced.

4.1.1 E:TSI (Time Slicing Interrupt Service Routine).

E:TSI is entered for all time slicing interrupts. It determines whether a background task is executing or not by the status of the time slicing flag (E. TSF). If the flag is not set, then the interrupt occurred during other than a background task, and control is immediately returned to whatever program was executing at the time of the interrupt. If, on the other hand, the flag is set, a background task was interrupted and the contents of all registers available to the background task (1 through 7 and 1Ø through 15) are saved, as is the address of the next instruction to be executed in the background program. The time slicing flag is reset to show that control is being returned to the foreground, and E:BSK is rescheduled in the scheduler's task table to continue processing of the background program when the priority 15 task is ready to be serviced again. Control is returned to the foreground at E:SKD.

4.1.2 B:IOR (Background Program IO Request Routine).

When a background program requests an IO action from the operating system, that request is made through B:IOR, which coordinates that request with real-time requirements. The current register contents and the location counter are saved to permit execution to be continued at the next location following the call to

B:IOR in the background program when the IO transaction is completed. The time slicing flag is reset prior to entry to any of the operating system's peripheral handlers to prevent possible confusion by subsequent entry to that same program in response to a real-time request. The calling sequence supplies a parameter word which specifies whether the request is for the mag tape or the ASR 35 handler. Additional parameters associated with the particular device specified are then transferred to that device's handler. When control is returned, B:IOR transfers it to the foreground at E:SKD. When the IO transfer is complete, flag bits in the parameter word signal the handler to reschedule E:BSK, which will continue execution of the background task with the data from the transfer ready for processing.

The calling sequence for the two devices differ. If input is required from the mag tape unit, the following sequence is used:

```
BLM, 15        B:IOR
DFC            #2ØØØ        BIT 2 SPECIFIES MAG TAPE INPUT
DFC            (message start address)
DFC            (count of words to be read)
```

IO communication between the background program and the operator via the ASR 35 teletype is more variable. In this case the calling sequence is:

```
BLM, 15        B:IOR
DFC            (parameter word)
DFC            (message start address)
```

where the parameter word is interpreted as follows:

BIT Ø = Ø Do not reschedule E:BSK immediately after the output is completed. This option is normally used with BIT 1 = 1 to permit the background to request information from the operator, then not reenter the background program until the operator's response has been read.

= 1 Reschedule E:BSK as soon as the output message specified by the second parameter word has been completed.

BIT 1 = Ø No response to the program's output is expected from the operator.

= 1 The message specified by the second parameter word is a request for information from the operator. Do not reschedule E:BSK until that response is completed.

BIT 2 = Ø Specifies request for action on the ASR 35.

= 1 Used to specify mag tape IO action.

BIT 3 = 1 Must be set as B:IOR teletype actions must begin with an output action.

For example, the parameter word would be #5ØØØ if the background program were requesting information from the operator. The background program would then continue execution after the operator response was completed. If the background program needed to print out the results of some operation and then continue processing, #9ØØØ would be used as the parameter word.

4.2 Called Subroutines.

Subroutine	Program	Function
E:035	E$T35	Transfers output message to buffer before transmission to the ASR 35. Also sets flag bits to control rescheduling E:BSK based on value of E.IOF.
E:MGS	E$MAG	Initiates Mag Tape read into specified area of memory.

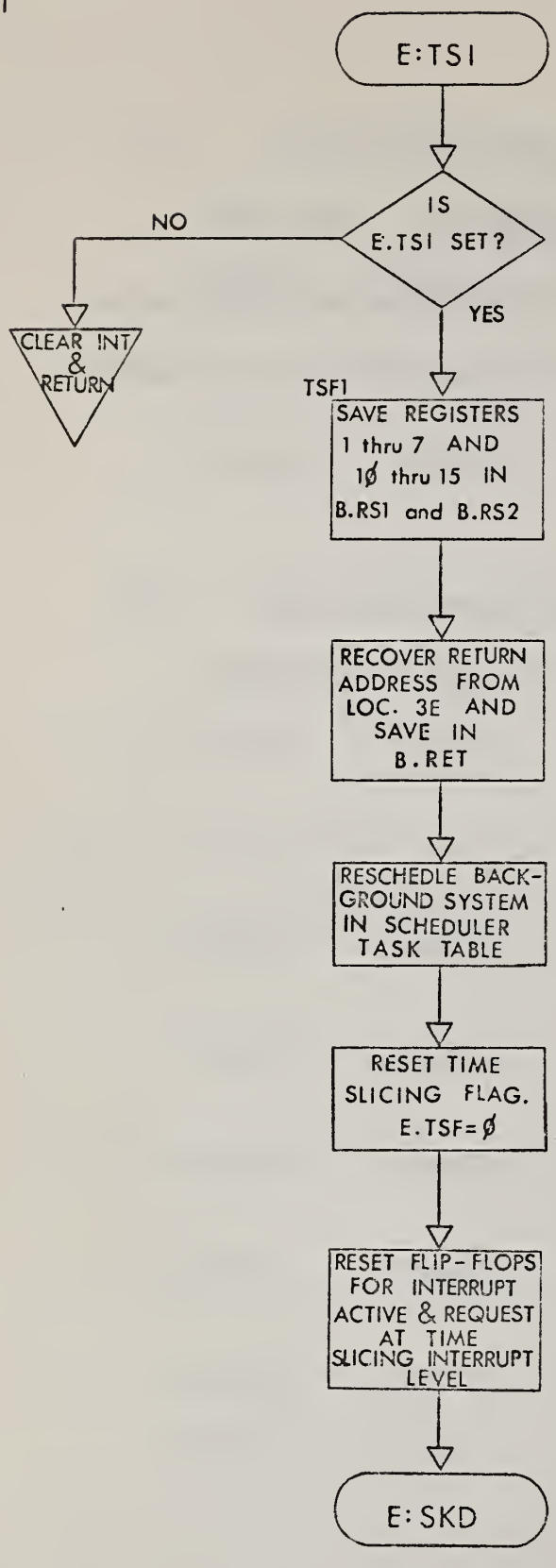
4.3 Input Parameter Descriptions.

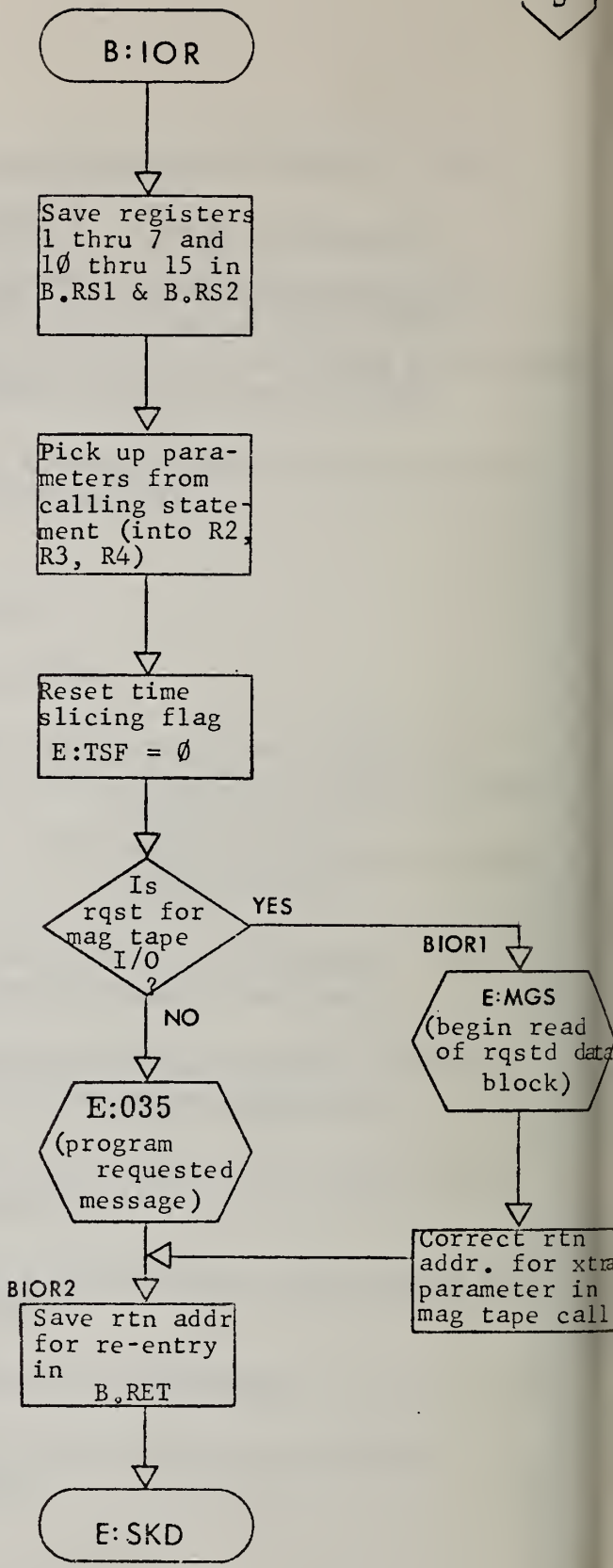
Parameter	Program	Description
E.TSF	E$SKD	Time slicing flag; (see section 4.1) BIT Ø = Ø to inhibit processing of time slice interrupt =1 to permit processing of time slice interrupt
B.RS1	E$SKD	Holding buffer for registers 1-7 of interrupted background task.
B.RS2	E$SKD	Holding buffer for registers 1Ø-15 of interrupted background task.
B.RET	E$SKD	Return location for interrupted background task.
E.T15	E$SKD	Task table entry for background system (E:BSK).
E.SKD	E$SKD	Scheduler reentry point.
E.IOF	E$T35	Parameter word used in calling E:035.

4.4 Output Parameter Descriptions.

Parameter	Size	Description
E:TSI		Entry to time slicing interrupt routine
B:IOR		Entry to background IO request routine

E$TS1


E:TS1
IS E.TS1 SET?
NO
YES
CLEAR INT & RETURN
TSF1
SAVE REGISTERS 1 thru 7 AND 1Ø thru 15 IN B.RS1 and B.RS2
RECOVER RETURN ADDRESS FROM LOC. 3E AND SAVE IN B.RET
RESCHEDLE BACK-GROUND SYSTEM IN SCHEDULER TASK TABLE
RESET TIME SLICING FLAG. E.TSF=Ø
RESET FLIP-FLOPS FOR INTERRUPT ACTIVE & REQUEST AT TIME SLICING INTERRUPT LEVEL
E:SKD


B
B:IOR
Save registers 1 thru 7 and 1Ø thru 15 in B.RS1 & B.RS2
Pick up parameters from calling statement (into R2, R3, R4)
Reset time slicing flag E:TSF = Ø
Is rqst for mag tape I/O ?
YES
NO
BIOR1
E:MGS (begin read of rqstd data block)
E:035 (program requested message)
Correct rtn addr. for xtra parameter in mag tape call
BIOR2
Save rtn addr for re-entry in B.RET
E:SKD

5. E$CLK

5.1 Functional Description.

E$CLK is the NUSTAD software clock. It contains the service routines for the one per second (E:SEC) and one per minute (E:MIN) time pulses from the system World Time Clock (WTC).

5.1.1 E:SEC (One Second Timing Interrupt Service Routine).

The one second time pulse triggers the level 1 external interrupt of the IOIS. Control is vectored to E:SEC, the service routine for that interrupt. It performs the following functions:

a. Supply a pulse to the ADACS power supply detection circuitry. If twenty seconds elapses without this pulse being received by the detectors, the power is turned off to the ADACS units and the sensors revert to their manual settings.

b. Check the delay times for scheduling M$ESC. When a change occurs in the sensor status which results in an INE interrupt, it takes several milliseconds for the levels to stabilize before meaningful values can be read. This may result in numerous interrupts, most with meaningless value changes associated. Also, when the operator changes the sensor frequency, interrupts would occur for each digit changed. NUSTAD therefore resets a five second delay timer with each INE interrupt. When that timer (M. TM1) runs

out, M$ESC is scheduled in the system scheduler.

c. Initiate a data transfer of U data from the sensors via the AIS DMP. After initiating this transfer, E:SEC checks to ensure that the DMP is then in use. If it isn't, NUSTAD will log a failure in the AIS (message reading "T AF"), and set a flag to inhibit repetition of this message until a good transfer is initiated. Without the AIS operating, E$UIN will not be executed and real-time U data processing will cease.

5.1.2 E:MIN (One Minute Timing Interrupt Service Routine).

The one minute time pulse triggers the level 2 external interrupt of the IOIS. Control is vectored to E:MIN, the service routine for that interrupt. It performs the following functions:

a. Check the timer for rescheduling U$RED, the channel redundancy checker. U. TM1 is a thirty minute timer which is incremented in E:MIN each minute until it reaches zero. When that happens, it is reset and U$RED is scheduled in the system scheduler.

b. Data are saved to determine the following historical information:

1. Percentage of time each channel is in the UP state.

2. Percentage of UP time that each channel was at each of the possible TRACKING RATE settings.

3. Percentage of UP time that each channel was in each RF GAIN grouping.

c. Read the BCD time to determine whether it is time to schedule execution of the M$STD or M$LEV programs.

5.2 Called Subroutines.

Subroutine	Program	Function
E:LOG	E$LOG	To generate coded messages for the station log and initiate their transfer to the ASR 28 via E$T28.

5.3 Data Formats.

The information needed by M$LEV in generating historical data tables to evaluate channel reliability is stored in the following areas:

a. E. TM3 counts the minutes that the system has been on-line since the last execution of M$LEV or since the last restart, whichever is more recent.

b. M. UPT is a series of counters, one per channel, used to count the minutes during which the channel was in an UP state.

c. M. TRT is a set of counters, with ten (one per tracking rate value) for each channel, used to tally the current tracking rate value each minute.

d. M. GNT is a set of counters, with eight for each channel, used to tally the gain group in which the current gain is found each

minute. The relation between the individual gain settings and the gain groups is given in the table below:

GAIN GROUP	RF GAIN VALUES
Ø	Ø, 1, 2
1	3, 4, 5
2	6, 7, 8
3	9, 1Ø, 11
4	12, 13, 14
5	15, 16, 17
6	18, 19, 2Ø
7	21, 22, 23, 24

TABLE 5.1

THE RELATION BETWEEN GAIN SETTINGS AND GAIN GROUPS

The organization of the counters used to tally gain and tracking rate settings is graphically represented in Table 5.2.

The times at which M$STD and M$LEV are automatically scheduled are maintained in STDTB and LEVTB respectively. These tables allow the user to designate up to six times per day for M$LEV and up to twenty four times per day for M$STD to be automatically executed. The format in which the time is stored is given in Table 5.3, and the current times now included in the system are given in Table 5.4.

CHANNEL	TRACK RATE	MEMORY LOCATION
A	Ø	M. TRT
	1	M. TRT+1
	2	M. TRT+2
	3	M. TRT+3
	4	M. TRT+4
	5	M. TRT+5
	6	M. TRT+6
	7	M. TRT+7
	8	M. TRT+8
	9	M. TRT+9
B	Ø	M. TRT+1Ø
	1	M. TRT+11
	2	M. TRT+12
	3	M. TRT+13
	4	M. TRT+14
	5	M. TRT+15
≷	≷	≷
N	7	M. TRT+137
	8	M. TRT+138
	9	M. TRT+139

TRACKING RATE TABLE
(M. TRT)

CHANNEL	GAIN GROUP	MEMORY LOCATION
A	Ø	M. GNT
	1	M. GNT+1
	2	M. GNT+2
	3	M. GNT+3
	4	M. GNT+4
	5	M. GNT+5
	6	M. GNT+6
	7	M. GNT+7
B	Ø	M. GNT+8
	1	M. GNT+9
	2	M. GNT+1Ø
	3	M. GNT+11
≷	≷	≷
N	5	M. GNT+1Ø9
	6	M. GNT+11Ø
	7	M. GNT+111

GAIN TABLE
(M. GNT)

TABLE 5.2

M. TRT and M. GNT STORAGE FORMAT

Time of Day	Table Value	Time of Day	Table Value	Time of Day	Table Value
ØØØØ	$ØØØØ_{16}$	Ø8ØØ	$1ØØØ_{16}$	16ØØ	$2CØØ_{16}$
Ø1ØØ	$Ø2ØØ_{16}$	Ø9ØØ	$12ØØ_{16}$	17ØØ	$2EØØ_{16}$
Ø2ØØ	$Ø4ØØ_{16}$	1ØØØ	$2ØØØ_{16}$	18ØØ	$3ØØØ_{16}$
Ø3ØØ	$Ø6ØØ_{16}$	11ØØ	$22ØØ_{16}$	19ØØ	$32ØØ_{16}$
Ø4ØØ	$Ø8ØØ_{16}$	12ØØ	$24ØØ_{16}$	2ØØØ	$4ØØØ_{16}$
Ø5ØØ	$ØAØØ_{16}$	13ØØ	$26ØØ_{16}$	21ØØ	$42ØØ_{16}$
Ø6ØØ	$ØCØØ_{16}$	14ØØ	$28ØØ_{16}$	22ØØ	$44ØØ_{16}$
Ø7ØØ	$ØEØØ_{16}$	15ØØ	$2AØØ_{16}$	23ØØ	$46ØØ_{16}$

NOTE: To get times other than the even hours, add the minutes directly to the hexadecimal table value. For example: to get 173Ø, add 3Ø to $2EØØ_{16}$ to get a table value of $2E3Ø_{16}$.

TABLE 5.3

Time of Day to STDTB/LEVTB Table Entry Value Conversions

TOD
ø2øø
ø6øø
1øøø
14øø
18øø
22øø
(eighteen entries unused)

TOD
øøøø
ø8øø
16øø
(three entries unused)

TABLE 5.4

CURRENT TABLE VALUES FOR STDTB
AND LEVTB

5.4 Input Parameter Descriptions.

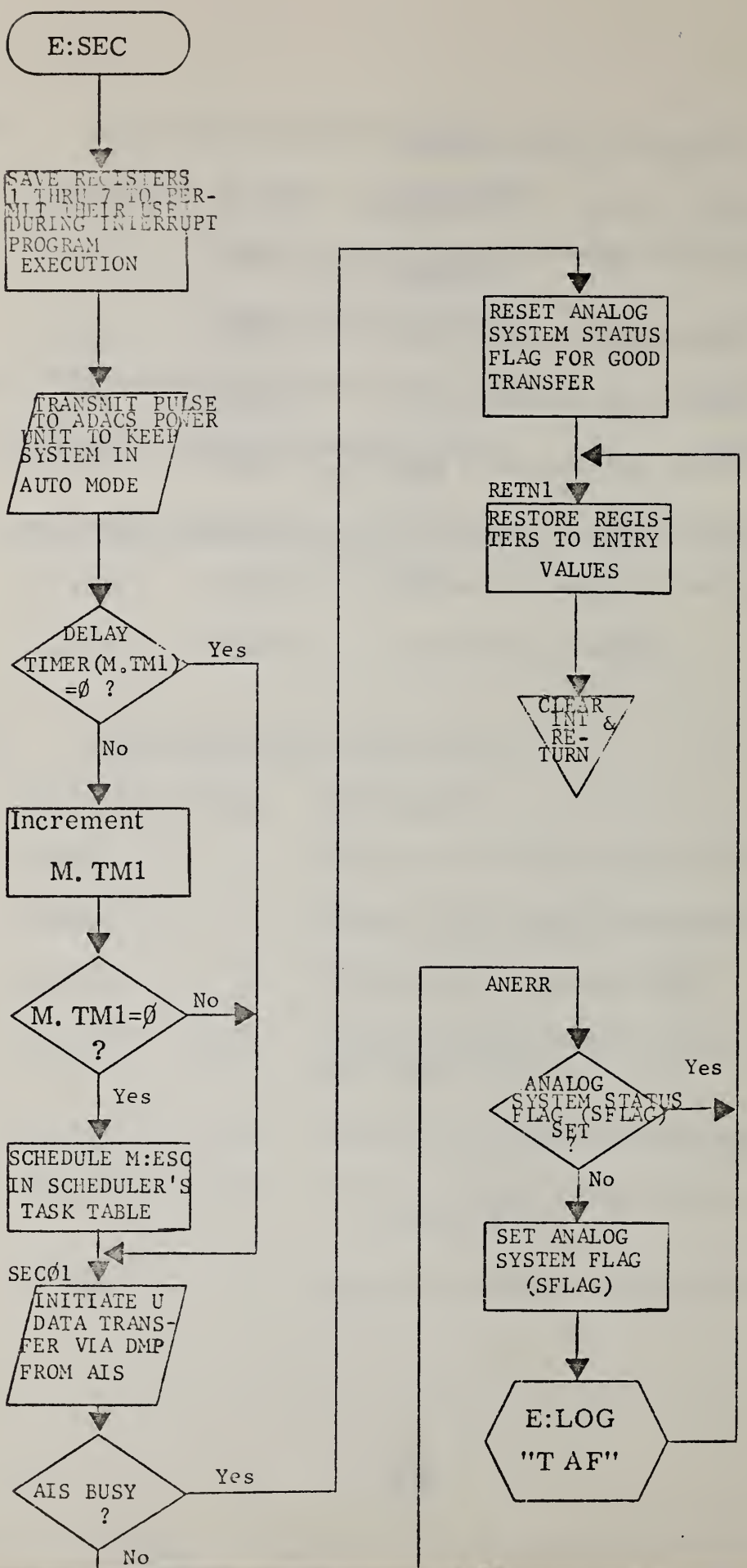
Parameter	Program	Description
M. TM1	M$ESC	Five second delay timer for scheduling M$ESC
E. TØ2	E$SKD	Task table entry for M$ESC
E. TØ4	E$SKD	Task table entry for U$RED
E. TØ8	E$SKD	Task table entry for M$STD
E. T14	E$SKD	Task table entry for M$LEV
U. TRK	U$DAT	Current tracking rate settings
U. GAN	U$DAT	Current gain settings

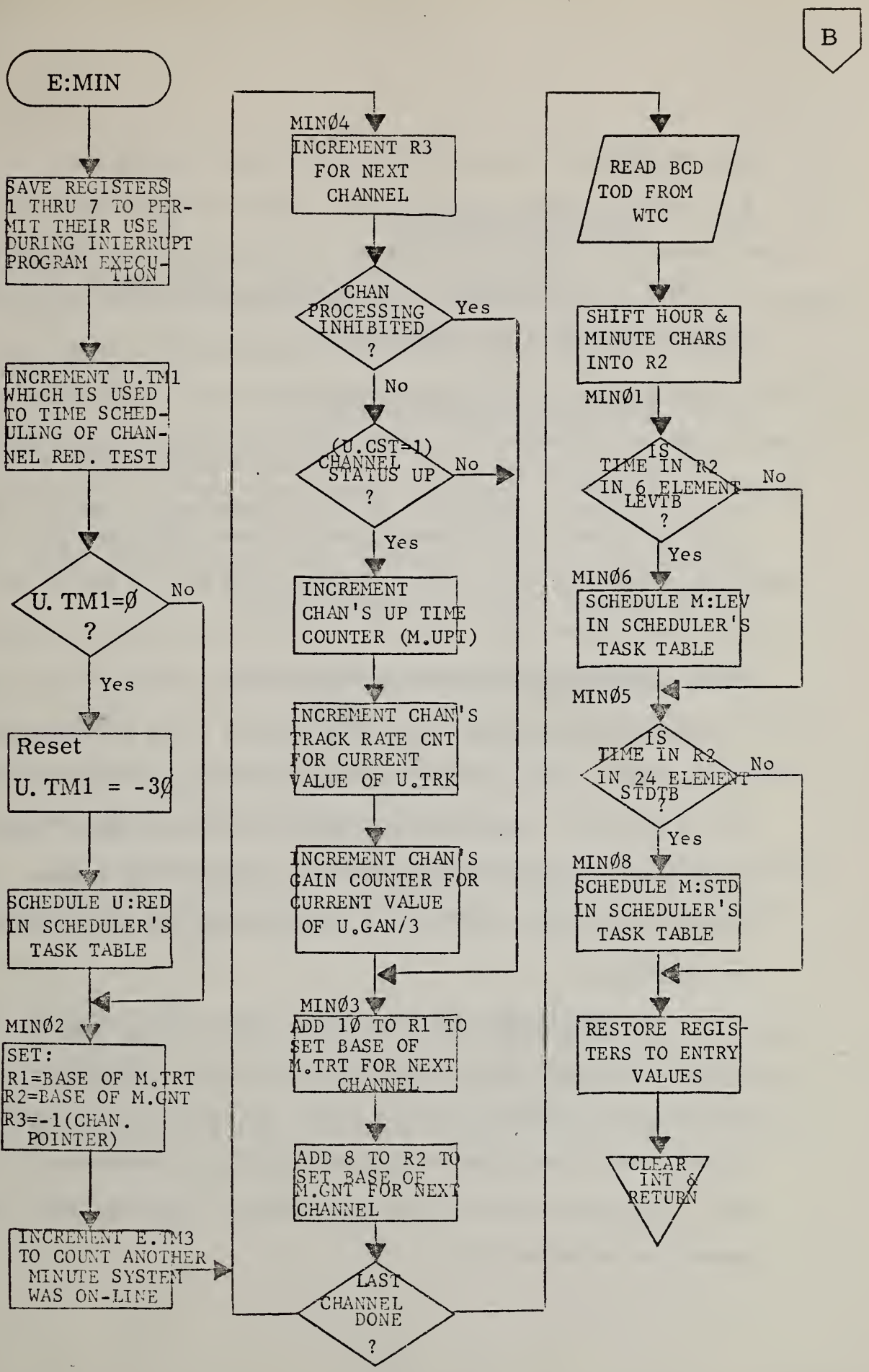
5.5 Output Parameter Descriptions.

Parameter	Size	Description
E:SEC		Entry to one second interrupt service routine
E:MIN		Entry to one minute interrupt service routine
U. TM1	1	Timer for scheduling U$RED
M. TRT	14Ø	Table of tracking rate setting frequency (See Table 5. 2)
M. GNT	112	Table of gain grouping frequency (See Table 5. 2)
M. UPT	14	Table of channel up time frequency (See Section 5. 3)
E. TM3	1	Counter for system up time (See section 5. 3)

5.6 Internal Data Descriptions.

Parameter	Size	Description
SAVRS	7	Register holding buffer
SAVRR	7	Register holding buffer
SFLAG	1	Flag set to suppress repeated "AF" messages
LEVTB	6	Table of times to schedule M$LEV (See Table 5.4)
STDTB	24	Table of times to schedule M$STD (See Table 5.4)


A
E:SEC
SAVE REGISTERS 1 THRU 7 TO PERMIT THEIR USE DURING INTERRUPT PROGRAM EXECUTION
TRANSMIT PULSE TO ADACS POWER UNIT TO KEEP SYSTEM IN AUTO MODE
DELAY TIMER(M,TM1) =Ø ?
Yes
No
Increment M. TM1
M. TM1=Ø ?
No
Yes
SCHEDULE M:ESC IN SCHEDULER'S TASK TABLE
SECØ1
INITIATE U DATA TRANSFER VIA DMP FROM AIS
AIS BUSY ?
Yes
No
RESET ANALOG SYSTEM STATUS FLAG FOR GOOD TRANSFER
RETN1
RESTORE REGISTERS TO ENTRY VALUES
CLEAR INT & RETURN
ANERR
ANALOG SYSTEM STATUS FLAG (SFLAG) SET ?
Yes
No
SET ANALOG SYSTEM FLAG (SFLAG)
E:LOG "T AF"


B
E:MIN
SAVE REGISTERS 1 THRU 7 TO PERMIT THEIR USE DURING INTERRUPT PROGRAM EXECUTION
INCREMENT U.TM1 WHICH IS USED TO TIME SCHEDULING OF CHANNEL RED. TEST
U. TM1=Ø ?
No
Yes
Reset U. TM1 = -3Ø
SCHEDULE U:RED IN SCHEDULER'S TASK TABLE
MINØ2
SET:
R1=BASE OF M.TRT
R2=BASE OF M.CNT
R3=-1(CHAN. POINTER)
INCREMENT E.TM3 TO COUNT ANOTHER MINUTE SYSTEM WAS ON-LINE
MINØ4
INCREMENT R3 FOR NEXT CHANNEL
CHAN PROCESSING INHIBITED ?
Yes
No
(U.CST=1) CHANNEL STATUS UP ?
No
Yes
INCREMENT CHAN'S UP TIME COUNTER (M.UPT)
INCREMENT CHAN'S TRACK RATE CNT FOR CURRENT VALUE OF U.TRK
INCREMENT CHAN'S GAIN COUNTER FOR CURRENT VALUE OF U.GAN/3
MINØ3
ADD 1Ø TO R1 TO SET BASE OF M.TRT FOR NEXT CHANNEL
ADD 8 TO R2 TO SET BASE OF M.CNT FOR NEXT CHANNEL
LAST CHANNEL DONE ?
READ BCD TOD FROM WTC
SHIFT HOUR & MINUTE CHARS INTO R2
MINØ1
IS TIME IN R2 IN 6 ELEMENT LEVTB ?
No
Yes
MINØ6
SCHEDULE M:LEV IN SCHEDULER'S TASK TABLE
MINØ5
IS TIME IN R2 IN 24 ELEMENT STDTB ?
No
Yes
MINØ8
SCHEDULE M:STD IN SCHEDULER'S TASK TABLE
RESTORE REGISTERS TO ENTRY VALUES
CLEAR INT & RETURN

6. E$UIN

6.1 Functional Description

E$UIN is a preprocessor for the analog U data, called after each transfer from the AIS is complete.

6.1.1 E:ANL (AIS SI Service Routine)

A service interrupt (SI) is generated by the AIS after a data transfer from it via DMP is completed. This interrupt vectors control to E:ANL in E$UIN where E:UIN is flagged in the scheduler's task table. Control is then returned to the interrupted program.

6.1.2 E:UIN (U Data Preprocessing Routine)

When E:UIN is entered from the scheduler, E.UBU will contain 42 AIS channels of analog U data, multiplexed through the AIS and read in via the DMP. These 42 AIS channels break down to three inputs (amplitude, phase, and blanking rate) for each of the fourteen sensor channels (see Figure 6.1). E:UIN then performs the following tasks on these data:

a. Amplitude: The AIS presets several flag bits (see Figure 6.2) in the input word. E:UIN strips these away. The analog range at the sensor should be Ø to +1Ø volts. If the low end adjustment is slightly off, a negative voltage may actually be transmitted to the AIS. Since the programs expect only positive values as input, negative points are converted to Ø.

b. Phase: Again E:UIN strips away the flag bits preset by the AIS and checks for negative input values, converting them to Ø. The sensor has a hardware Ø to 1ØØ to Ø equivalence. To prevent confusion in detecting when this shift of reference occurs, E:UIN anticipates it and sends a 5Ø microsecond phase shift to the reference frequency in the sensor mixer. This creates an apparent 5Ø microsecond shift in the phase input, toward the midrange value. To compensate for this processor induced shift in later computations, the sample is flagged to indicate that the shift will have occurred before the next sample is read. U.CYC is set to $\pm$ 5Ø microseconds, a value which is added to subsequent samples to provide continuity to the phase input data stream. Since the maximum response of the sensor is about 15 microseconds/second, the equivalent of 15 and 85 microseconds are used as the points at which the cycle shift is transmitted to the sensor. This prevents the sensor from ever reaching its automatic recycle point.

c. Blanking Rate: As with the amplitude value, the bits preset by the AIS are stripped away and the negative value to zero conversion is made.

As each value in E.UBU is examined as described above, it is moved in a holding buffer called E.UBF. When all 42 words of AIS input have been preporcessed and moved to E.UBF, two digital words of DOY/TOD data

are read from the WTC via the IOIS and stored in the next two words of E.UBF. This associates a time value with the current data values. Forty-four words of E.UBF are therefore filled each time E:UIN is executed; i.e., once per second. After ten seconds, or 44Ø words of E.UBF, the data are transferred to U.WRK, a working buffer, and the analysis programs are scheduled in E:SKD. The pointers for E.UBF are reset and it becomes available for the next ten seconds of data.

Actually, U.WRK is an eleven row buffer. After each ten seconds, E:UIN moves E.UBF to rows 2 through 11 of it. U$RTA will have moved the previous eleventh row to the first so that the data from the most previous second prior to the current ten second period is also available for the analysis programs. During system startup, this first row of U.WRK must be filled by E:UIN with unprocessed input data. This start-up state is identified by E.SK1 being set, which signals the program to reset E.SF1 and move the first row of E.UBF to the first row of U.WRK and then reset the pointers to begin normal data gathering, ten seconds at a time, for rows 2 through 11 of U.WRK.

6.1.3 E:MIT (IOIS Digital Output Routine)

E:MIT is an executive support routine which transmits the current tracking rate, gain, and blanking level settings to the desired sensor channel. It also transmits the 5Ø microsecond phase shift from E:UIN when needed.

The calling sequence is:

```
BLM,5          E:MIT
```

with the desired channel in R3. The tracking rate value is taken from the channel's U.TRK, the gain from U.GAN, the blanking level from U.BLL and the cycle shift bit from SHIFT. The format of the output word is shown in Figure 6.3. Only register 5 is affected by this routine.

CHANNEL	VALUE	LOCATION
A	AMPLITUDE	E.UBU
	PHASE	E.UBU+1
	BLANKING RATE	E.UBU+2
B	AMPLITUDE	E.UBU+3
	PHASE	E.UBU+4
	BLANKING RATE	E.UBU+5
C	AMPLITUDE	E.UBU+6
	PHASE	E.UBU+7
M	BLANKING RATE	E.UBU+38
N	AMPLITUDE	E.UBU+39
	BLANKING RATE	E.UBU+41

Figure 6.1 Input Buffer (E.UBU) Format

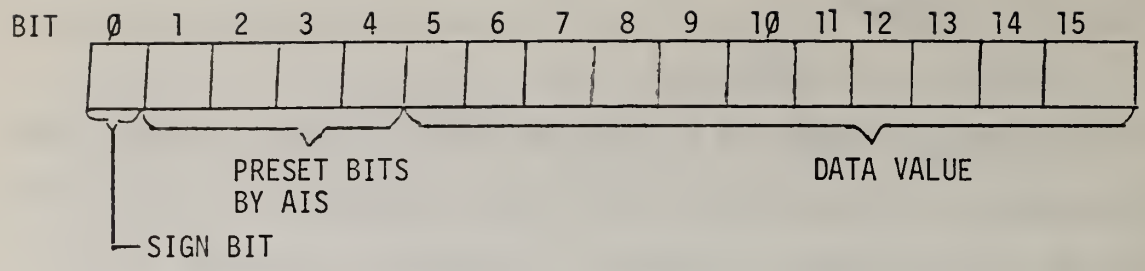


Figure 6.2 Input Data Word (AIS) Format

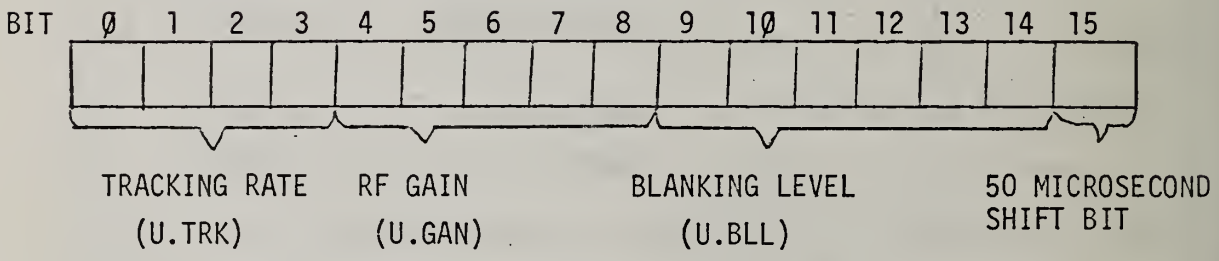
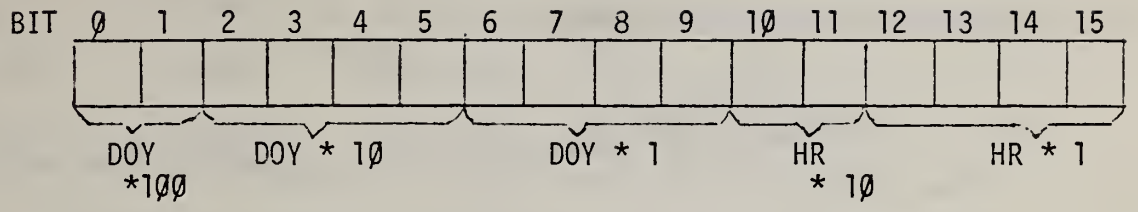


Figure 6.3 Output Data Word (IOIS) Format

WORD Ø OF IOIS EXTENDER:



WORD 1 OF IOIS EXTENDER:

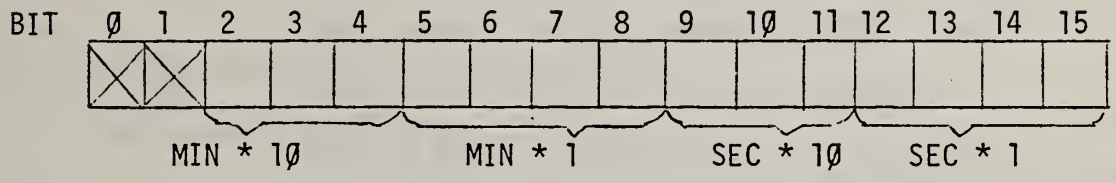


Figure 6.4 Input Data Word (IOIS EXTENDER WORDS Ø) Format

6.2 Data Formats

6.2.1 AIS Input Data

The analog data multiplex through the AIS supplies eleven bits plus sign for each word. Additionally, the AIS presets four bits to fixed values. See Figure 6.2.

6.2.2 Sensor Parameter Control Output via IOIS

The tracking rate, RF gain, and blanking level settings are transmitted to the sensor/ADACS via words Ø through 13 of digital output

6.2.3 DOY/TOD Input from the WTC via IOIS

The DOY and TOD are read in from words Ø and 1 of the channel extender for the digital input of the IOIS. See Figure 6.4.

6.2.4 Amplitude Values

The amplitude value ranges linearly over the range from zero to $2Ø47_{1Ø}$ corresponding to actual amplitude values from -2Ø dB to +2Ø dB.

6.2.5 Phase Values

The phase values range linearly over the range from zero to $1599_{1Ø}$ corresponding to phase values from Ø to 99.9 microseconds.

6.2.6 Blanking Rate Values

The blanking rate values range linearly over the range from zero to $2Ø47_{1Ø}$ corresponding to blanking rates from Ø% to 1ØØ%.

6.3 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
U.IHB	U$DAT	Bit Ø set to inhibit processing on channel if INE or Maintenance set on the channel.
U.CYC	U$DAT	Set to $\pm$ 5Ø microseconds for channel when cycle shift is sent to the sensor.
U.WRK	U$DAT	Working storage for data from sensor.
U.TRK	U$DAT	Current tracking rate settings for the channels.
U.GAN	U$DAT	Current RF gain settings for the channels.

6.3 Input Parameter Descriptions (Continued)

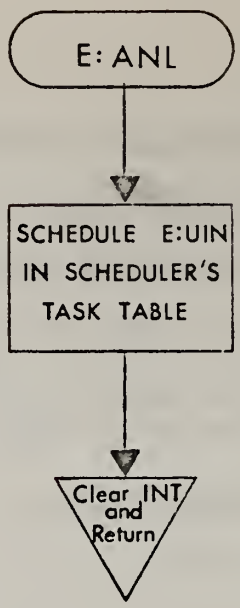
PARAMETER	PROGRAM	DESCRIPTION
U.BLL	U$DAT	Current blanking level settings for the channels.
E.TØ1	E$SKD	Task table entry for R$RTA
E.TØ3	E$SKD	Task table entry for E:UIN

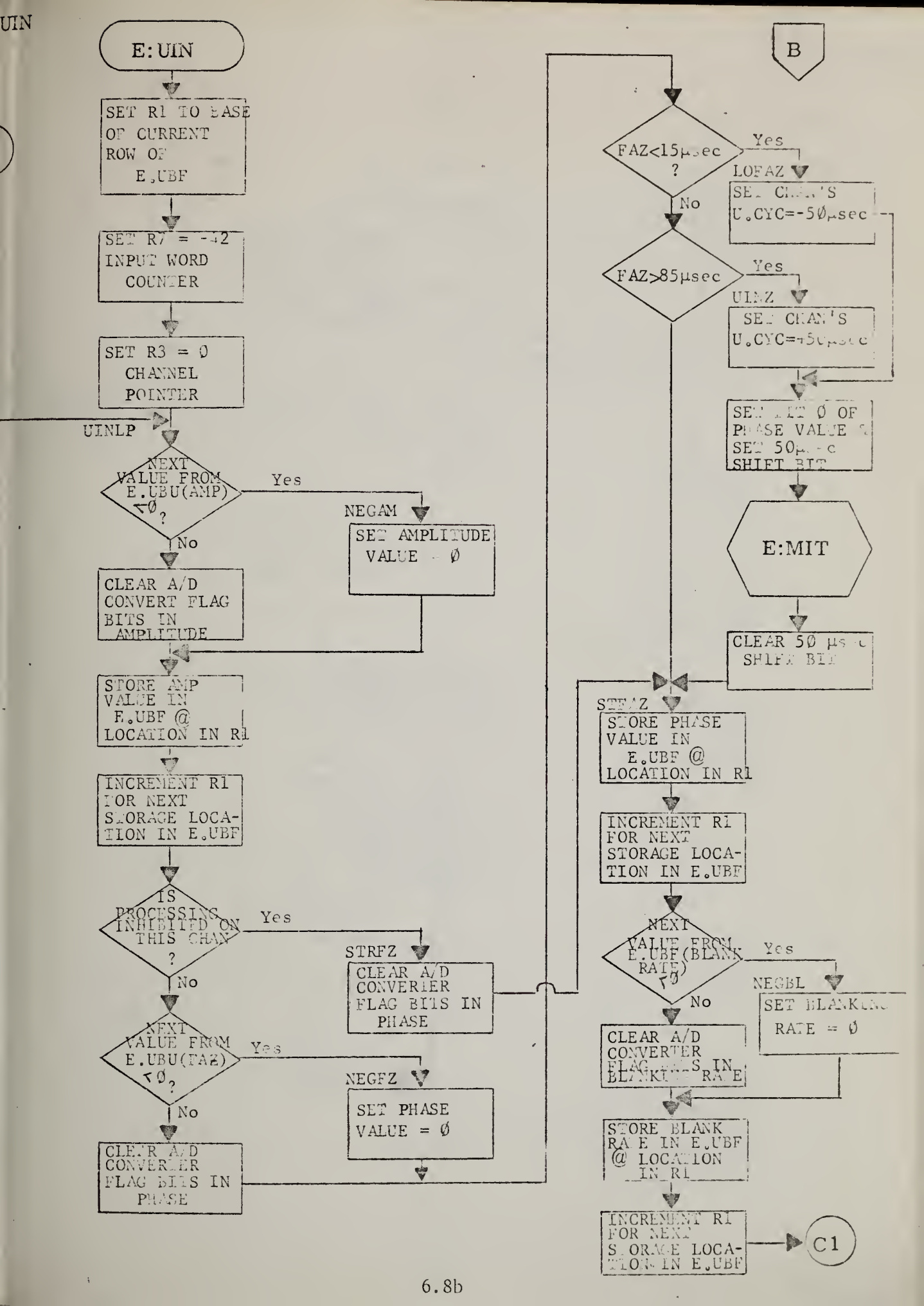
6.4 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
E:UIN		Entry point for data preprocessor
E:ANL		Entry point for AIS SI service routine
E:MIT		Entry point for executive service routine to transmit sensor parameter settings to equipment.
E:UBU	42	Input buffer for data read in from AIS via DMP
E.UBF	44Ø	Holding buffer for input data, preprocessed with time words appended, for ten seconds.
E.SF1	1	Bit Ø set for first AIS record, reset thereafter

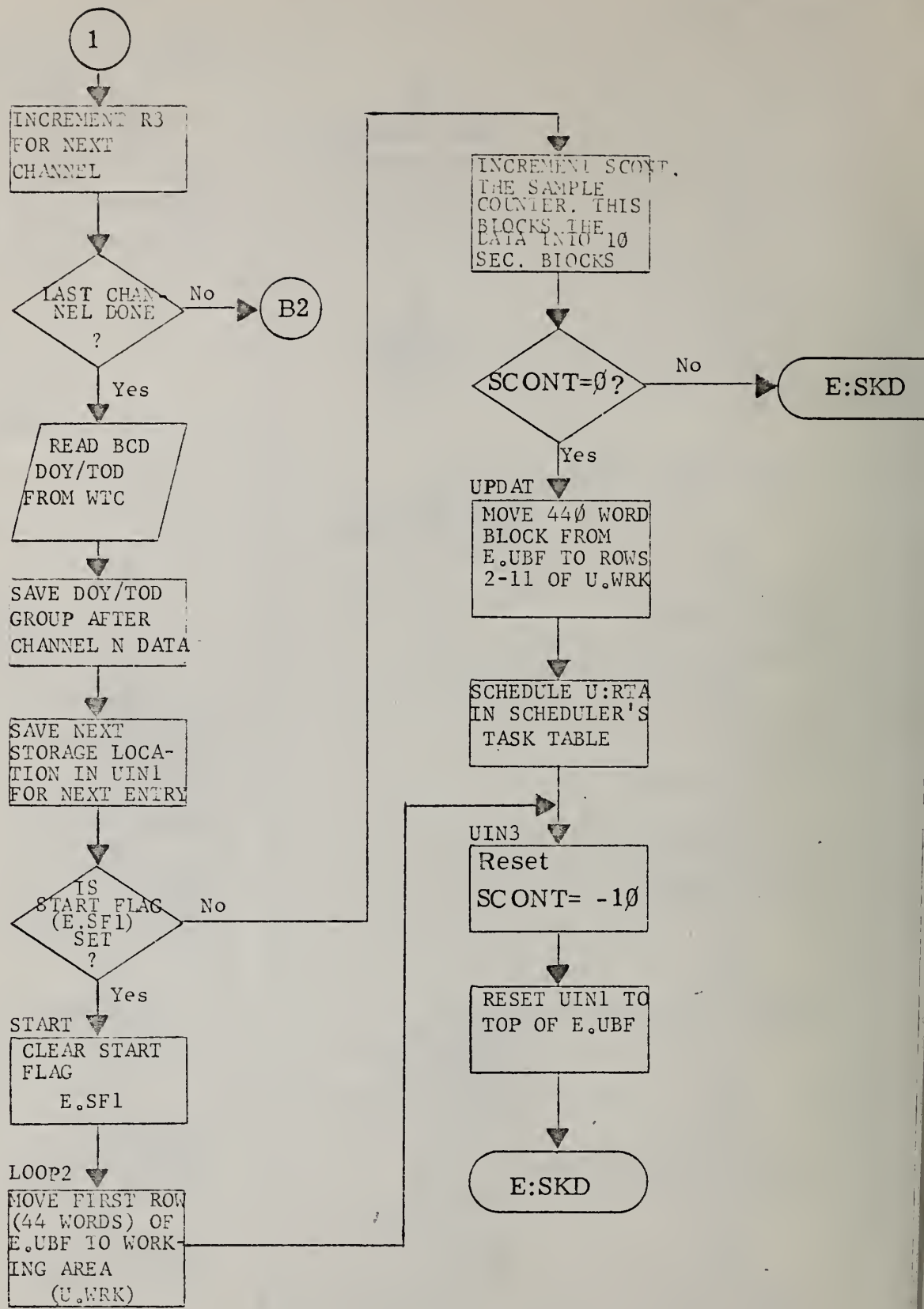
6.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
SHIFT	1	Bit 15 used to flag need to send 5Ø microsecond phase shift.
SCONT	1	Ten second counter used to recognize when E.UBF is full.

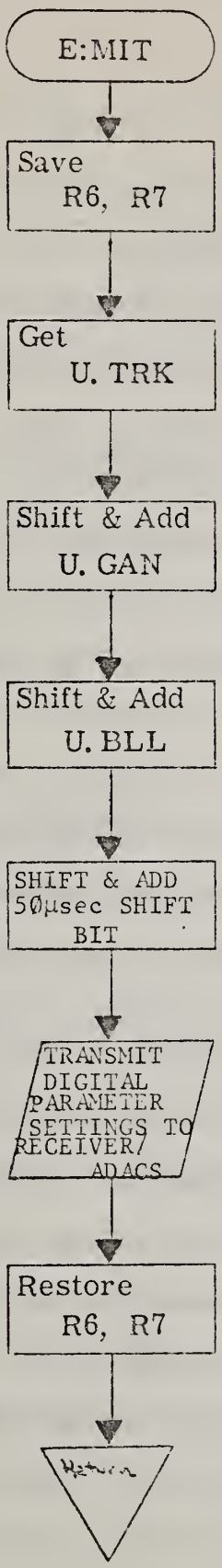

E:ANL
SCHEDULE E:UIN IN SCHEDULER'S TASK TABLE
Clear INT and Return


UIN
E:UIN
SET R1 TO BASE OF CURRENT ROW OF E.UBF
SET R7 = -42 INPUT WORD COUNTER
SET R3 = 0 CHANNEL POINTER
UINLP
NEXT VALUE FROM E.UBU(AMP) <0 ?
Yes
NEGAM
SET AMPLITUDE VALUE = 0
No
CLEAR A/D CONVERT FLAG BITS IN AMPLITUDE
STORE AMP VALUE IN E.UBF @ LOCATION IN R1
INCREMENT R1 FOR NEXT STORAGE LOCATION IN E.UBF
IS PROCESSING INHIBITED ON THIS CHAN ?
Yes
STRFZ
CLEAR A/D CONVERTER FLAG BITS IN PHASE
No
NEXT VALUE FROM E.UBU(PAZ) <0 ?
Yes
NEGFZ
SET PHASE VALUE = 0
No
CLEAR A/D CONVERTER FLAG BITS IN PHASE
B
FAZ<15μsec ?
Yes
LOFAZ
SET CHAN'S U.CYC=-50μsec
No
FAZ>85μsec
Yes
UINZ
SET CHAN'S U.CYC=+50μsec
SET BIT 0 OF PHASE VALUE & SET 50μsec SHIFT BIT
E:MIT
CLEAR 50 μsec SHIFT BIT
STFAZ
STORE PHASE VALUE IN E.UBF @ LOCATION IN R1
INCREMENT R1 FOR NEXT STORAGE LOCATION IN E.UBF
NEXT VALUE FROM E.UBF(BLANK RATE) <0
Yes
NEGBL
SET BLANKING RATE = 0
No
CLEAR A/D CONVERTER FLAG BITS IN BLANKING RATE
STORE BLANK RATE IN E.UBF @ LOCATION IN R1
INCREMENT R1 FOR NEXT STORAGE LOCATION IN E.UBF
C1

C


1
INCREMENT R3 FOR NEXT CHANNEL
LAST CHANNEL DONE ?
No
B2
Yes
READ BCD DOY/TOD FROM WTC
SAVE DOY/TOD GROUP AFTER CHANNEL N DATA
SAVE NEXT STORAGE LOCATION IN UIN1 FOR NEXT ENTRY
IS START FLAG (E.SF1) SET ?
No
Yes
START
CLEAR START FLAG E.SF1
LOOP2
MOVE FIRST ROW (44 WORDS) OF E.UBF TO WORKING AREA (U.WRK)
INCREMENT SCONT, THE SAMPLE COUNTER. THIS BLOCKS THE DATA INTO 10 SEC. BLOCKS
SCONT=Ø?
No
E:SKD
Yes
UPDAT
MOVE 44Ø WORD BLOCK FROM E.UBF TO ROWS 2-11 OF U.WRK
SCHEDULE U:RTA IN SCHEDULER'S TASK TABLE
UIN3
Reset SCONT= -1Ø
RESET UIN1 TO TOP OF E.UBF
E:SKD

D


E:MIT
Save
R6, R7
Get
U. TRK
Shift & Add
U. GAN
Shift & Add
U. BLL
SHIFT & ADD
50μsec SHIFT
BIT
TRANSMIT
DIGITAL
PARAMETER
SETTINGS TO
RECEIVER/
ADACS
Restore
R6, R7
Return

7. E$SUB

7.1 Functional Description

E$SUB contains a set of interrupt service routines for power loss, memory parity errors, and console interrupts.

7.1.1 E:PWD (The Power Loss Interrupt)

Hardware power sensors vector control to the power down subroutine (E:PWD) at least 2ØØ machine cycles prior to total power failure. This program resets the interrupt location, which indicates where the power failure service routine is located, to point to the power up subroutine (E:PWU). When the power is restored, control will then be vectored to that program where processing may be resumed. E:PWD also reads the current BCD time as the time of the power failure. The program then hangs itself in a tight no-op loop until the power drops completely out.

7.1.2 E:PWU (The Power Restored Interrupt)

When power is restored to the processor, an interrupt is generated which vectors control to the power up subroutine, E:PWU. Here the current time is read to indicate when power was restored, and a message is generated to log the power loss and resumption. The interrupt location is reset to vector control to E:PWD for the next failure. Since any loss of continuity in data is considered serious, and the fact that power fluctuations causes noise spikes in the sensor, the system will be re-started after each power failure. Therefore, control is transferred to E:ANF in E$INT.

7.1.3 E:PAR (The Memory Parity Error Interrupt)

When the hardware memory parity checking circuitry detects a memory parity error, control is vectored to E:PAR. This routine generates a log message indicating the time of the error detection and the memory location at which the error was detected. For the first two such errors, the system will restart at E:ANF in E$INT. In this way, if the location affected is not executed often, the system will continue to process where it can. System restarts would serve no purpose if the error were common to many sections of memory, or if they were in heavily used sections of the program, so the system halts if more than two errors are detected.

7.1.4 E:ABR (The Console Interrupt)

When the operator depresses the Console Interrupt switch on the console panel, control is vectored to E:ABR, where B:ORT is scheduled in the scheduler's task table. Control is then returned to the program in progress.

7.1.5 B:ORT (The Background Task Abortion Routine)

B:ORT is entered from the scheduler in response to a console interrupt. This routine resets B.STT (the background status) to Ø, generates a message to the operator on the ASR 35 announcing, "BACKGROUND TASK ABORTED BY OPERATOR," and returns control to the scheduler at E:SKD.

If the background scheduler should be entered again, it will find B.STT = Ø and bypass background processing.

7.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:FRT	E$FRT	Reformats BCD time from the WTC to ASCII for output.
E:FCT	E$FRT	Reformats BCD time from memory to ASCII for output.
E:028	E$T28	Translates message to BAUDOT code and stores it in buffer before transmission to the ASR 28.
E:035	E$T35	Transfers output message to buffer before transmission to the ASR 35.

7.3 Input Parameter Descriptions

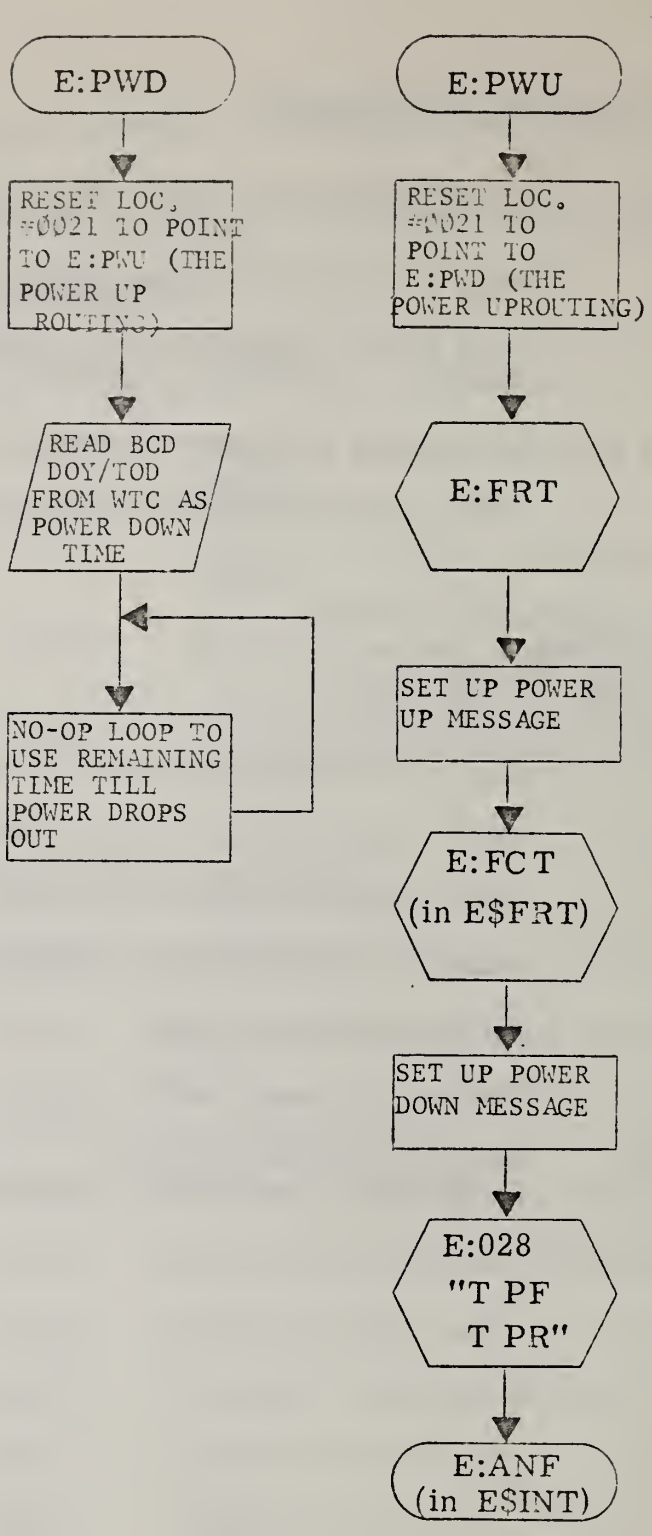
PARAMETER	PROGRAM	DESCRIPTION
E:TM1 E:TM2	E$FRT	Two word BCD time used as parameter value for E:FCT.
E.28F	E$T28	Parameter word used in calling E:028.
E.IOF	E$T35	Parameter word used in calling E:035.
B.STT	E$SKD	Background processing status (See Table 3.2).
E.35Ø	E$T35	ASR 35 IO status word.
E.T1Ø	E$SKD	Task table entry for B:ORT.
E:ANF	E$INT	System Restart Point.
E:SKD	E$SKD	Scheduler entry point.

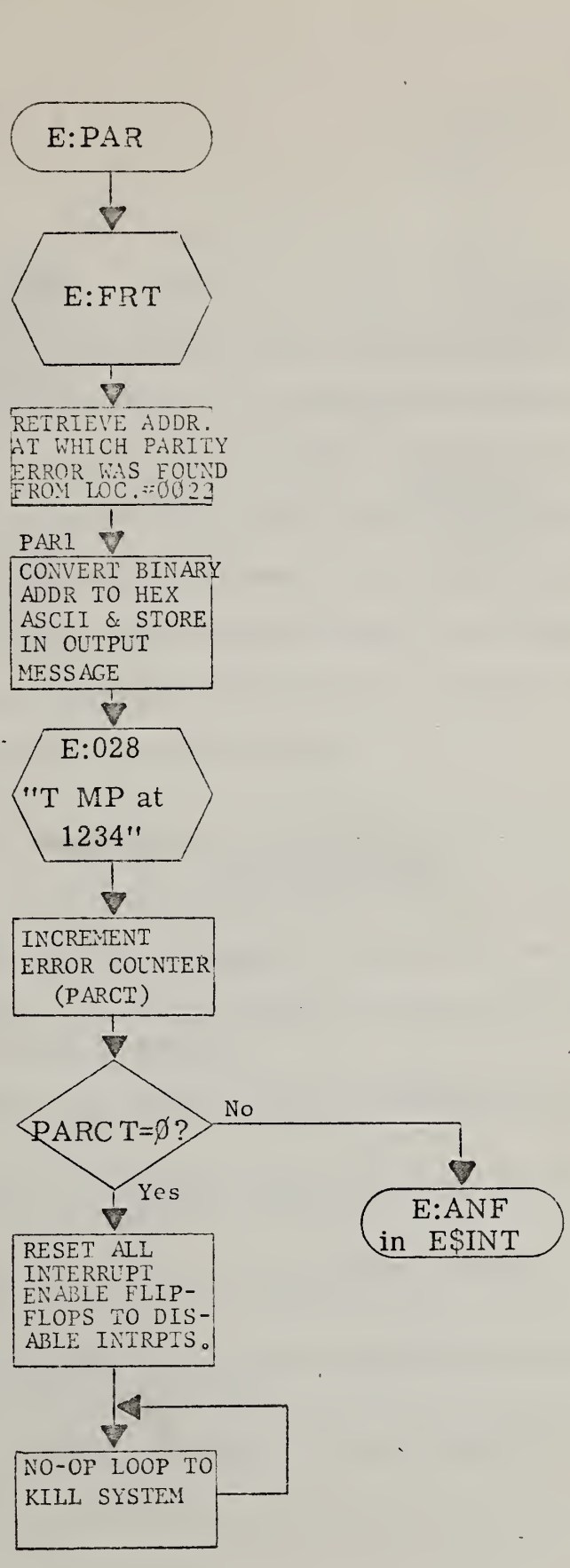
7.4 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
E:PWD		Entry point to power down interrupt service routine.
E:PAR		Entry point to memory parity interrupt service routine.
E:ABR		Entry point to console interrupt service routine.
B:ORT		Entry point to background task abortion routine.

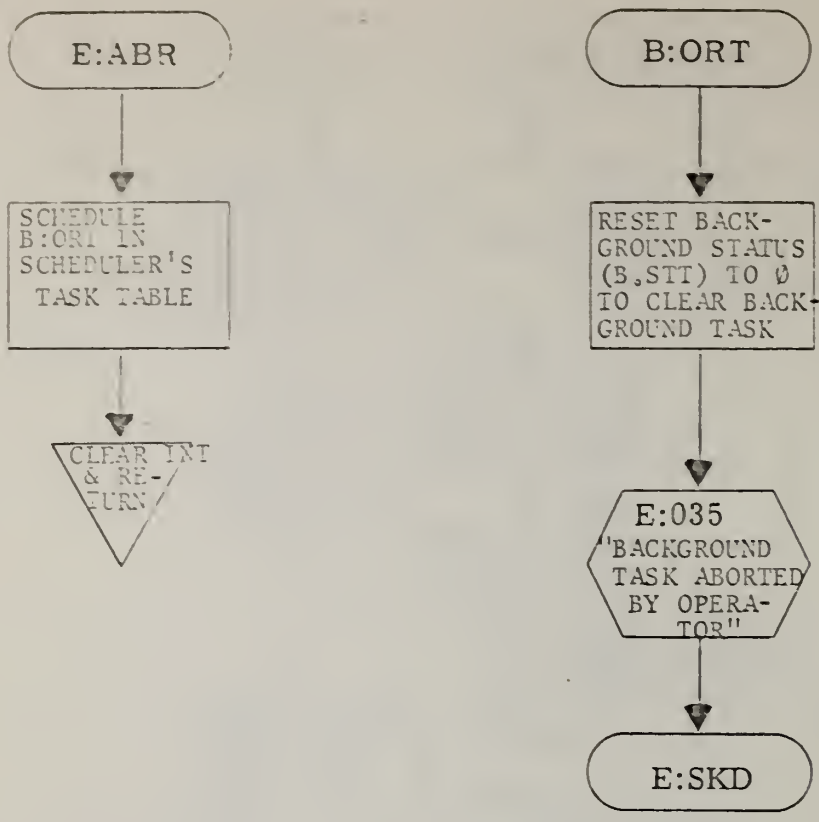
7.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
PWDT1	2	Storage for BCD time of power down
PWRMS	11	Power failure message "123 123456 T PF"
PMS1	9	Power restored message "123 123456 T PR"
PARMS	15	Memory parity message "123 123456 T MP AT ØØØØ"
PARS1		Memory location in PARMS
PARCT	1	Counter for memory parity errors
BMSG	21	Console Interrupt message: "BACKGROUND TASK ABORTED BY OPERATOR."


A
E:PWD
RESET LOC. #0021 TO POINT TO E:PWU (THE POWER UP ROUTINE)
READ BCD DOY/TOD FROM WTC AS POWER DOWN TIME
NO-OP LOOP TO USE REMAINING TIME TILL POWER DROPS OUT
E:PWU
RESET LOC. #0021 TO POINT TO E:PWD (THE POWER UPROUTING)
E:FRT
SET UP POWER UP MESSAGE
E:FCT (in E$FRT)
SET UP POWER DOWN MESSAGE
E:028 "T PF T PR"
E:ANF (in E$INT)


B
E:PAR
E:FRT
RETRIEVE ADDR. AT WHICH PARITY ERROR WAS FOUND FROM LOC.=0022
PAR1
CONVERT BINARY ADDR TO HEX ASCII & STORE IN OUTPUT MESSAGE
E:028
"T MP at 1234"
INCREMENT ERROR COUNTER (PARCT)
PARCT=Ø?
No
Yes
E:ANF in E$INT
RESET ALL INTERRUPT ENABLE FLIP-FLOPS TO DIS-ABLE INTRPTS.
NO-OP LOOP TO KILL SYSTEM

C


E:ABR
SCHEDULE B:ORT IN SCHEDULER'S TASK TABLE
CLEAR INT & RE-TURN
B:ORT
RESET BACK-GROUND STATUS (B,STT) TO Ø TO CLEAR BACK-GROUND TASK
E:035 "BACKGROUND TASK ABORTED BY OPERA-TOR"
E:SKD

8. E$OMI

8.1 Functional Description

When the ASR 35 is in the request mode (i.e., awaiting input not in response to a background task request for information), E$OMI will be scheduled when the operator completes his input, terminated by a carriage return character. Appendix III provides operating instructions on the operator's intercourse with the system. His request for system action is received by E:OMI as a four character keyword and perhaps additional information required by the desired task. Table 8.1 lists the normal keywords and the actions they generate.

KEYWORD	ACTION RESULTING
LOG:	Transfer operator's message to station log on ASR 28
DFC:	Set B.STT = 1, schedule E:BSK to execute DRFUD tape format checking routine.
DDD:	Set B.STT = 2, schedule E:BSK to execute DRFUD data display routine.
DDA:	Set B.STT = 3, schedule E:BSK. This now executes a dummy task in E$INT.
OPC:	Schedule U:PST to initiate operator parameter change to a sensor channel.
STD:	Schedule M:STD to generate a Current Status Display table in the station log.
CRC:	Schedule U:RED to perform a channel redundancy test.

Table 8.1 E:OMI Keyword Decoding List

If the first four characters of the operator's input does not match any of the keywords in the above list, bit 7 of the console switch register is checked. If it is set, two additional keywords are available; "DIS:" and "SET:". These additional options are protected by the position of bit 7 as they are intended for the use of programmers knowledgeable in the software system design, and not by the normal operator. The DIS: option cuases the contents of a specified memory location to be displayed on the ASR 35. The SET: option permits the operator to specify a value to which a location will be set. The formats are:

DIS:AAAA

SET:AAAA=VVVV

where AAAA is a four digit hexadecimal memory address, and VVV is a four digit hexadecimal value to be stored in the specified memory location.

If the keyword is not in the list in Table 8.1 and bit 7 is reset, or if the keyword is not in the list or either DIS: or SET:, then a keyword error is reported to the operator by an "INVALID KEYWORD, MSG. IGNORED" message on the ASR 35. If a character used in specifying either an address or a value in a DIS: or SET: request is not a valid hexadecimal digit, an "INVALID HEX DIGIT" message is generated. If an equal sign (=) does not appear between the address and the value of a SET: request, an "INVALID FORMAT" message is generated.

After E:OMI completes those actions associated with the operator's request, control is returned to the scheduler.

8.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:035	E$T35	Transfers output messages to buffer before transmission to the ASR 35.
E:028	E$T28	Translates message to BAUDOT code and stores it in buffer before transmission to the ASR 28.
E:FRT	E$FRT	Reformats BCD time from the WTC to ASCII for output.

8.3 Data Formats

The list of valid keywords is kept in a table called MSGTB. Each entry corresponds to one keyword, and requires four computer words, interpreted as follows:

WORD 1 -- First two characters of the keyword.

WORD 2 -- Last two characters of the keyword.

WORD 3 -- Bit Ø set for LOG: option, otherwise reset.

Bit 1 set if request is to schedule foreground task in scheduler's task table, otherwise reset.

Bit 2 set if request is for a background task, otherwise reset.

Bits 13 - 15 hold value to which B.STT is to be set if request is for a background task, otherwise unused.

WORD 4 -- Address of the task table entry to be flagged for this request (set to schedule E:BSK for all background tasks).

8.4 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
E.35I	E$T35	Address of first character of input from ASR 35.
E.IOF	E$T35	Parameter word used in calling E:035.
E.31C	E$T35	Count of characters in ASR 35 input buffer.
B.STT	E$SKD	Background processing status (see Table 3.2).
E.TØ4	E$SKD	Task table entry for U$RED.
E.TØ8	E$SKD	Task table entry for M$STD.
E.T13	E$SKD	Task table entry for R$PST.
E.T15	E$SKD	Task table entry for E:SKD.
E.28F	E$T28	Parameter word used in calling E:028.
E:SKD	E$SKD	Scheduler entry point.

8.5 Output Parameter Description

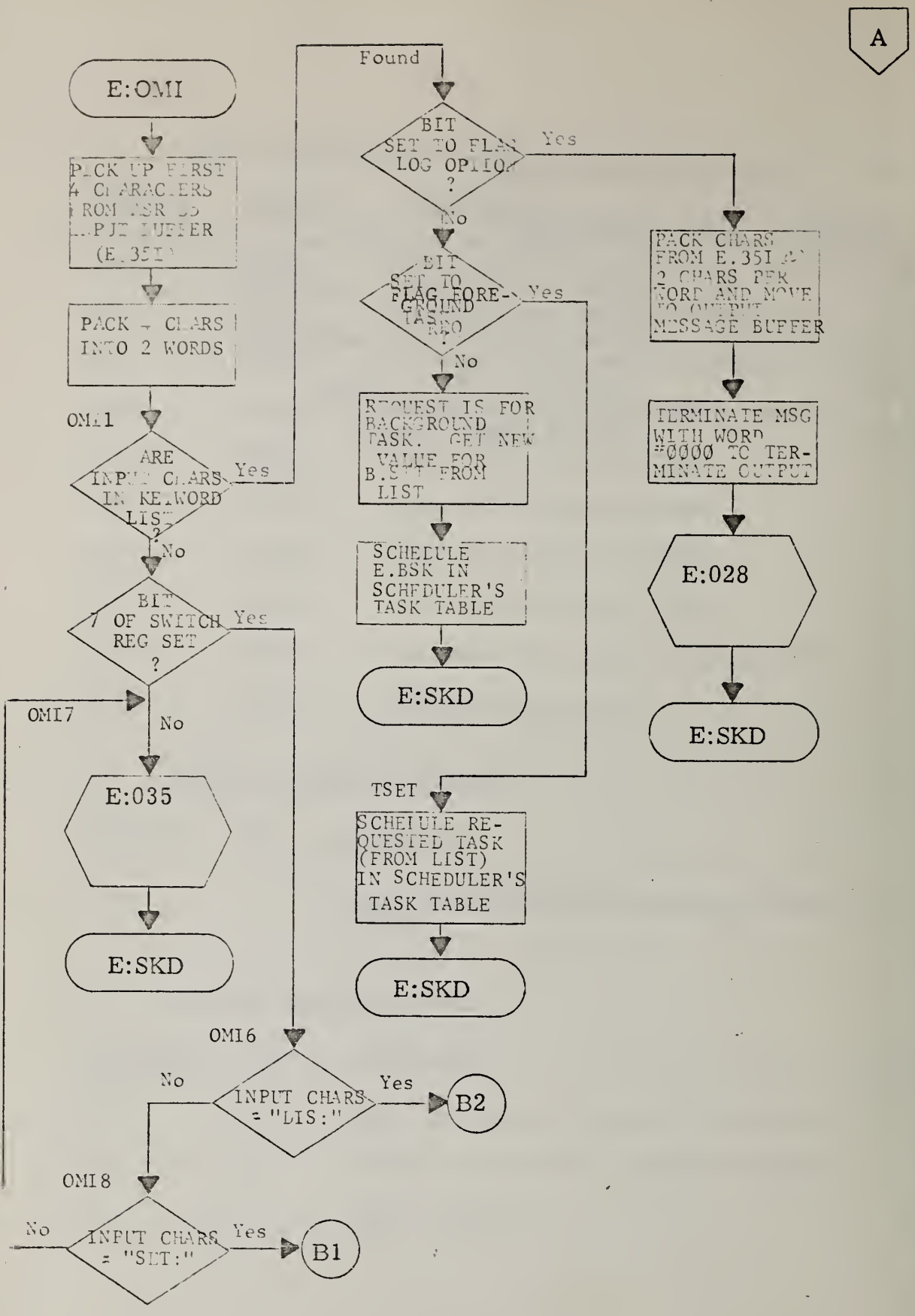
PARAMETER	SIZE	DESCRIPTION
E:OMI		Entry point for operator message interpreting routine.

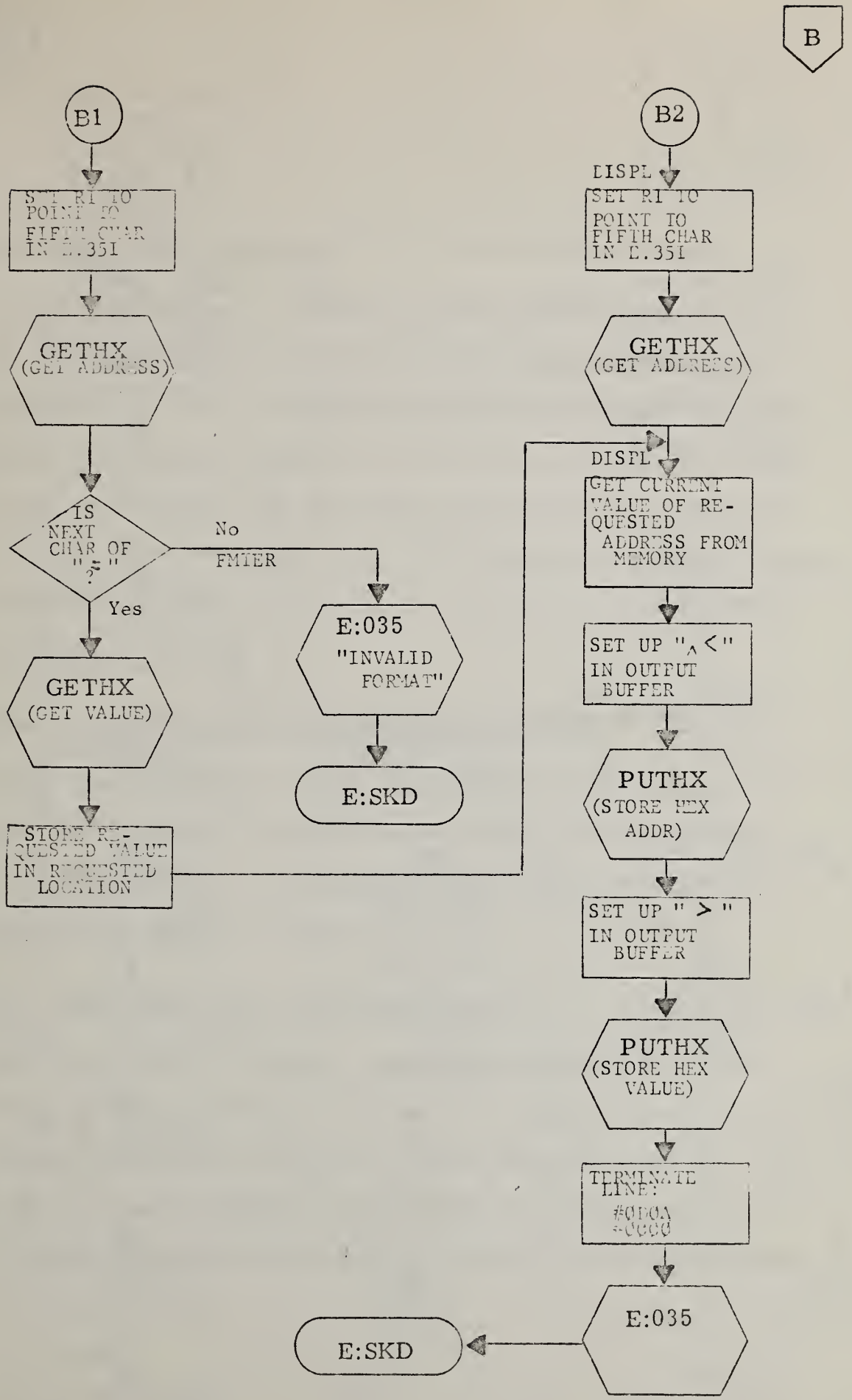
8.6 Internal Data Descriptions

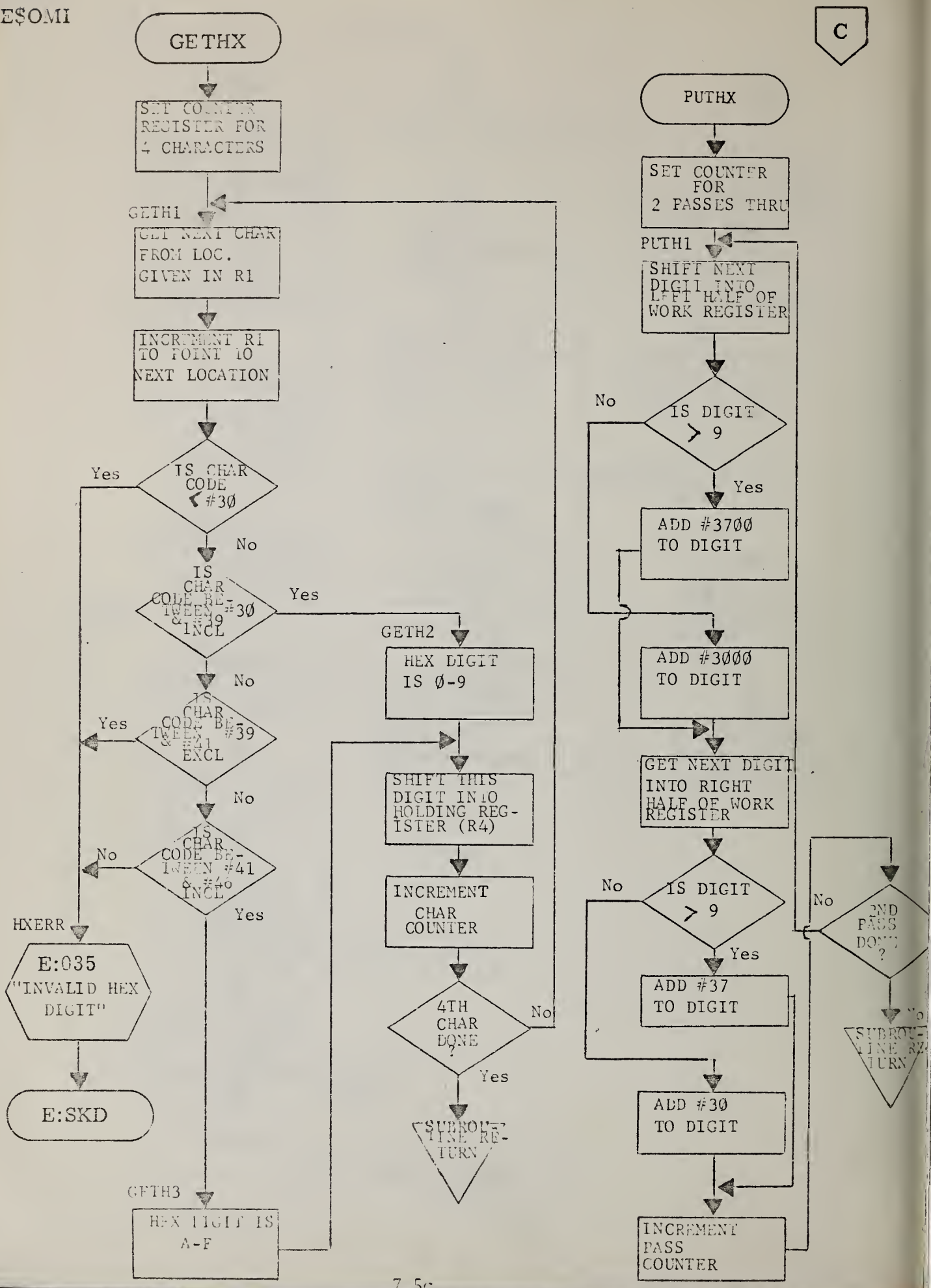
PARAMETER	SIZE	DESCRIPTION
MSGTB	28	Table to interpret keywords (see Section 8.3)
MSG1	17	"INVALID KEYWORD, MSG. IGNORED" message
SPACE	1	Space character

8.6 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
MSG2	8	Header for log message: "123 123456 L:".
MSG2A	4Ø	Buffer for operator's log message.
MSG3	11	"INVALID HEX DIGIT" message.
MSG4	9	"INVALID FORMAT" message.


A
E:OMI
PACK UP FIRST 4 CHARACTERS FROM USR'S INPUT BUFFER (E.35I)
PACK 4 CHARS INTO 2 WORDS
OMI1
ARE INPUT CHARS IN KEYWORD LIST ?
Yes
No
BIT 7 OF SWITCH REG SET ?
Yes
No
OMI7
E:035
E:SKD
Found
BIT SET TO FLAG LOG OPTION ?
Yes
No
BIT SET TO FLAG FORE-GROUND REQ ?
Yes
No
REQUEST IS FOR BACKGROUND TASK. GET NEW VALUE FOR B.SIT FROM LIST
SCHEDULE E.BSK IN SCHEDULER'S TASK TABLE
E:SKD
PACK CHARS FROM E.35I 2 CHARS PER WORD AND MOVE TO OUTPUT MESSAGE BUFFER
TERMINATE MSG WITH WORD #0000 TO TERMINATE OUTPUT
E:028
E:SKD
TSET
SCHEDULE REQUESTED TASK (FROM LIST) IN SCHEDULER'S TASK TABLE
E:SKD
OMI6
INPUT CHARS = "LIS:"
No
Yes
B2
OMI8
INPUT CHARS = "SIT:"
No
Yes
B1


B
B1
SET RI TO POINT TO FIFTH CHAR IN L.351
GETHX (GET ADDRESS)
IS NEXT CHAR OF "=" ?
No
ERMTER
Yes
E:035 "INVALID FORMAT"
E:SKD
GETHX (GET VALUE)
STORE REQUESTED VALUE IN REQUESTED LOCATION
B2
DISPL
SET RI TO POINT TO FIFTH CHAR IN L.351
GETHX (GET ADDRESS)
DISPL
GET CURRENT VALUE OF REQUESTED ADDRESS FROM MEMORY
SET UP "A<" IN OUTPUT BUFFER
PUTHX (STORE HEX ADDR)
SET UP ">" IN OUTPUT BUFFER
PUTHX (STORE HEX VALUE)
TERMINATE LINE
#0D0A
-0000
E:035
E:SKD


GETHX
SET COUNTER REGISTER FOR 4 CHARACTERS
GETH1
GET NEXT CHAR FROM LOC. GIVEN IN R1
INCREMENT R1 TO POINT TO NEXT LOCATION
IS CHAR CODE < #3Ø
Yes
No
IS CHAR CODE BE-TWEEN #3Ø & #39 INCL
Yes
No
IS CHAR CODE BE-TWEEN #41 & #46 INCL
Yes
No
IS CHAR CODE BE-TWEEN #41 & #46 INCL
No
Yes
HXERR
E:035 "INVALID HEX DIGIT"
E:SKD
GETH2
HEX DIGIT IS Ø-9
GETH3
HEX DIGIT IS A-F
SHIFT THIS DIGIT INTO HOLDING REG-ISTER (R4)
INCREMENT CHAR COUNTER
4TH CHAR DONE ?
No
Yes
SUBROU-TINE RE-TURN
C
PUTHX
SET COUNTER FOR 2 PASSES THRU
PUTH1
SHIFT NEXT DIGIT INTO LEFT HALF OF WORK REGISTER
IS DIGIT > 9
No
Yes
ADD #37ØØ TO DIGIT
ADD #3ØØØ TO DIGIT
GET NEXT DIGIT INTO RIGHT HALF OF WORK REGISTER
IS DIGIT > 9
No
Yes
ADD #37 TO DIGIT
ADD #3Ø TO DIGIT
INCREMENT PASS COUNTER
2ND PASS DONE ?
No
SUBROU-TINE RE-TURN

9. E$T28

9.1 Functional Description

The ASR 28 teletype is a BAUDOT character oriented teleprinter with the capability to punch five-level paper tapes simultaneous to teleprinter operation. In NUSTAD, the ASR 28 is configured in a "receive only" mode of operation. It is used to maintain the station log and prepare paper tapes with signal descriptions for transmission over standard communications lines. E$T28 handles all aspects of data transmissions concerning the ASR 28. It consists of three subprograms: E:I28, E:T28, and E:O28.

9.1.1 E:I28 (ASR 28 Data Interrupt Service Routine)

After the transmission of each character to the ASR 28 is completed, a data interrupt (DI) is generated which vectors control to E:I28, which schedules E:T28 in the scheduler's task table, and returns control to the interrupt program.

9.1.2 E:T28 (ASR 28 Character Output Routine)

After each character has been transmitted to the ASR 28, E:T28 is entered from the scheduler to determine if another character is ready for transmission, and if it is, to initiate that transfer. If the output buffer (CHRBF) is empty, then all messages in that buffer have been transmitted and the ASR 28 will go idle until another

message is entered into CHRBF via the E:028 routine. Part III of Reportable Signal Description (RSD) messages will not be initiated until CHRBF is empty. Therefore, whenever the buffer is emptied, a flag bit in T28IO is examined to determine if a Part III RSD is waiting. If it is, U:RP3 is flagged in the scheduler's task table before control is returned to the scheduler. If not, control is returned immediately.

9.1.3 E:028 (ASR 28 Message Output Routine)

This routine is called by all programs desiring to transmit data to the ASR 28 teletype. The program translates the message from the internal storage form (ASCII characters) to the BAUDOT code, and stores the BAUDOT characters in the output buffer (CHRBF). After all ASCII characters have been translated (see Table 9.1 for the ASCII to BAUDOT conversion used), E:028 determines whether the teletype is already in use or not. If not, it initiates output by transmitting a null character to start up the IO interface and the teletype. When this first character transmission is completed, a DI will occur, vectoring control to E:T28 through the DI service routine (E:I28) and the system scheduler to continue further output. If the ASR 28 is already outputting characters when the last message character is moved to the output buffer, the program will in effect have appended this new message to whatever output is currently underway so that the E:T28 program will treat all output as one continuous message. E.28F is then examined to

determine whether or not to set the reschedule bit for U:RP3 in T28IO. Control is returned to the calling program.

The station log will contain four types of messages:

a. Routine; change of status, parameter value, etc.

b. Tables; current or historical data on system operating status.

c. Reportable Signal Descriptors.

d. Operator generated messages.

The first type is generated by E$LOG (see Section 23) upon request of either an applications or a system program. The tables are generated by either M$STD (Section 22) or M$LEV (Section 21). Reportable Signal Descriptions are generated as a result of waveform analysis via U$REP (Section 17). The final type of messages is generated by the operator using the LOG: option (see Section 8, E$OMI).

The program transmits data to the ASR 28 by calling E:028 using the following calling sequence:

```
BLM,14        E:028
DFC           (Address of first character to be transmitted)
```

and E.28F is set as follows:

BIT Ø = Ø All messages other than a Reprotable Signal Descriptor.

= 1 If message is Part II of a RSD and the system is to schedule U:RP3 when all other output is completed.

ASCII CODE	ASCII CHAR	BAUDOT CODE	BAUDOT CHAR	ASCII CODE	ASCII CHAR	BAUDOT CODE	BAUDOT CHAR	ASCII CODE	ASCII CHAR	BAUDOT CODE	BAUDOT CHAR
ØØ	NUL	ØØ	NUL	2B	+	F-ØB	&	56	V	L-ØF	V
Ø1	SOH	ØØ	NUL	2C	,	F-Ø6	,	57	W	L-19	W
Ø2	STX	ØØ	NUL	2D	-	F-18	-	58	X	L-17	X
Ø3	ETX	ØØ	NUL	2E	.	F-Ø7	.	59	Y	L-15	Y
Ø4	EOT	ØØ	NUL	2F	/	F-17	/	5A	Z	L-11	Z
Ø5	ENQ	ØØ	NUL	3Ø	Ø	F-ØD	Ø	5B	[	F-1E	(
Ø6	ACK	ØØ	NUL	31	1	F-1D	1	5C	\	F-Ø6	,
Ø7	BEL	ØØ	NUL	32	2	F-19	2	5D	]	F-Ø9	)
Ø8	BS	ØØ	NUL	33	3	F-1Ø	3	5E	^	ØØ	NUL
Ø9	HT	ØØ	NUL	34	4	F-ØA	4	5F	_	F-18	-
ØA	LF	L-Ø8	LF	35	5	F-Ø1	5	6Ø	`	F-Ø6	,
ØB	VT	ØØ	NUL	36	6	F-15	6	61	a	L-18	A
ØC	FF	ØØ	NUL	37	7	F-1C	7	62	b	L-13	B
ØD	CR	L-Ø2	CR	38	8	F-ØC	8	63	c	L-ØE	C
ØE	SO	ØØ	NUL	39	9	F-Ø3	9	64	d	L-12	D
ØF	SI	ØØ	NUL	3A	:	F-ØE	:	65	e	L-1Ø	E
1Ø	DLE	ØØ	NUL	3B	;	F-ØF	;	66	f	L-16	F
11	DC1	ØØ	NUL	3C	<	F-1E	(	67	g	L-ØB	G
12	DC2	ØØ	NUL	3D	=	F-16	!	68	h	L-Ø5	H
13	DC3	ØØ	NUL	3E	>	F-Ø9	)	69	i	L-ØC	I
14	DC4	ØØ	NUL	3F	?	F-13	?	6A	j	L-1A	J
15	NAK	ØØ	NUL	4Ø	@	ØØ	NUL	6B	k	L-1E	K
16	SYN	ØØ	NUL	41	A	L-18	A	6C	l	L-Ø9	L
17	ETB	ØØ	NUL	42	B	L-13	B	6D	m	L-Ø7	M
18	CAN	ØØ	NUL	43	C	L-ØE	C	6E	n	L-Ø6	N
19	EM	ØØ	NUL	44	D	L-12	D	6F	o	L-Ø3	O
1A	SVB	ØØ	NUL	45	E	L-1Ø	E	7Ø	p	L-ØD	P
1B	ESC	ØØ	NUL	46	F	L-16	F	71	q	L-1D	Q
1C	FS	L-1B	FIG	47	G	L-ØB	G	72	r	L-ØA	R
1D	GS	ØØ	NUL	48	H	L-Ø5	H	73	s	L-14	S
1E	RS	ØØ	NUL	49	I	L-ØC	I	74	t	L-Ø1	T
1F	US	L-1F	LTR	4A	J	L-1A	J	75	u	L-1C	U
2Ø	space	L-Ø4	space	4B	K	L-1E	K	76	v	L-ØF	V
21	!	F-16	!	4C	L	L-Ø9	L	77	w	L-19	W
22	"	F-11	"	4D	M	L-Ø7	M	78	x	L-17	X
23	#	F-Ø5	NP	4E	N	L-Ø6	N	79	y	L-15	Y
24	$	F-12	$	4F	O	L-Ø3	O	7A	z	L-11	Z
25	%	F-17	/	5Ø	P	L-ØD	P	7B	{	F-1E	(
26	&	F-ØB	&	51	Q	L-1D	Q	7C	!	F-Ø6	,
27	'	F-1A	'	52	R	L-ØA	R	7D	}	F-Ø9	)
28	(	F-1E	(	53	S	L-14	S	7E	~	ØØ	NUL
29	)	F-Ø9	)	54	T	L-Ø1	T	7F	DEL	F-14	BEL
2A	*	F-1A	'	55	U	L-1C	U				

NOTE: BAUDOT code transmits in two modes. L is used to denote characters in the LTR mode, and F to denote characters in the FIG mode. Both ASCII and BAUDOT codes are shown in hexadecimal.

Table 9.1 NUSTAD ASCII to BAUDOT Conversion Table

All characters in consecutive memory locations beginning at the location specified will be translated and stored for output until a null character ($\emptyset\emptyset_{16}$) is reached. This will be considered as a terminator for the output message.

9.2 Data Formats

9.2.1 Conversion Table Entries

The table used to equate ASCII characters with the BAUDOT equivalents as given in Table 9.1 is called BAUDT. Each ASCII character corresponds to one character (byte) in the table. The Most Significant Bit (MSB) of the byte is set if the character in that byte is in the FIG mode. The actual bits of the BAUDOT character are stored in the five Least Significant Bits of that byte, in reverse order. For example, the letter "A" is normally represented in BAUDOT as an 18_{16}. In BAUDT it is stored as $\emptyset 3_{16}$.

9.2.2 FLAG

During the translation process, mode change characters ($1B_{16}$ to FIG and $1F_{16}$ to LTR) are transmitted only when the next character is not in the same mode as the last character translated. Therefore, bit 8 of FLAG is used to determine the mode of the last character moved to CHRBF. If bit 8 is set, the last character considered was in the FIG mode, and a mode change character will not be needed until the next character is in the LTR mode.

9.2.3 T28IO

T28IO maintains all necessary status information concerning the ASR 28. It is interpreted as follows:

BIT Ø = Ø ASR 28 is idle, no output in progress.

= 1 Output is underway to the ASR 28.

BIT 1 = Ø No report message (Part III of RSD) waiting.

= 1 Need to schedule U:RP3 first time CHRBF becomes empty.

BIT 2 = 0 Normal output mode.

= 1 Next DI will be to output first character from CHRBF.

9.3 Input Parameter Descriptions

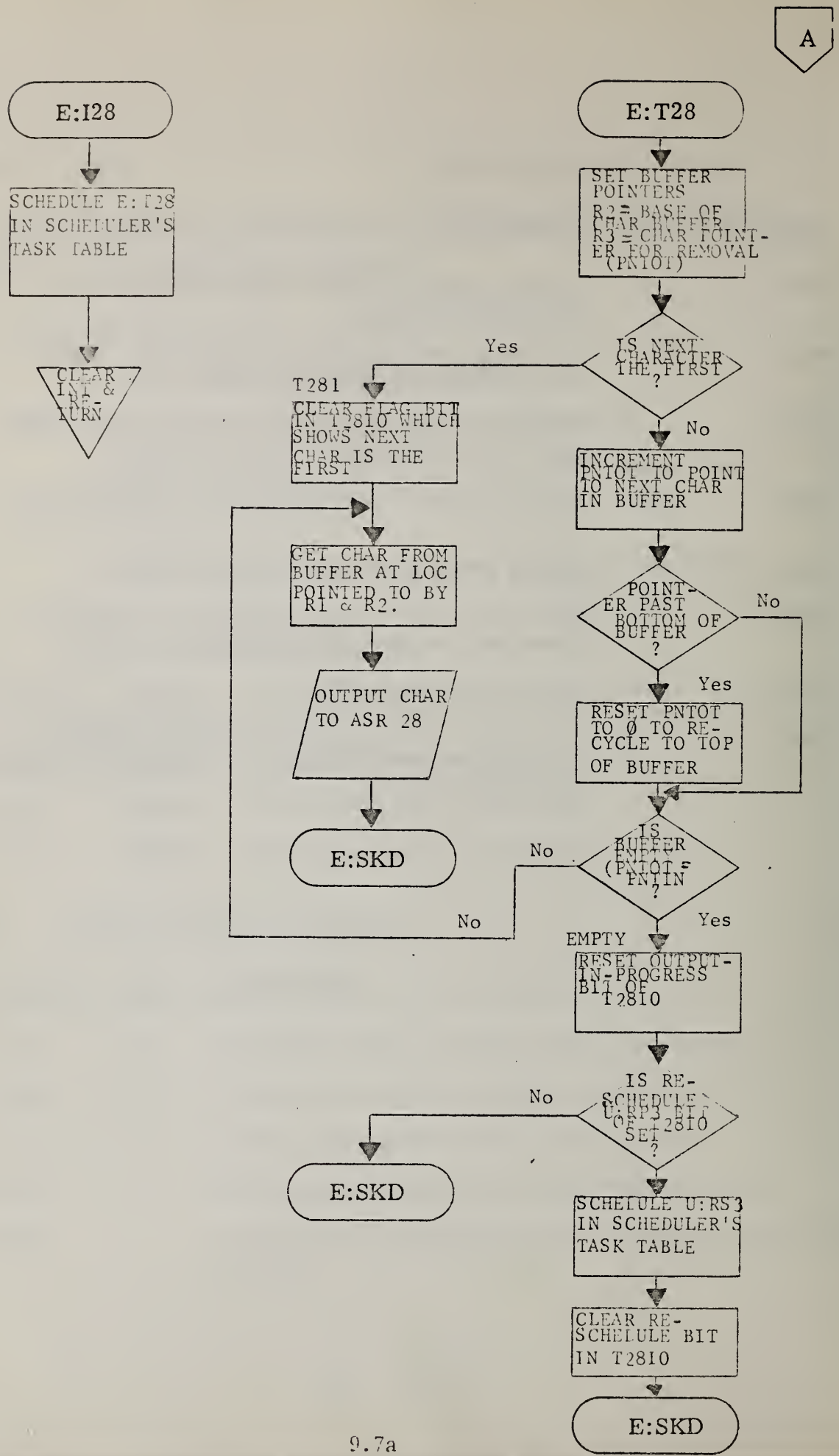
PARAMETER	PROGRAM	DESCRIPTION
E:SKD	E$SKD	Scheduler entry point.
E.TØ5	E$SKD	Task table entry for E:T28.
E.TØ7	E$SKD	Task table entry for U:RP3.

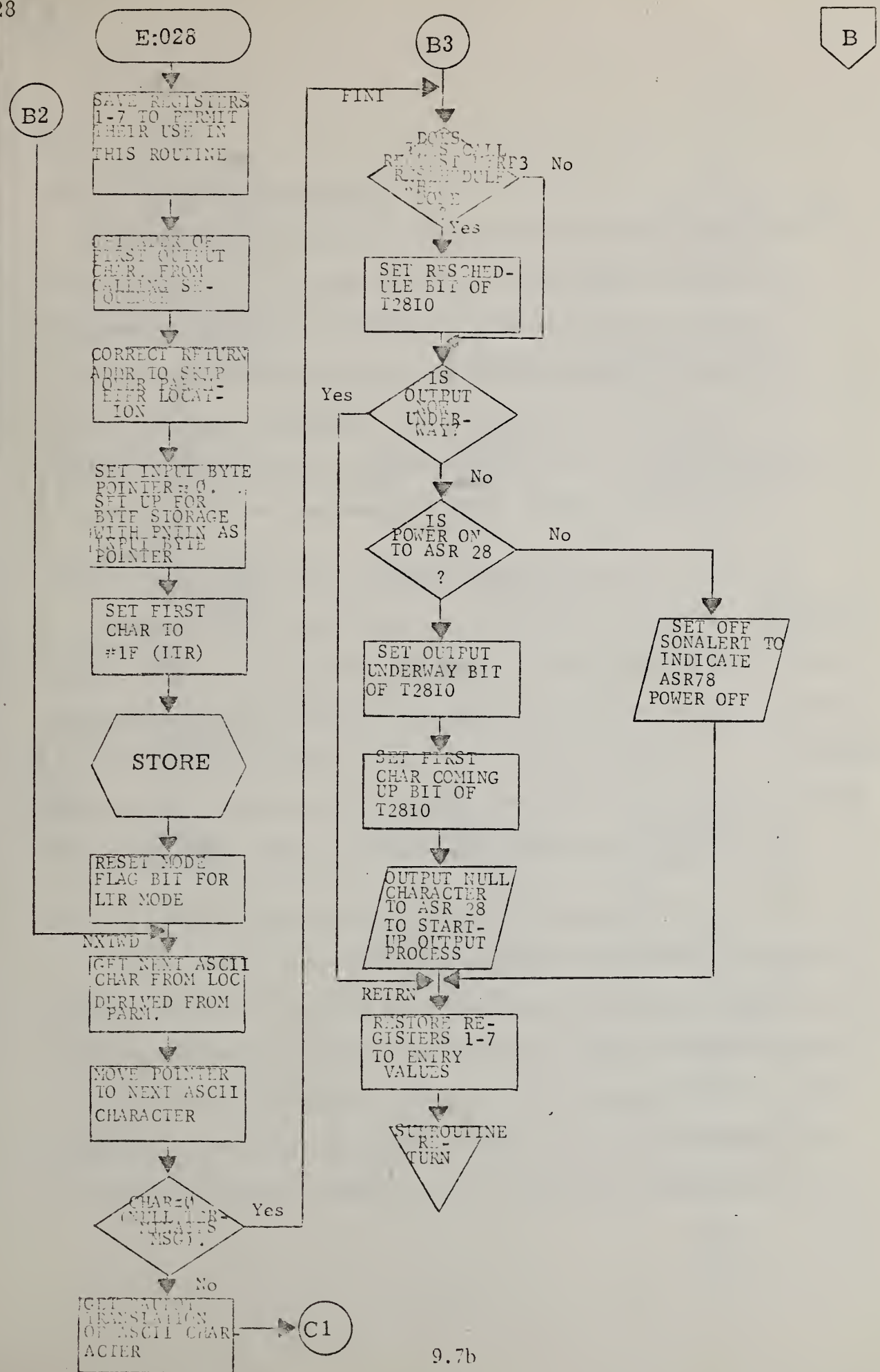
9.4 Output Parameter Descriptions

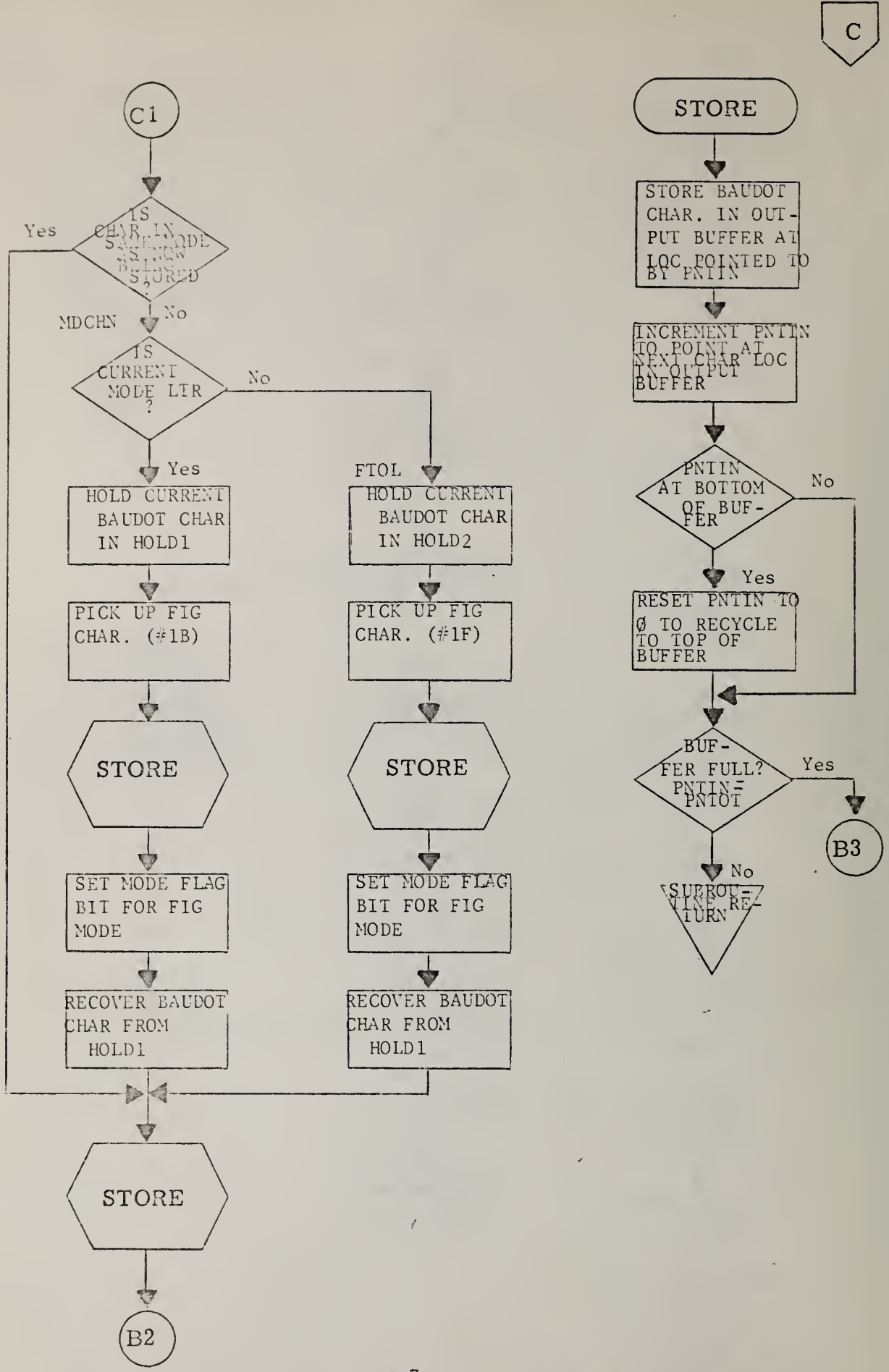
PARAMETER	SIZE	DESCRIPTION
E.28F	1	Parameter used in calling E:028 (see Section 9.1.3).
E.28Ø	1	External name given to T28IO (see Section 9.2.3).
E:I28		Entry point to ASR 28 DI service routine.
E:T28		Entry point to ASR 28 character output routine.
E:028		Entry point to BAUDOT character translator and buffering routine.

9.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
BAUDT	64	Table of ASCII to BAUDOT character equivalents (see Section 9.2.1).
PNTIN	1	Pointer to next location in CHRBF into which a character may be stored by E:028.
PNTOT	1	Pointer to next character to be taken from CHRBF by E:T28 for transmission to the ASR 28.
CHRBF	2Ø48	Output buffer for characters for transmission to the ASR 28.
T28IO	1	ASR 28 status word (see Section 9.2.3).
CONTR	3	The three control words necessary to initiate a character transfer to the ASR 28.
SAVRS	7	Register holding buffer.
FLAG	1	Bit 8 = Ø if last character moved to CHRBF by E:028 was in the LTR mode, = 1 if it was FIG mode (see Section 9.2.2).


A
E:I28
SCHEDULE E:T28 IN SCHEDULER'S TASK TABLE
CLEAR INT & RE-TURN
E:T28
SET BUFFER POINTERS R2 = BASE OF CHAR BUFFER R3 = CHAR POINTER FOR REMOVAL (PNTOT)
IS NEXT CHARACTER THE FIRST ?
Yes
No
T281 CLEAR FLAG BIT IN T2810 WHICH SHOWS NEXT CHAR IS THE FIRST
INCREMENT PNTOT TO POINT TO NEXT CHAR IN BUFFER
GET CHAR FROM BUFFER AT LOC POINTED TO BY R1 & R2.
POINTER PAST BOTTOM OF BUFFER ?
No
Yes
OUTPUT CHAR TO ASR 28
RESET PNTOT TO Ø TO RECYCLE TO TOP OF BUFFER
E:SKD
IS BUFFER EMPTY (PNTOT = PNTIN ?
No
Yes
No
EMPTY
RESET OUTPUT-IN-PROGRESS BIT OF T2810
IS RE-SCHEDULE U:RS3 BIT OF T2810 SET ?
No
E:SKD
SCHEDULE U:RS3 IN SCHEDULER'S TASK TABLE
CLEAR RE-SCHEDULE BIT IN T2810
E:SKD


E:028
B2
SAVE REGISTERS 1-7 TO PERMIT THEIR USE IN THIS ROUTINE
CORRECT RETURN ADDR TO SKIP OVER PARAMETER LOCATION
SET INPUT BYTE POINTER = 0. SET UP FOR BYTE STORAGE WITH PNTIN AS INPUT BYTE POINTER
SET FIRST CHAR TO #1F (LTR)
STORE
RESET MODE FLAG BIT FOR LTR MODE
NXTWD
GET NEXT ASCII CHAR FROM LOC DERIVED FROM PARM.
MOVE POINTER TO NEXT ASCII CHARACTER
Yes
No
C1
B3
FINI
No
Yes
SET RESCHEDULE BIT OF T2810
IS OUTPUT NOW UNDERWAY?
Yes
No
IS POWER ON TO ASR 28 ?
No
SET OUTPUT UNDERWAY BIT OF T2810
SET FIRST CHAR COMING UP BIT OF T2810
OUTPUT NULL CHARACTER TO ASR 28 TO START-UP OUTPUT PROCESS
SET OFF SONALERT TO INDICATE ASR78 POWER OFF
RETRN
RESTORE REGISTERS 1-7 TO ENTRY VALUES
SUBROUTINE RETURN
B


C
C1
IS CHAR IN SAME MODE AS PREVIOUS BAUDOT CHAR STORED ?
Yes
No
MDCHN
IS CURRENT MODE LTR ?
No
Yes
FTOL
HOLD CURRENT BAUDOT CHAR IN HOLD1
HOLD CURRENT BAUDOT CHAR IN HOLD2
PICK UP FIG CHAR. (#1B)
PICK UP FIG CHAR. (#1F)
STORE
STORE
SET MODE FLAG BIT FOR FIG MODE
SET MODE FLAG BIT FOR FIG MODE
RECOVER BAUDOT CHAR FROM HOLD1
RECOVER BAUDOT CHAR FROM HOLD1
STORE
B2
STORE
STORE BAUDOT CHAR. IN OUTPUT BUFFER AT LOC POINTED TO BY PNTIN
INCREMENT PNTIN TO POINT AT NEXT CHAR LOC IN OUTPUT BUFFER
PNTIN AT BOTTOM OF BUFFER
No
Yes
RESET PNTIN TO Ø TO RECYCLE TO TOP OF BUFFER
BUFFER FULL? PNTIN=PNTOT
Yes
B3
No
SUBROUTINE RETURN

1Ø. E$T35

1Ø.1 Functional Description

The ASR 35 teletype is an ASCII character oriented teleprinter with the capability to punch eight-level paper tapes simultaneous to teleprinter operation. In NUSTAD, the ASR 35 is used to provide the operator with a means to communicate with the operating system, and provide the control necessary to the execution of background tasks. E$T35 handles all aspects of data transmissions concerning the ASR 35. It consists of three subprograms: E:I35, E:T35, and E:035.

1Ø.1.1 E:I35 (ASR 35 Data Interrupt Service Routine)

On input, after the hardware character buffer contains a character as the result of the operator depressing a key on the ASR 35 keyboard, or on output as the transfer of a character from the hardware character buffer to the teleprinter is completed, a data interrupt (DI) is generated which vectors control to E:I35, which schedules E:T35 in the scheduler's task table, and returns control to the interrupted program.

1Ø.1.2 E:T35 (ASR 35 Character Input/Output Routine

Since the ASR 35 is configured for both input and output, and the same interrupts are used for both functions, NUSTAD must always know what the ASR 35 is currently being used for. This is done by means of a status word called T35IO. Whenever E:T35 is entered from the system scheduler after a DI, its response depends upon what role the ASR 35 is currently playing. Basically, the roles may be considered three:

a. Awaiting the operator to request an action through the use of a keyword input (See Section 8.1 for a discussion of keywords).

b. Awaiting the operator to respond to a background program request for information.

c. Busy outputting characters to the ASR 35 as specified by a NUSTAD program.

We may summarize these states as being either input (a and b) or output (c); and if awaiting input, then either the REQUEST mode (a) or RESPONSE mode (b).

If the ASR 35 is currently being used for output, each entry to E:T35 signals the end of one character's transmission; thus the teleprinter is ready to receive another. If another character is available in the output buffer, it is transmitted. Otherwise, the buffer is considered empty and output is terminated. When the buffer is emptied, status bits are checked in T35IO to determine if the output is from a background task and whether that task is ready to resume processing. If it is, E:BSK is rescheduled. In either case, a lack of output puts the ASR 35 into an input state.

Normally, the ASR 35 is in the REQUEST mode. The operator calls NUSTAD's attention by typing the slash character (/). E:T35 detects this as the only valid initial character in the REQUEST mode, and crosses it to form the letter X, informing the operator that NUSTAD

is ready to accept a keyword input. When the operator terminates his input by typing a carriage return character, E$OMI is scheduled in the scheduler's task table and control is returned to the scheduler.

If an output request from a background program sets a flag bit to identify a request for an operator response, then the ASR 35 automatically goes into the RESPONSE mode when the output buffer becomes empty. When the operator terminates his response with a CR, NUSTAD will reschedule the background scheduler (E:BSK) in the task table to permit the background task to resume processing.

10.1.3 E:035 (ASR 35 Message Output Routine)

Any foreground program (or B:IOR for background programs) which desires to output to the ASR 35 does so by calling E:035. This routine transfers the message into an output buffer. When the transfer is complete, T35IO is examined to determine if input is actually going on. If it is, T35IO is flagged to indicate that output is pending, to be started as soon as the current input is terminated. If there is no input underway, E:035 checks to see if output is underway. If it is, the current message will be considered as a continuation of the current output stream and nothing further need be done. If neither input nor output is underway, the output is initiated by issuing a terminate command to the ASR 35. When this is received, a service interrupt (SI) is received, vectoring control to E:35S where the first of two null

characters is transmitted. E:035 returns control to the calling program after checking the desired options as requested in E.IOF and setting T35IO accordingly.

The calling sequence to initiate an output to the ASR 35 is:

```
BLM,14        E:035
DFC           (Address of first character to be transmitted)
```

and E.IOF set as follows:

BIT Ø = Ø Do not reschedule E:BSK immediately after the output is completed. This option is used by foreground tasks with output to the ASR 35 or by background tasks in conjunction with BIT 1 = 1 to permit the background to request information from the operator, then not reenter the background program until the operator's response has been read.

= 1 Reschedule E:BSK as soon as the output buffer is empty.

BIT 1 = Ø No response to the program's output is expected from the operator.

= 1 The message now in the output buffer is a request by a background program for information. Do not reschedule E:BSK until the input is complete. The ASR 35 will be put into the RESPONSE mode when the the output buffer is emptied.

All characters in consecutive memory locations beginning at the location specified will be moved to the output buffer (two characters per word) until a null word ($ØØØØ_{16}$) is encountered. This will be considered as a terminator for the output message.

While entering his input data stream, the operator may use two options designed to permit text editing:

a. The most previous character entered may be deleted from the input buffer by typing a RUB OUT character. This feature may be repeated to delete several letters to the point where the initial system call request is deleted, at which point E:T35 will disregard the entire message and reset flags to begin receiving input anew.

b. The entire message may be disregarded by typing a CAN, entered by simultaneously depressing the CONTR and X keys. Input may then begin anew for that message.

E:T35 expects the first character entered while in the REQUEST mode to be the slash (/). If it is not, an "INVALID SYSTEM CALL" message is generated and the message is disregarded.

10.2 Data Formats

10.2.1 T35IO

The current status of IO operations with the ASR 35 is maintained in T35IO. The bits of this status word are interpreted as follows:

BIT Ø = Ø Input is expected. The ASR 35 is set to respond to input characters entered from the keyboard, but has not yet received the first character of an input message.

= 1 Output is currently in progress to the ASR 35. Further output requests are not needed as additional messages will be appended as a continuation of the current data stream. Input is inhibited until output is complete.

BIT 1 = Ø Data input is awaiting the first character of an input message.

= 1 Input message is underway; i.e., past the first character.

BIT 2 = Ø Input is in the REQUEST mode. Input message will be processed by E$OMI.

= 1 Input is in the RESPONSE mode. Termination of input message will cause E:BSK to be rescheduled.

BIT 3 = Ø No output messages have been entered into the output buffer while current input has been underway.

= 1 At least one program has requested a message to be output to the teleprinter while input was underway. When the input is completed, initiate the sequence to begin the character output transfer.

BIT 4 = Ø The ASR 35 is not currently busy with output.

= 1 The ASR 35 currently has output underway.

BIT 5 = Ø Do not reschedule E:BSK after the output is completed. If the output is generated by a background program, an operator response is expected before background processing may be resumed.

= 1 When the output buffer becomes empty, reschedule E:BSK to permit the background task to resume processing.

BIT 6 = Ø Normal output underway.

= 1 The current DI follows the first null character transfer, transmit another null as the next output character.

BIT 7 = Ø Normal output underway.

= 1 Second null completed, begin with first character from output buffer.

10.3 Input Parameter Descriptions

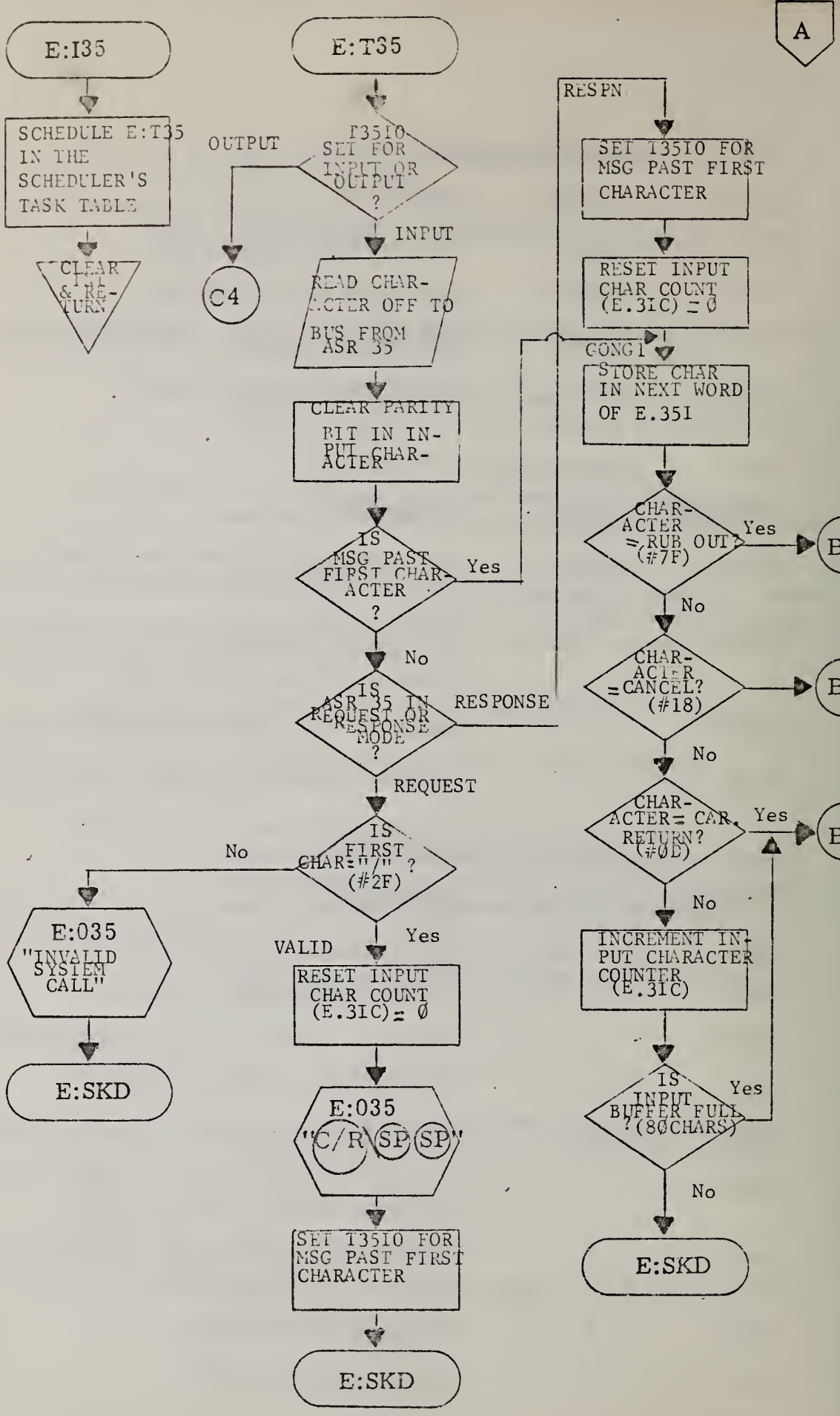
PARAMETER	PROGRAM	DESCRIPTION
E.T06	E$SKD	Task table entry for E$OMI
E.T12	E$SKD	Task table entry for E:T35
E.T15	E$SKD	Task table entry for background system (E:BSK)
E:SKD	E$SKD	System scheduler entry point

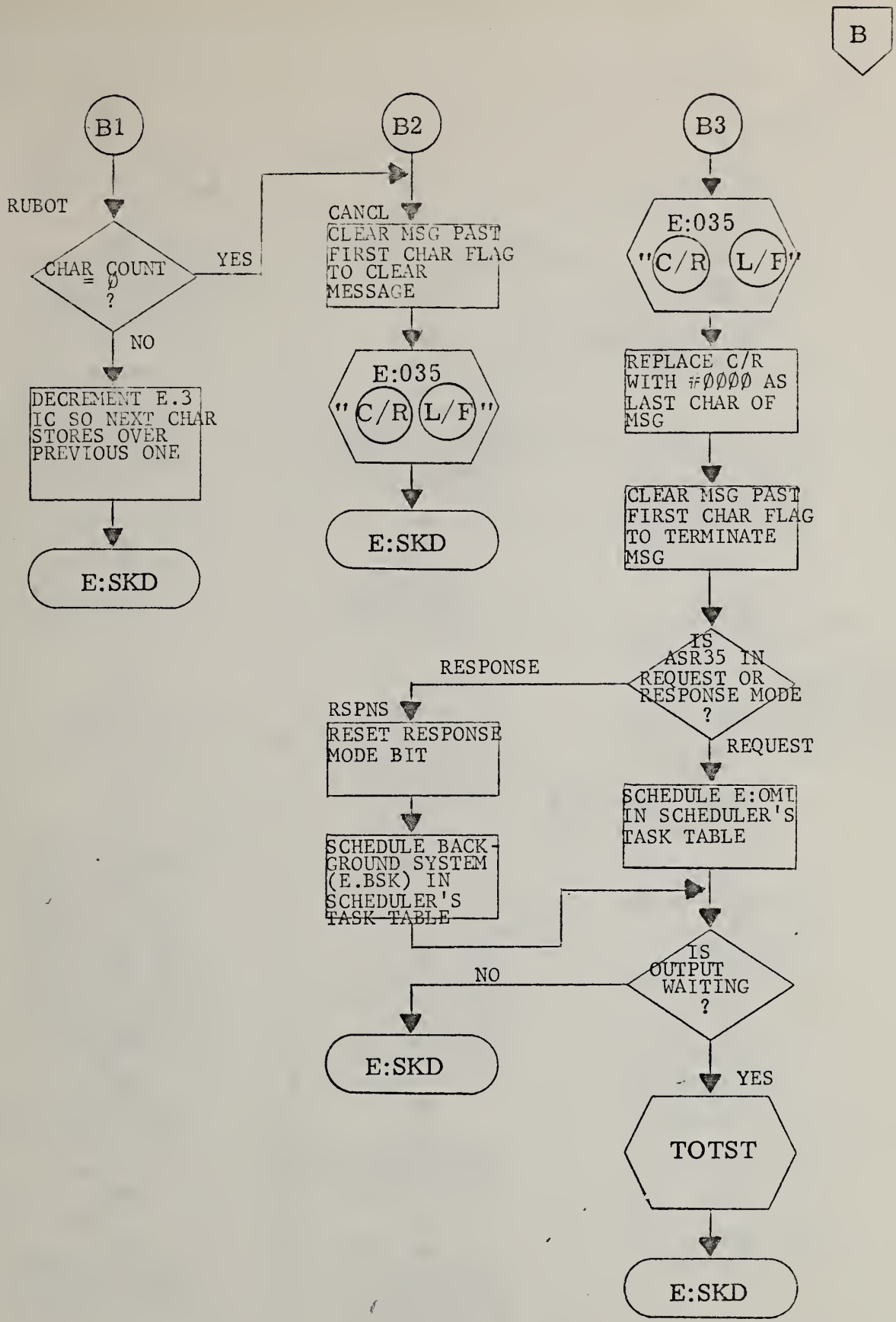
10.4 Output Parameter Descriptions

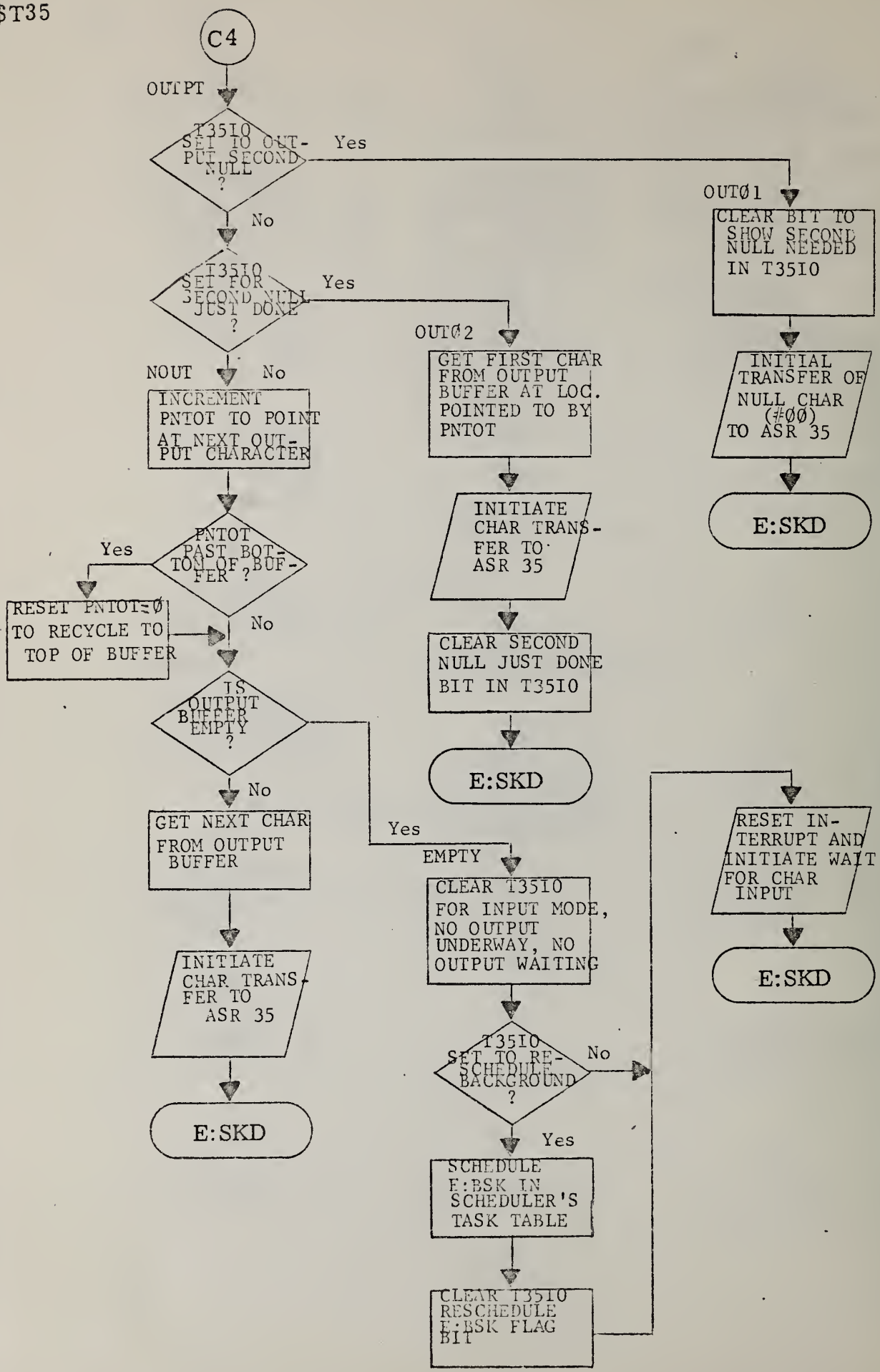
PARAMETER	SIZE	DESCRIPTION
E.35I	80	Input character buffer, one character per word. Input character stream terminated by word = 0000_{16}
E.31C	1	Counter of input characters in input buffer. Used as a pointer to indicate where to store next character during actual input.
E.IOF	1	Parameter word used with call to E:035
E.350	1	External reference to T35IO (See Section 10.2.1)

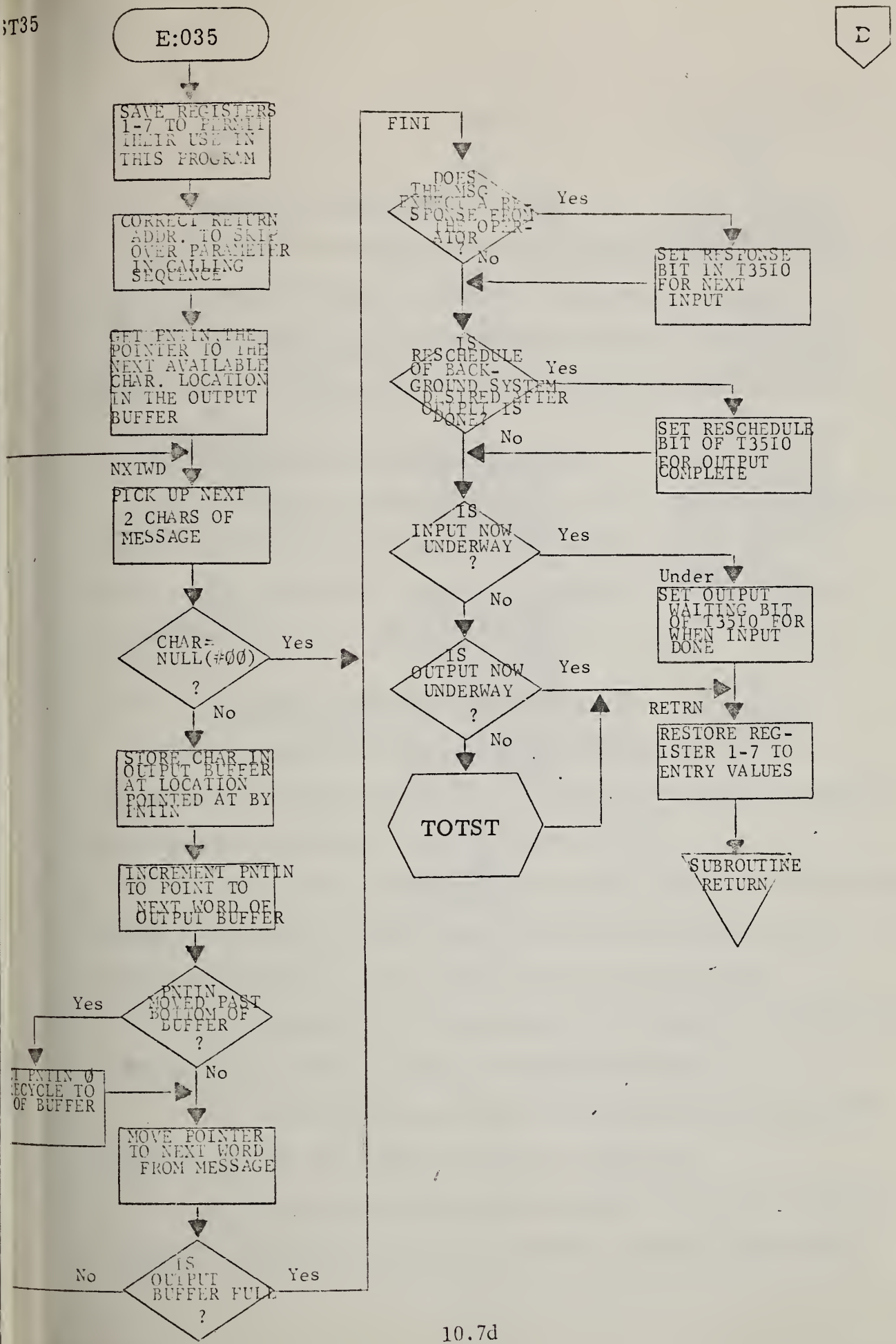
10.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
T35IO	1	ASR 35 processing status (See Section 10.2.1)
FOUL1	13	"INVALID SYSTEM CALL" message
GOOD1	3	Backslash response to valid system call
CRLF	2	Carriage return and Line feed
OUTBF	256	Output character buffer, pack two characters per word
PNTIN	1	Pointer to next location in OUTBF into which a character may be stored by E:035
PNTOT	1	Pointer to next character to be taken from OUTBF by E:T35 for transmission to the ASR 35
SAVRS	7	Register holding buffer
E35SV	7	Register holding buffer

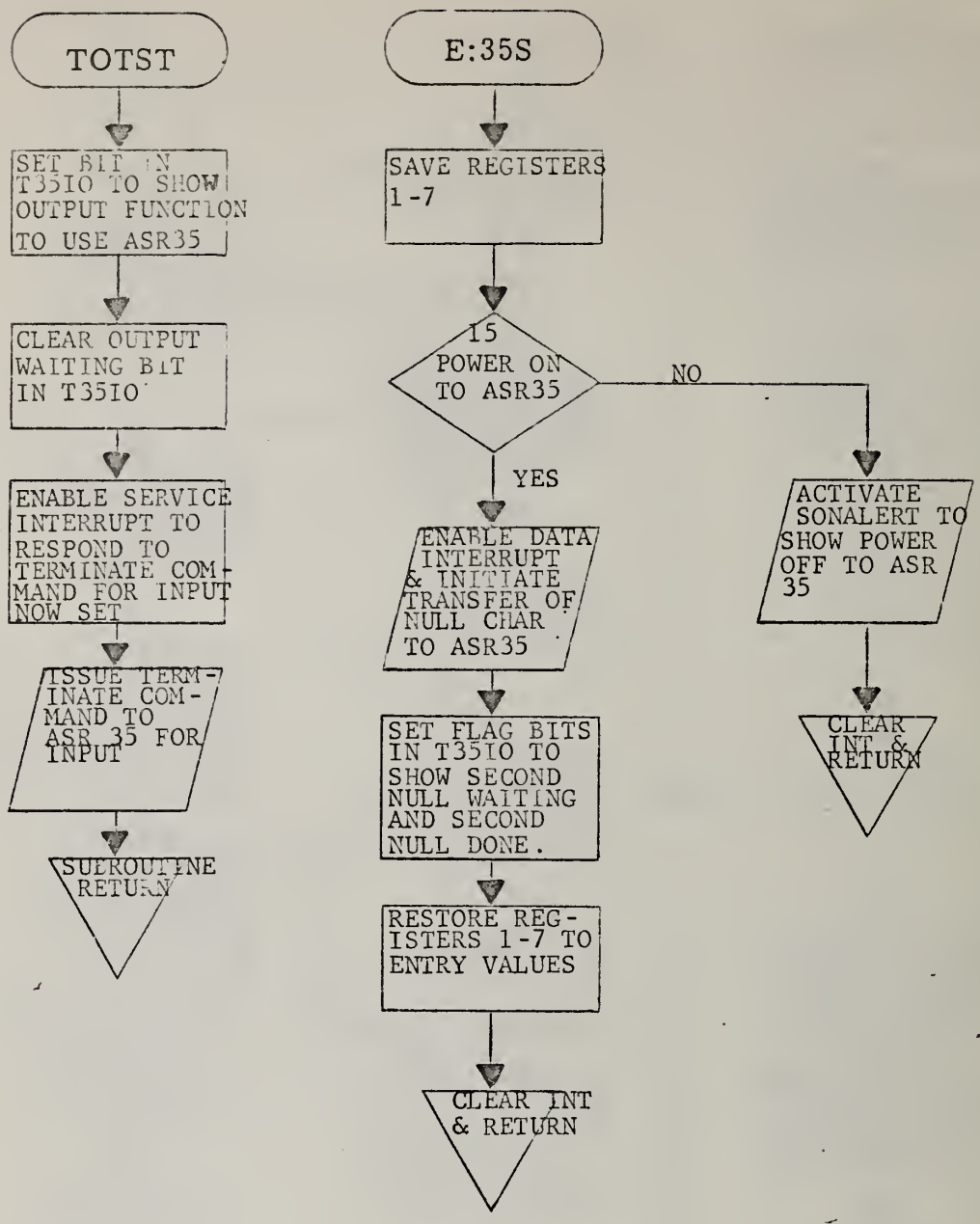

E:I35
SCHEDULE E:T35 IN THE SCHEDULER'S TASK TABLE
CLEAR T1 & RE-TURN
E:T35
T3510 SET FOR INPUT OR OUTPUT ?
OUTPUT
C4
INPUT
READ CHAR-ACTER OFF TO BUS FROM ASR 35
CLEAR PARITY BIT IN IN-PUT CHAR-ACTER
IS MSG PAST FIRST CHAR-ACTER ?
Yes
No
IS ASR 35 IN REQUEST OR RESPONSE MODE ?
RESPONSE
REQUEST
IS FIRST CHAR="/" ? (#2F)
No
Yes
E:035 "INVALID SYSTEM CALL"
E:SKD
VALID
RESET INPUT CHAR COUNT (E.31C)= Ø
E:035 "C/R SP SP"
SET T3510 FOR MSG PAST FIRST CHARACTER
E:SKD
A
RESPN
SET T3510 FOR MSG PAST FIRST CHARACTER
RESET INPUT CHAR COUNT (E.31C) = Ø
GONG1
STORE CHAR IN NEXT WORD OF E.351
CHAR-ACTER =RUB OUT? (#7F)
Yes
B1
No
CHAR-ACTER =CANCEL? (#18)
B2
No
CHAR-ACTER= CAR. RETURN? (#ØD)
Yes
B3
No
INCREMENT IN-PUT CHARACTER COUNTER (E.31C)
IS INPUT BUFFER FULL ? (80CHARS)
Yes
No
E:SKD


B
B1
RUBOT
CHAR COUNT ≡ Ø ?
YES
NO
DECREMENT E.3 IC SO NEXT CHAR STORES OVER PREVIOUS ONE
E:SKD
B2
CANCL
CLEAR MSG PAST FIRST CHAR FLAG TO CLEAR MESSAGE
E:035 "C/R L/F"
E:SKD
B3
E:035 "C/R L/F"
REPLACE C/R WITH #ØØØØ AS LAST CHAR OF MSG
CLEAR MSG PAST FIRST CHAR FLAG TO TERMINATE MSG
IS ASR35 IN REQUEST OR RESPONSE MODE ?
RESPONSE
RSPNS
RESET RESPONSE MODE BIT
SCHEDULE BACK-GROUND SYSTEM (E.BSK) IN SCHEDULER'S TASK TABLE
REQUEST
SCHEDULE E:OMI IN SCHEDULER'S TASK TABLE
IS OUTPUT WAITING ?
NO
E:SKD
YES
TOTST
E:SKD


C4
OUTPT
T3510 SET TO OUTPUT SECOND NULL ?
Yes
No
OUTØ1
CLEAR BIT TO SHOW SECOND NULL NEEDED IN T3510
INITIAL TRANSFER OF NULL CHAR (#ØØ) TO ASR 35
E:SKD
T3510 SET FOR SECOND NULL JUST DONE ?
Yes
OUTØ2
GET FIRST CHAR FROM OUTPUT BUFFER AT LOC. POINTED TO BY PNTOT
INITIATE CHAR TRANSFER TO ASR 35
CLEAR SECOND NULL JUST DONE BIT IN T3510
E:SKD
NOUT
No
INCREMENT PNTOT TO POINT AT NEXT OUTPUT CHARACTER
PNTOT PAST BOTTOM OF BUFFER ?
Yes
RESET PNTOT=Ø TO RECYCLE TO TOP OF BUFFER
No
IS OUTPUT BUFFER EMPTY ?
No
GET NEXT CHAR FROM OUTPUT BUFFER
INITIATE CHAR TRANSFER TO ASR 35
E:SKD
Yes
EMPTY
CLEAR T3510 FOR INPUT MODE, NO OUTPUT UNDERWAY, NO OUTPUT WAITING
T3510 SET TO RESCHEDULE BACKGROUND ?
No
Yes
SCHEDULE E:BSK IN SCHEDULER'S TASK TABLE
CLEAR T3510 RESCHEDULE E:BSK FLAG BIT
RESET INTERRUPT AND INITIATE WAIT FOR CHAR INPUT
E:SKD


E:035
D
SAVE REGISTERS 1-7 TO PERMIT THEIR USE IN THIS PROGRAM
CORRECT RETURN ADDR. TO SKIP OVER PARAMETER IN CALLING SEQUENCE
GET PNTIN, THE POINTER TO THE NEXT AVAILABLE CHAR. LOCATION IN THE OUTPUT BUFFER
NXTWD
PICK UP NEXT 2 CHARS OF MESSAGE
CHAR= NULL(#ØØ) ?
Yes
No
STORE CHAR IN OUTPUT BUFFER AT LOCATION POINTED AT BY INTIN
INCREMENT PNTIN TO POINT TO NEXT WORD OF OUTPUT BUFFER
PNTIN MOVED PAST BOTTOM OF BUFFER ?
Yes
No
T PNTIN Ø ECYCLE TO OF BUFFER
MOVE POINTER TO NEXT WORD FROM MESSAGE
IS OUTPUT BUFFER FULL ?
No
Yes
FINI
DOES THE MSG EXPECT A RESPONSE FROM THE OPERATOR ?
Yes
No
SET RESPONSE BIT IN T3510 FOR NEXT INPUT
IS RESCHEDULE OF BACKGROUND SYSTEM DESIRED AFTER OUTPUT IS DONE?
Yes
No
SET RESCHEDULE BIT OF T3510 FOR OUTPUT COMPLETE
IS INPUT NOW UNDERWAY ?
Yes
No
Under
SET OUTPUT WAITING BIT OF T3510 FOR WHEN INPUT DONE
IS OUTPUT NOW UNDERWAY ?
Yes
No
TOTST
RETRN
RESTORE REGISTER 1-7 TO ENTRY VALUES
SUBROUTINE RETURN

E


TOTST
SET BIT IN T3510 TO SHOW OUTPUT FUNCTION TO USE ASR35
CLEAR OUTPUT WAITING BIT IN T3510
ENABLE SERVICE INTERRUPT TO RESPOND TO TERMINATE COMMAND FOR INPUT NOW SET
ISSUE TERMINATE COMMAND TO ASR 35 FOR INPUT
SUBROUTINE RETURN
E:35S
SAVE REGISTERS 1-7
15 POWER ON TO ASR35
NO
YES
ACTIVATE SONALERT TO SHOW POWER OFF TO ASR 35
CLEAR INT & RETURN
ENABLE DATA INTERRUPT & INITIATE TRANSFER OF NULL CHAR TO ASR35
SET FLAG BITS IN T3510 TO SHOW SECOND NULL WAITING AND SECOND NULL DONE.
RESTORE REGISTERS 1-7 TO ENTRY VALUES
CLEAR INT & RETURN

11. E$MAG

11.1 Functional Description

The WANG 45 ips nonvacuum tape drive is used to process 7-track IBM compatible magnetic tapes. In NUSTAD, this device is dedicated to the input of DRFUD data from tapes previously recorded on the DRFUD units. E$MAG consists of three routines, E:MTI, M:MAG, and M:MGS.

11.1.1 E:MTI (Mag Tape SI Service Routine)

Whenever a mag tape data transfer (via DMP) is completed, a service interrrupt (SI) vectors control to the interrupt service routine, E:MTI. This routine flags E:MAG in the scheduler's task table and returns control to the interrupted program.

11.1.2 E:MAG (Mag Tape Error Checking Routine)

E:MAG is entered from the scheduler to examine a completed data transfer from the mag tape unit. It reads the hardware status for that transfer and checks for the following errors:

a. If switch register bit 2 is reset, E:MAG will record parity errors with a "MAG TAPE PARITY ERROR, CALLING TASK ABORTED" message. If switch register bit 2 is set, parity errors will be ignored.

b. Tape defects will be brought to the operator's attention with a "TAPE DEFECT DETECTED, CALLING TASK ABORTED" message.

c. If the end of tape marker is discovered, an "END OF TAPE DETECTED, CALLING TASK ABORTED" message is generated.

d. If the tape unit became inoperative during the transfer, a "TAPE UNIT INOPERATIVE, CALLING TASK ABORTED" message is generated.

If any of these errors are reported to the operator on the ASR 35, the background task is aborted (B.STT is set to Ø), and the data transfer is ignored. If, however, no errors are discovered, E:BSK is rescheduled to permit the current background task to resume processing and control is returned to the scheduler.

11.1.3 E:MGS (Mag Tape Input Initiate Routine)

Currently, the only program which requests a mag tape data transfer is B:IOR, which does so for the background programs processing DRFUD data tapes. The calling sequence for a data read from mag tape is:

```
BLM,13    E:MGS
DFC       (Memory address into which first word to be stored)
DFC       (Count of words to be transferred)
```

The two parameters are stored into the DMP transfer address and transfer count (after negating the TC).

The status of the equipment is read and if it is either off-line, not ready, or without power, a "MAG TAPE NOT READY, CALLING TASK ABORTED" message is generated and the background task underway is aborted. If all equipment is ready for the transfer, it is initiated, and control is returned to the calling routine.

11.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:035	E$T35	Transfers output message to buffer before transmission to the ASR 35.

11.3 Input Parameter Description

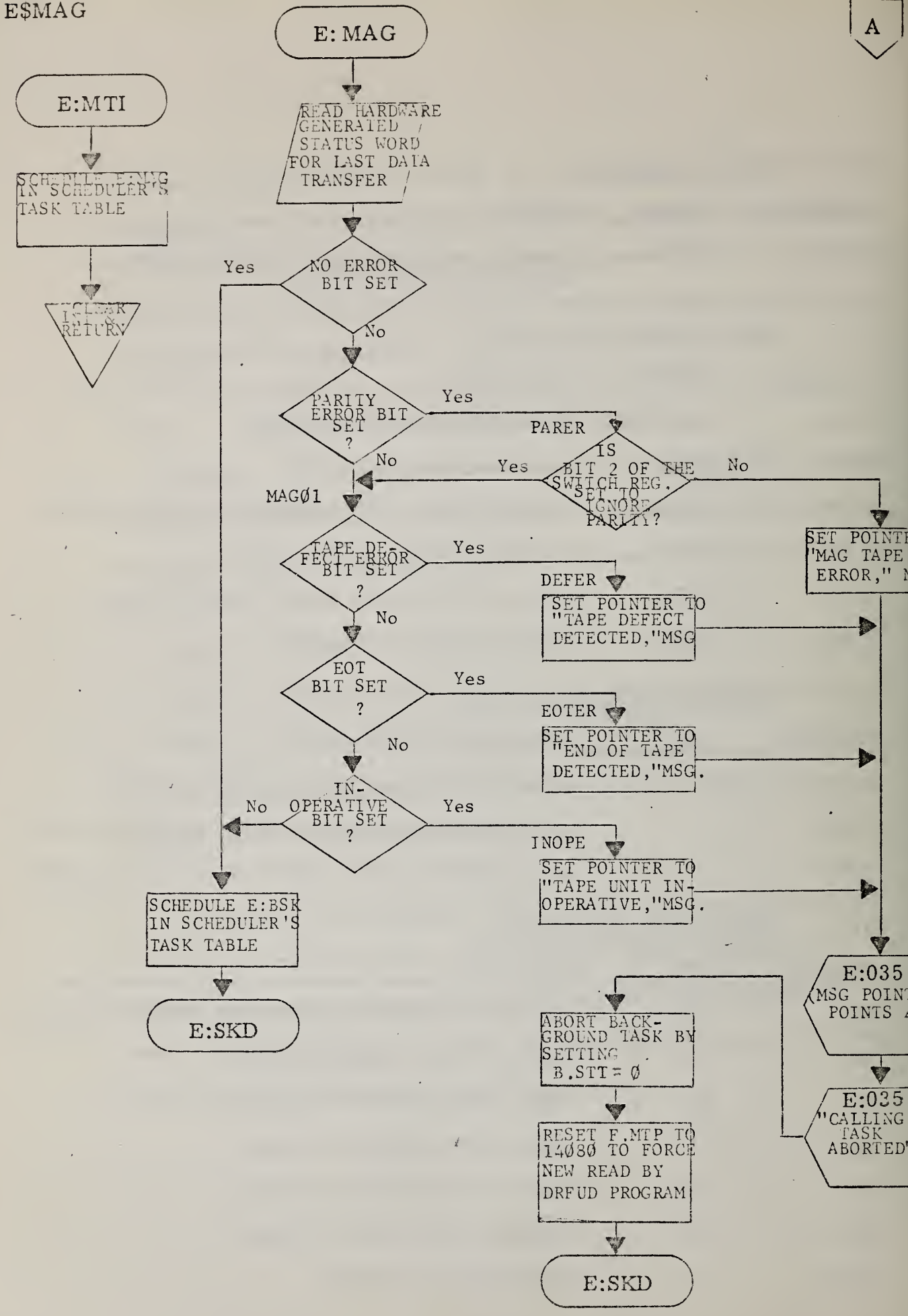
PARAMETER	PROGRAM	DESCRIPTION
E:SKD	E$SKD	System scheduler's entry point.
E.T11	E$SKD	Task table entry for E:MAG.
E.T15	E$SKD	Task table entry for background scheduler (E:BSK)
E.IOF	E$T35	Parameter used in calling E:035.
B.STT	E$T35	Background processing status (See Table 3.2)
F.MTP	F$FMT	Mag tape buffer word pointer.

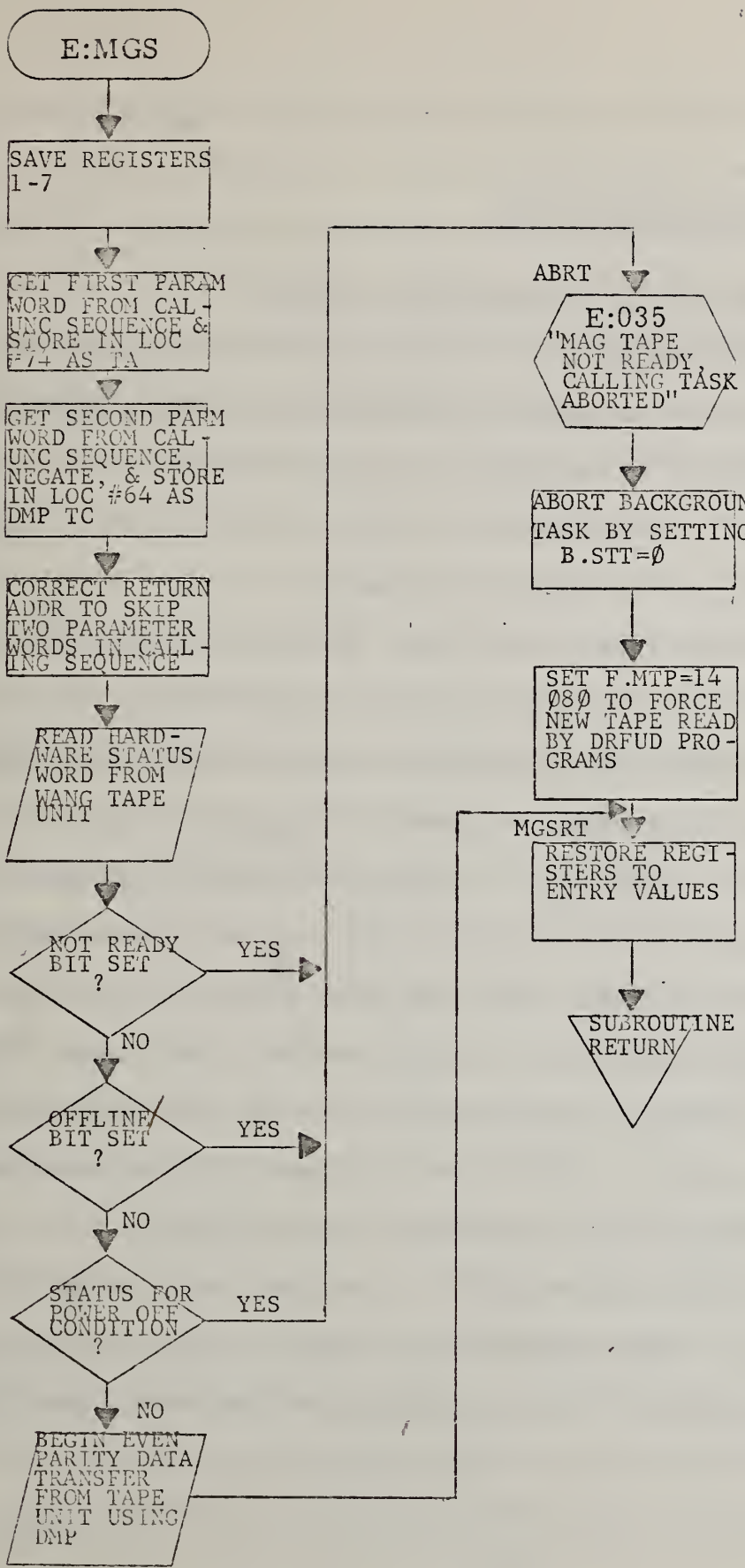
11.4 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
E:TMI		Entry point for mag tape SI service routine.
E:MAG		Entry point for mag tape transfer completed routine.
E:MGS		Entry point for input request routine for mag tape.

11.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
MØ1	24	"MAG TAPE NOT READY, CALLING TASK ABORTED." message.
MØ2	14	"MAG TAPE PARITY ERROR," message
MØ3	13	"TAPE DEFECT DETECTED," message
MØ4	13	"END OF TAPE DETECTED," message
MØ5	14	"TAPE UNIT INOPERATIVE," message
MØ6	13	"CALLING TASK ABORTED." message
TEMP	7	Register holding buffer.


E:MAG
A
E:MTI
SCHEDULE E:MTG IN SCHEDULER'S TASK TABLE
CLEAR I/O & RETURN
READ HARDWARE GENERATED STATUS WORD FOR LAST DATA TRANSFER
NO ERROR BIT SET
Yes
No
PARITY ERROR BIT SET ?
Yes
PARER
IS BIT 2 OF THE SWITCH REG. SET TO IGNORE PARITY?
Yes
No
No
MAGØ1
TAPE DEFECT ERROR BIT SET ?
Yes
DEFER
SET POINTER TO "TAPE DEFECT DETECTED,"MSG
No
EOT BIT SET ?
Yes
EOTER
SET POINTER TO "END OF TAPE DETECTED,"MSG.
No
IN-OPERATIVE BIT SET ?
No
Yes
INOPE
SET POINTER TO "TAPE UNIT IN-OPERATIVE,"MSG.
SET POINTER T "MAG TAPE PAR ERROR," MSG.
SCHEDULE E:BSK IN SCHEDULER'S TASK TABLE
E:SKD
E:035 (MSG POINTER POINTS AT)
E:035 "CALLING TASK ABORTED"
ABORT BACK-GROUND TASK BY SETTING B.STT = Ø
RESET F.MTP TO 14ØBØ TO FORCE NEW READ BY DRFUD PROGRAM
E:SKD


E:MGS
SAVE REGISTERS 1-7
GET FIRST PARAM WORD FROM CAL-UNC SEQUENCE & STORE IN LOC #/+ AS TA
GET SECOND PARM WORD FROM CAL-UNC SEQUENCE, NEGATE, & STORE IN LOC #64 AS DMP TC
CORRECT RETURN ADDR TO SKIP TWO PARAMETER WORDS IN CALL-ING SEQUENCE
READ HARD-WARE STATUS WORD FROM WANG TAPE UNIT
NOT READY BIT SET ?
YES
NO
OFFLINE BIT SET ?
YES
NO
STATUS FOR POWER OFF CONDITION ?
YES
NO
BEGIN EVEN PARITY DATA TRANSFER FROM TAPE UNIT USING DMP
ABRT
E:035 "MAG TAPE NOT READY, CALLING TASK ABORTED"
ABORT BACKGROUND TASK BY SETTING B.STT=Ø
SET F.MTP=14 Ø8Ø TO FORCE NEW TAPE READ BY DRFUD PRO-GRAMS
MGSRT
RESTORE REGI-STERS TO ENTRY VALUES
SUBROUTINE RETURN

12. U$RTA

12.1 Functional Description

12.1.1 U:RTA (U Data Real Time Analysis Routine)

U:RTA (Real Time Analysis) is the program responsible for maintaining the sensor parameters at optimum operating levels. It is entered from E:SKD after E:UIN flags the scheduler that ten seconds of data have been collected. It performs the following functions with that data from the ten-second time segment just ending:

a. Monitor channel amplitude. Amplitude values between AMPMN and AMPMX (see Figure 12.1) are considered "good" points. Any value below AMPMN is considered low and any value above AMPMX high. These points are tallied in counters called HIVTY (High Value Tally) and LOVTY (Low Value Tally) respectively. Furthermore, points below AMPDR indicate sufficient loss of signal strength to cause the phase value at this time to be considered unusable. The first three amplitude samples during a ten-second time segment which are below the AMPDR level cause the previous second's phase value to replace the current one. This substitution of phase values account for the last second's data from the previous ten-second time segment being saved in the first row of the working buffer--U.WRK (making eleven rows in all). If more than three values below AMPDR are encountered, a data validity flag, MUBAV, is set to -1 to indicate a signal lost condition. Of the points greater than AMPMX, those above

SATUR saturate the sensor, causing the phase estimation to be distorted and therefore unreliable. If more than six points are greater than SATUR during a ten-second time segment, MUBAV is then set to +1 to indicate a saturated signal condition. The last amplitude value from the ten-second time segment is saved for each channel in U.AMP as that channel's amplitude estimate for the ten-second segment.

b. Monitor channel phase. When a fifty microsecond phase shift is induced in the reference frequency of the sensor's mixer, E:UIN (see Section 6.1.2 (b)) sets a flag bit for the then current phase value to show that the shift would take place before the next sample. The phase monitoring part of U:RTA detects this bit and adds U.CYC (which was set to ±5Ø microseconds, depending on the direction of the shift) to U.CCN, which contains the total compensation for the cycle shifts to the moment, before the next point is considered. U.CCN is added to each phase value to create continuity in the data stream over these shifts. This extends the phase range from 1ØØ microseconds at the sensor to about 8ØØØ microseconds at the processor. The average of the current ten-phase values, including the shift compensations, is finally stored for use by the least squares slope algorithm (U:LSQ).

c. Performs data compression. Each data point is compared to the current window maximum and minimum values to determine whether or not it lies within the current window (see Section 12.3.2 for a discussion of the data compression algorithm). If a point falls outside the window, it is established as the center (CENTR) of the new window, around which new maximum (WINMX) and minimum (WINMN) values are computed. The window

size is determined by the standard deviation of the phase values. The new window center is considered a compressed data point, and is held with its time in a buffer (U.CMP) and tallied by a compressed point counter (U.CPC). Each time a compressed point is discovered, bit 11 of the console switch register is examined. If that bit is set, and the binary representation of the sensor channel on which the point was discovered is given in switch register bits 12 - 15, then the time and phase value of that compressed point is displayed for the operator on the ASR 35 teleprinter.

The following table relates the sensor channels and the value to be entered into bits 12 - 15 of the console switch register for use in specifying which channel's compressed data points are to be displayed on the ASR 35.

CHANNEL	BIT 12	13	14	15
A	Ø	Ø	Ø	Ø
B	Ø	Ø	Ø	1
C	Ø	Ø	1	Ø
D	Ø	Ø	1	1
E	Ø	1	Ø	Ø
F	Ø	1	Ø	1
G	Ø	1	1	Ø
H	Ø	1	1	1
I	1	Ø	Ø	Ø
J	1	Ø	Ø	1
K	1	Ø	1	Ø
L	1	Ø	1	1
M	1	1	Ø	Ø
N	1	1	Ø	1

Ø = Reset Bit
1 = Set Bit

Table 12.1 Compressed Data Point Channel Specification

d. Monitors percent blanked level. The last "percent blanked" value of each ten-second segment is summed (for each channel) over two minutes (i.e. twelve points).

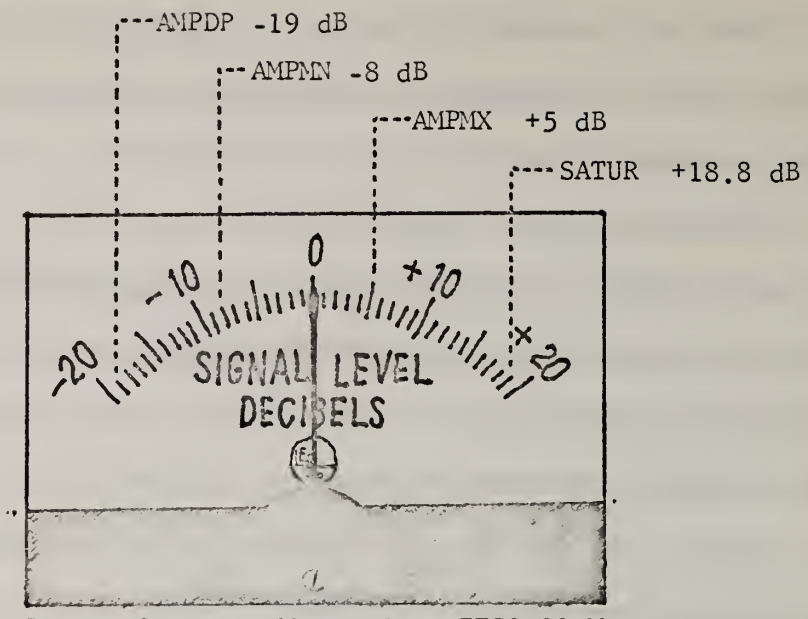
e. Controls channel RF gain. Every two minutes, controlled by the gain clock (GCLOK), the number of points tallied below AMPMN and above AMPMX are compared to a count of 9Ø (i.e. 75% of all points during that two minute period). If one of these levels exceeds this value, the RF gain is increased or decreased accordingly, and the action is logged on the ASR 28. All counters and clocks are reset for the next two minute period.

f. Controls blanking level. When the gain control program completes execution, the sum of "percent blanked" values over the previous two minutes is compared against BLKMN and BLKMX (see Figure 12.1) to determine the need to increase or decrease the blanking level. If such a change is made, the action is logged on the ASR 28.

g. Compute standard deviation. In the phase monitoring part of U:RTA, the difference between the individual phase values and the previous ten seconds' average (XBAR) was accumulated. Once every 9Ø seconds, controlled by the tracking clock (TCLOK), this accumulated sum is fed into the standard deviation algorithm described in Section 12.3.1 and a standard deviation estimate (SIGMA) is computed.

h. Controls tracking rate. The standard deviation is compared against TRMIN and TRMAX (see Figure 12.1) to determine the need to increase or decrease the tracking rate. If such a change is made, the action is logged on the ASR 28.

GAIN CONTROL LEVELS



Signal Strength Meter from EECO 881M

BLANKING RATE CONTROL LEVELS

4.1%	4.5%
BLKMN	BLKMX

TRACKING RATE CONTROL LEVELS

Standard Deviation:	.5 microseconds	1.25 microseconds
	TRMIN	TRMAX

Figure 12.1 Parameter Control Levels

i. Controls the channel down sequence. When MUBAV is set to $\pm$1, the data during that segment is considered invalid, and the channel is put into, or continues in a down sequence. The channel passes through four states (determined by the value of U.CST):

(1) UP (U.CST=1). In this case, MUBAV = Ø, indicating good data. Waveform processing continues as normal.

(2) COASTING, NO REPORT (U.CST=2). The first two times MUBAV is not Ø, the channel is put into the first coasting state. The operator is not informed and most waveform processing continues as normal.

(3) COASTING, REPORTED (U.CST=3). After thirty seconds of bad data; i.e., MUBAV $\neq$ Ø three times, the channel is put into the second coasting state and the reason for the data being considered invalid is logged on the ASR 28. If MUBAV was -1 all three times, the signal will be logged as lost ("CF", channel Coasting for signal Failure). If MUBAV was +1 all three times, the signal will be logged as saturated ("CS", channel Coasting for signal Saturation). If neither of these cases should occur, the channel is logged "CN." In this state, the waveform analysis will be permitted to continue on any signal currently in progress, but new signals will not be started.

(4) DOWN (U.CST=4). Whenever processing is inhibited by an INE or MAINTENANCE condition (see Section 2Ø), or in a coasting state for five minutes, the channel is put DOWN. While in the DOWN state, no data processing whatsoever is performed on that channel.

A channel's status will be returned to UP from any state when three minutes pass with all values of MUBAV = Ø, indicating a continuous stream of good data for 18Ø seconds. The amplitude monitoring part of U:RTA performs this movement to the UP state by incrementing the recovery tally (U.RTY) each time it is not zero and MUBAV is zero. When U.RTY reaches zero, the channel is put up and the necessary parameters are reset to permit the data processing to resume on it.

12.1.2 U:CNI (Signal In Progress Checking Subroutine)

U:CNI is a subsection of the internal subroutine called CANI. During periods when a valid signal is probably in progress, NUSTAD refrains from making automatic adjustments to the control settings on the sensor. The OPC: option permits the operator to request these adjustments without his knowing the waveform processing status. Therefore, before his requested adjustment is made, U:CNI is called to determine whether or not a signal is in progress. The following criteria are used to establish a signal as in progress:

a. U.AST, the analysis status, indicates a peak has been found.

b. If an onset has been found, more than 5Ø seconds have elapsed since that onset.

The answer as to whether a signal is in progress or not is indicated to the calling program by the location where control is returned. If the adjustment is not permitted, control is returned immediately. Otherwise, the location counter is incremented by two before the return. The calling sequence looks like this:

```
        BLM,15      U:CNI
        BRU         CANOT     (return if signal in progress, not allowing
                               adjustments to sensor settings)
        .................     (return if no signal in progress,
                               adjustments may be made).
```

Where channel being checked is indicated in R6.

12.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:DIF	E$DIF	Establishes whether or not a signal is in progress on a given channel, and if one is, returns the time difference in seconds between onset and the parameter value.
E:SRT	E$SRT	Computes the square root of the parameter.
E:MIT	E$UIN	Transmits sensor parameter settings to equipment.
U:LSQ	U$LSQ	Least squares slope computation routine, next step in processing current ten-second data segment.
E:035	E$T35	Transfers output message to buffer before transmission to the ASR 35.
E:FCT	E$FRT	Reformats BCD time from memory to ASCII for output.
E:LOG	E$LOG	Generates coded messages for the station log and initiates their transfer to the ASR 28 via E$T28.
E:FMF	E$FMF	Reformats phase values from internal binary representation to ASCII decimal for output.

12.3 Computational Techniques

12.3.1 Standard Deviation

NUSTAD uses the standard deviation of the incoming phase values to adjust the tracking rate and to determine the offset necessary to trigger the waveform analysis routine. The standard deviation is computed by a variation on the mathematical definition of the standard deviation. The actual definition for the standard deviation of a set of n elements, call them ($x_\emptyset$, x_1, x_2, ... x_{n-1}) is:

$$\text{Standard deviation} = \sqrt{\frac{\sum_{i=\emptyset}^{n-1} (x_i - \bar{x})}{(n - 1)}}$$

Where $\bar{x} = \frac{\sum_{i=\emptyset}^{n-1} x_i}{n}$

In NUSTAD, the buffering requirement necessary to actually use this approach (9Ø samples per channel times 14 channels) makes the computation impractical. Therefore, $\bar{x}$ (called XBAR) is approximated by the arithmetic mean of the previous rather than the current 9Ø second period. Experience has shown this to be reasonable as the standard deviation is "frozen" during periods of large phase offsets, where this computation would be most affected by such a substitution. The sum of the

differences between the individual points and XBAR is stored (double precision) in U2ACC; while UACC1 accumulates the sum of the current points to determine XBAR for the next 90 second interval. The square root is computed by the executive support subroutine E$SRT (see Section 28).

12.3.2 Data Compression

The data compression algorithm used by NUSTAD is based on a technique called the Zero-Order Predictor Floating Aperture method. The procedures of the technique are:

> "In the floating aperture algorithm of the zero-order predictor, an aperture of 2K is placed around the last transmitted data point. If each new data point lies within the aperture placed about the last transmitted data point, then the new data points are not transmitted. If a new data point falls outside the aperture about the last transmitted data point, then the present data point is transmitted and the process is repeated. The predicted point in this case is the last transmitted data point with a tolerance of ±K placed about it. The aperture, then, has the effect of 'floating' with the last transmitted value."
>
> (From: Andrews, CA.; Davies, J.M.; Schware, R.R.; "Adaptive Data Compression," Proceedings of the IEEE, Volume 55, Number 3, March 1967, page 268.)

In NUSTAD we refer to the aperture as the data window and establish its size as ± DELTA, a variable as defined below. The window therefore, has minimum and maximum values as defined by:

```
WINMN = CENTR - DELTA
WINMX = CENTR + DELTA
```

Where CENTR is the last point to fall outside a previous data window. We refer to these points as compressed data points and retain them as the only phase values used by the waveform analysis programs.

The original design was to establish DELTA as a constant times the last computed standard deviation value (SIGMA), with a minimum value of one microsecond. Experiments with this approach were very encouraging, but a major flaw was soon uncovered. The trigger detection algorithm (see Section 14.1.1) requires a predetermined number of compressed data points in a single direction to establish an event trigger. If a sudden phase excursion occurred near the end of a 9Ø second interval for which a new value of SIGMA would be computed, an insufficient number of compressed points may have been read to establish the trigger. The new SIGMA value, however, would have ballooned due to the effect of points significantly apart from XBAR, and the window opened up accordingly. This would naturally reduce the number of compressed points considered, and on several occasions, to the point where the remaining points needed to establish the trigger, or to confirm a potential peak were not detected. To avoid this situation, SIGMA from the previous computation, called LSIGM was used to establish the value for DELTA, ensuring that the phase excursion could not occur in the same interval for which the standard deviation was computed. Therefore, we may summarize that DELTA is determined as follows:

a. If LSIGM, the standard deviation value used to estimate the background noise level, times 1.5 is less than one microsecond, DELTA is set to one microsecond.

b. If LSIGM times 1.5 is not less than one microsecond, DELTA is set to LSIGM times 1.5.

c. If a signal is in progress; i.e., U.AST > 1, DELTA will not be adjusted.

In this way, compressed points are collected based on the level of the background noise for that channel. In a very quiet environment, points separated by no less than one microsecond are examined, while greater noise will desensitize the triggering and waveform analysis routines.

12.4 Data Formats

See Section 6.2 for a description of data values used by U:RTA. The phase range, however, has been extended by the addition of U.CCN to compensate for the 5Ø microsecond phase shifts as described above. The internal representation of phase may be regarded as follows:

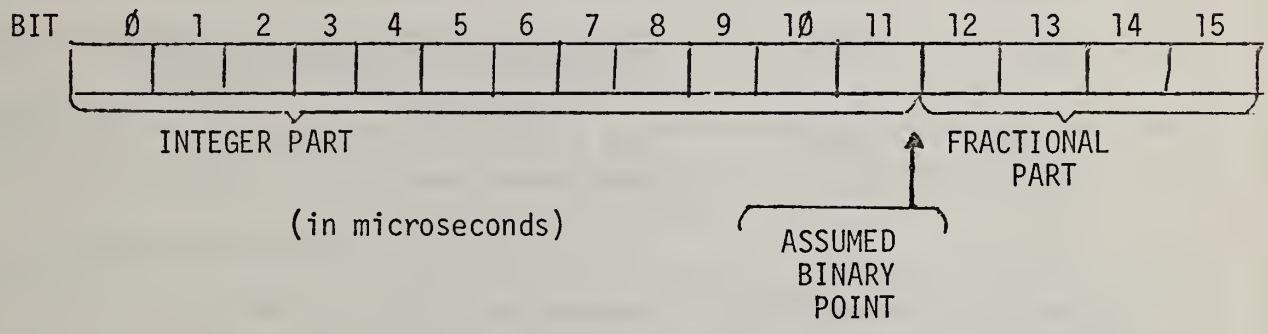


Figure 12.2 Internal Phase Value Representation

12.5 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
U.CYC	U$DAT	Set to ± 5Ø microseconds when cycle shift is sent to the sensor.
U.WRT	U$DAT	Working storage for data from sensor.
U.RTY	U$DAT	Channel recovery tally. Counts ten-second segments with good amplitude values to bring channel up after three minutes.
U.IHB	U$DAT	Bit Ø set to inhibit processing on channel if INE or Maintenance condition set on the channel.
U.AST	U$DAT	Channel waveform analysis status, indicates point in signal to which processing has progressed.
U.FAC	U$DAT	The update factor used in the digital filter for the diurnal estimate.
U.CCN	U$DAT	Accumulated effect of cycle shifts.
U.LST	U$DAT	Table of ten-second averages used in least squares slope computation.
U.LSP	R$DAT	Pointer to next row for storage of points in U.LST.
U.LTF	U$DAT	The longer time constant factor for the digital filter of the diurnal estimate.
U.DIU	U$DAT	The diurnal slope estimate, an estimate of the long term trends in phase deviation.
U.BLL	U$DAT	Current blanking level settings for the channels.
U.TRK	U$DAT	Current tracking rate settings for the channels.
U.GAN	U$DAT	Current RF gain settings for the channels.
U.CPC	U$DAT	Channel compressed point counter.
U.CMP	U$DAT	Compressed point phase and time value table.
U.CTM	U$DAT	Two words of BCD time for the last samples read; i.e., the current time for the ten-second segment.

12.5 Input Parameter Descriptions (continued)

PARAMETER	PROGRAM	DESCRIPTION
U.TRF	U$TGR	Channel trigger flag, indicates status of trigger detecting program.
E.TM1 E.TM2	E$FRT	Two word BCD time used as parameter value for E:FCT
U.CST	U$DAT	Channel status, used to indicate validity of input data based on amplitude monitoring program evaluation.
U.AMP	U$DAT	Amplitude estimate for current ten-second segment, taken from last second's value of segment for each channel.
U.CPP	U$DAT	Pointers to the beginning of each channel's section of U.CMP.
E.IOF	E$T35	Parameter word used in calling E:035.
M.STA	M$ESC	Current values of digital input word status from the sensor.

12.6 Output Parameter Descriptions

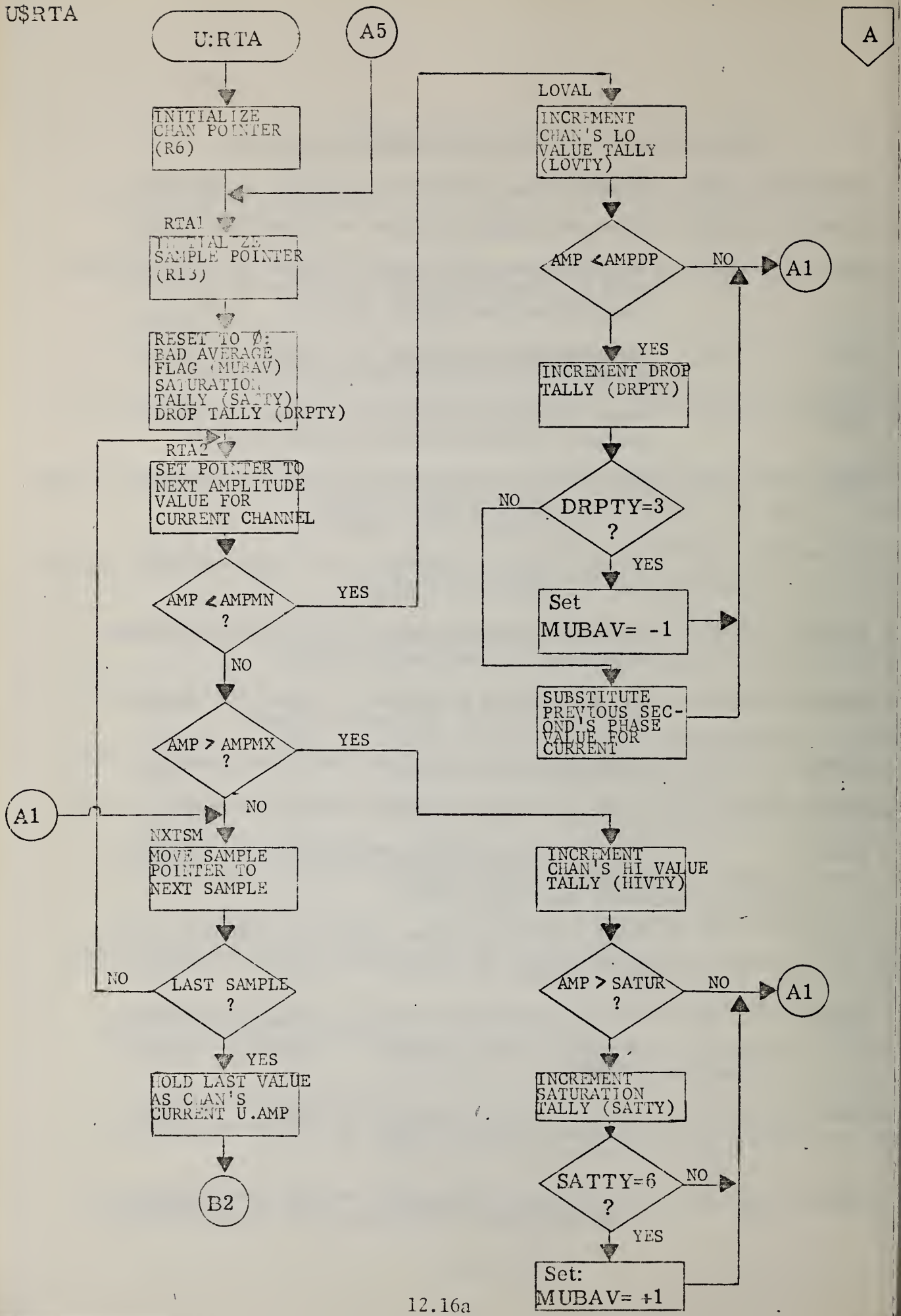
PARAMETER	SIZE	DESCRIPTION
U:RTA		Entry point for Real Time Analysis routine (see Section 12.1.1).
U:CNI		Entry point for routine to determine whether signal is in progress for granting permission to make sensor parameter setting adjustment. (See Section 12.1.2.)
U.SIG	14	Standard deviation estimate. U.SIG is used to externally access internal parameter SIGMA.
U.TM3	1	External reference name for the gain clock, GCLOK.
U.TM4	1	External reference name for the track clock, TCLOK

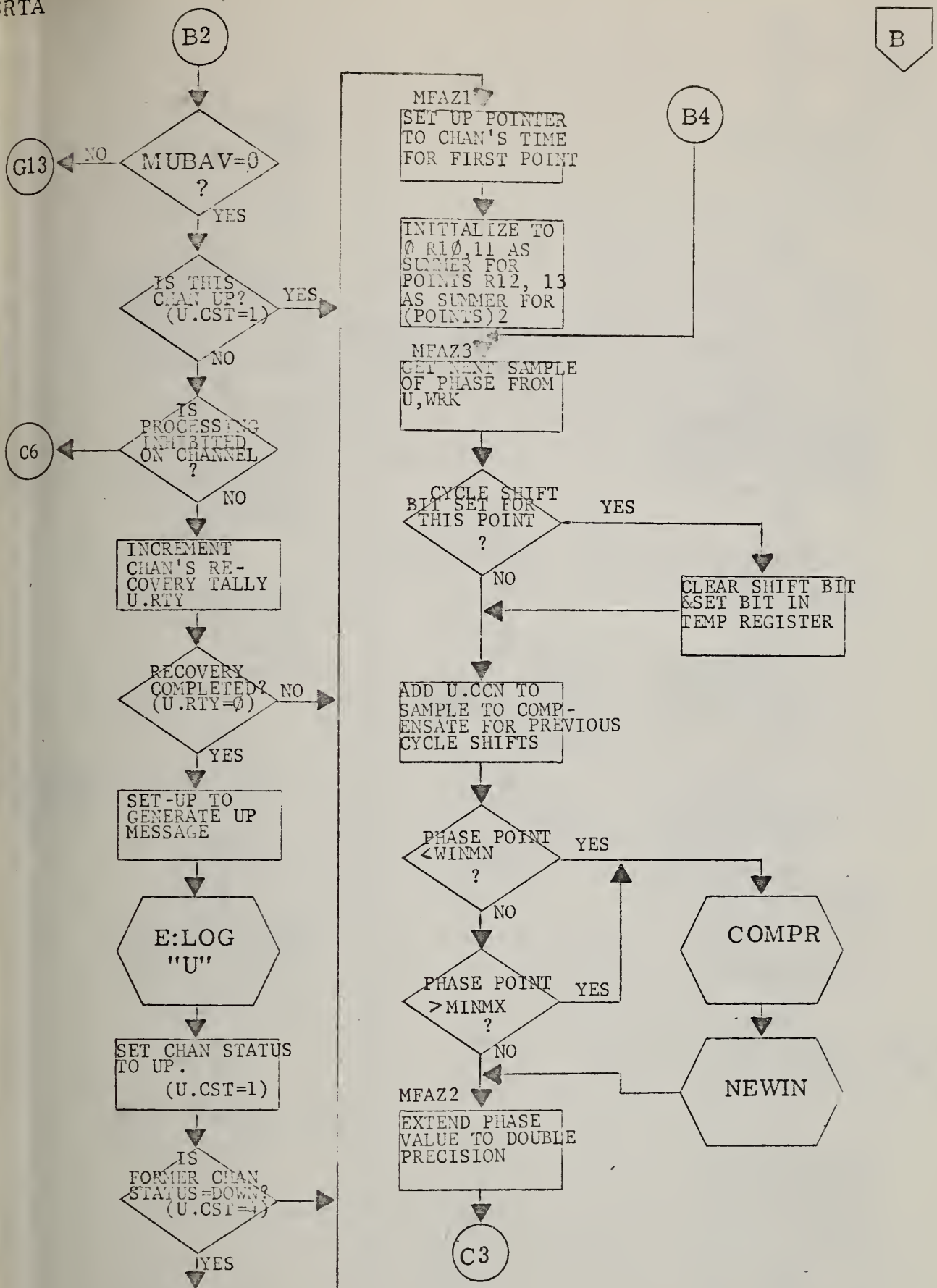
12.7 Internal Data Descriptions.

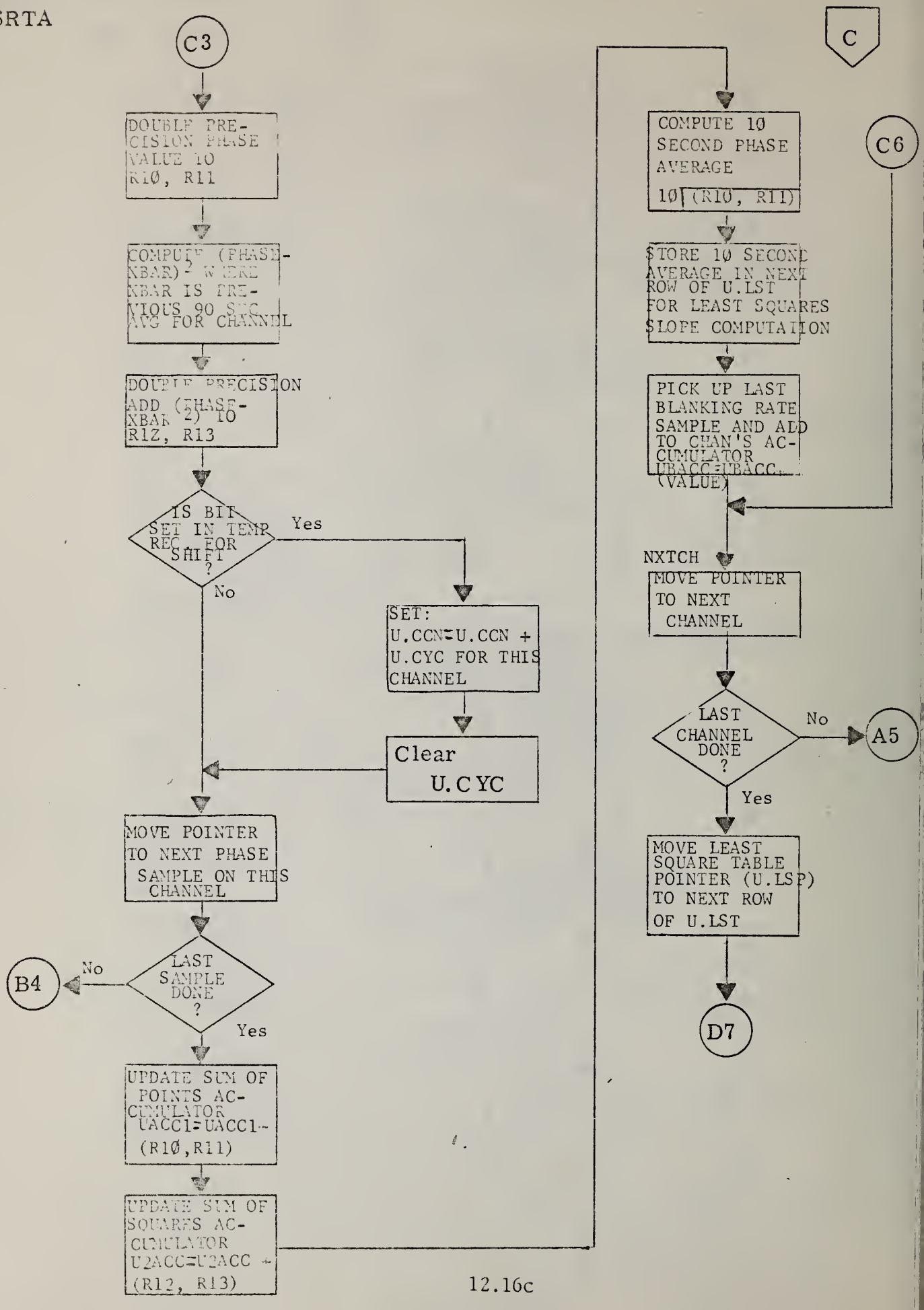
PARAMETER	SIZE	DESCRIPTION
LSTMS	5	DOY/TOD group for optional compressed point listing.
LSTMG	7	Phase value for optional compressed point listing.
COSVR	6	Register holding buffer.
TREGS	7	Register holding buffer.
AMPMN	1	$=614_{10}$ (equivalent of -8dB) minimum amplitude in "good" range.
AMPMX	1	$=666_{10}$ (equivalent of +5dB) when added to AMPMN, gives the maximum amplitude in the "good" range.
AMPDP	1	$=563_{10}$ (equivalent of -19dB) when subtracted from AMPMN, gives the minimum amplitude in the "valid" rang
SATUR	1	$=707_{10}$ (equivalent of +18.8 dB) when added to AMPMX, gives the maximum amplitude in the "valid" range.
LOVTY	14	Count of amplitude values below AMPMN (2 minutes).
HIVTY	14	Count of amplitude values above AMPMX (2 minutes).
SATTY	1	Count of amplitude values above SATUR (10 seconds).
DRPTY	1	Count of amplitude values below AMPDP (10 seconds).
MUBAV	1	Amplitude validity flag: +1 if amplitude indicates saturated data 0 if amplitude indicates valid data -1 if amplitude indicates lost signal
UBADT	14	Counter of ten-second segments during which MUBAV $\neq$ 0.
UBADS	14	Sum of MUBAV values during times of "bad" amplitude.
UACC1	28	Double precision sums of current phase values with cycle shift compensation included.
U2ACC	28	Double precision sums of the difference between curren phase values and the average phase value of the previo 90 second interval (i.e., XBAR)
SIGMA	14	Computed standard deviation of incoming phase values. (See Section 12.3.1.)

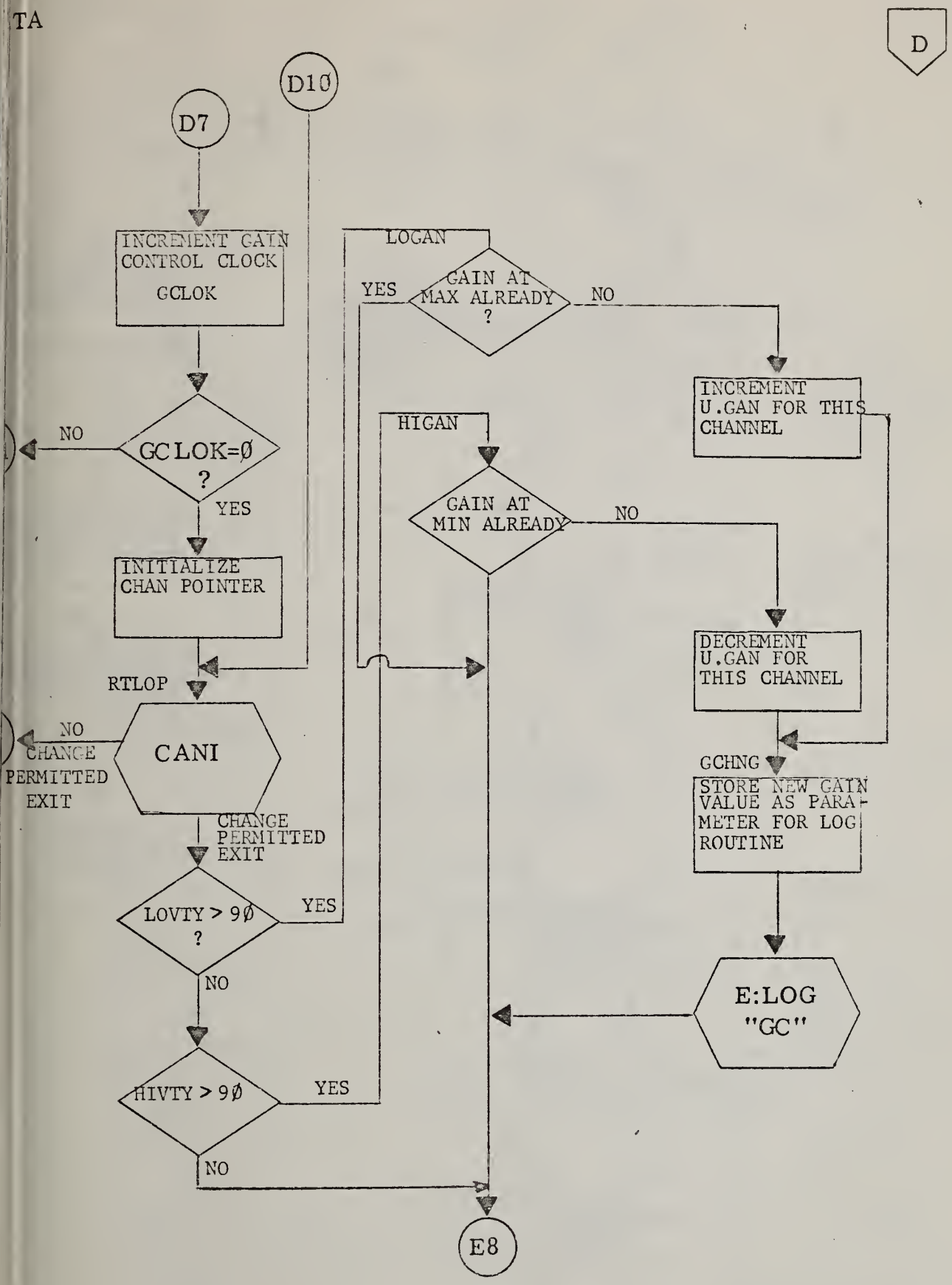
12.7 Internal Data Descriptions (continued)

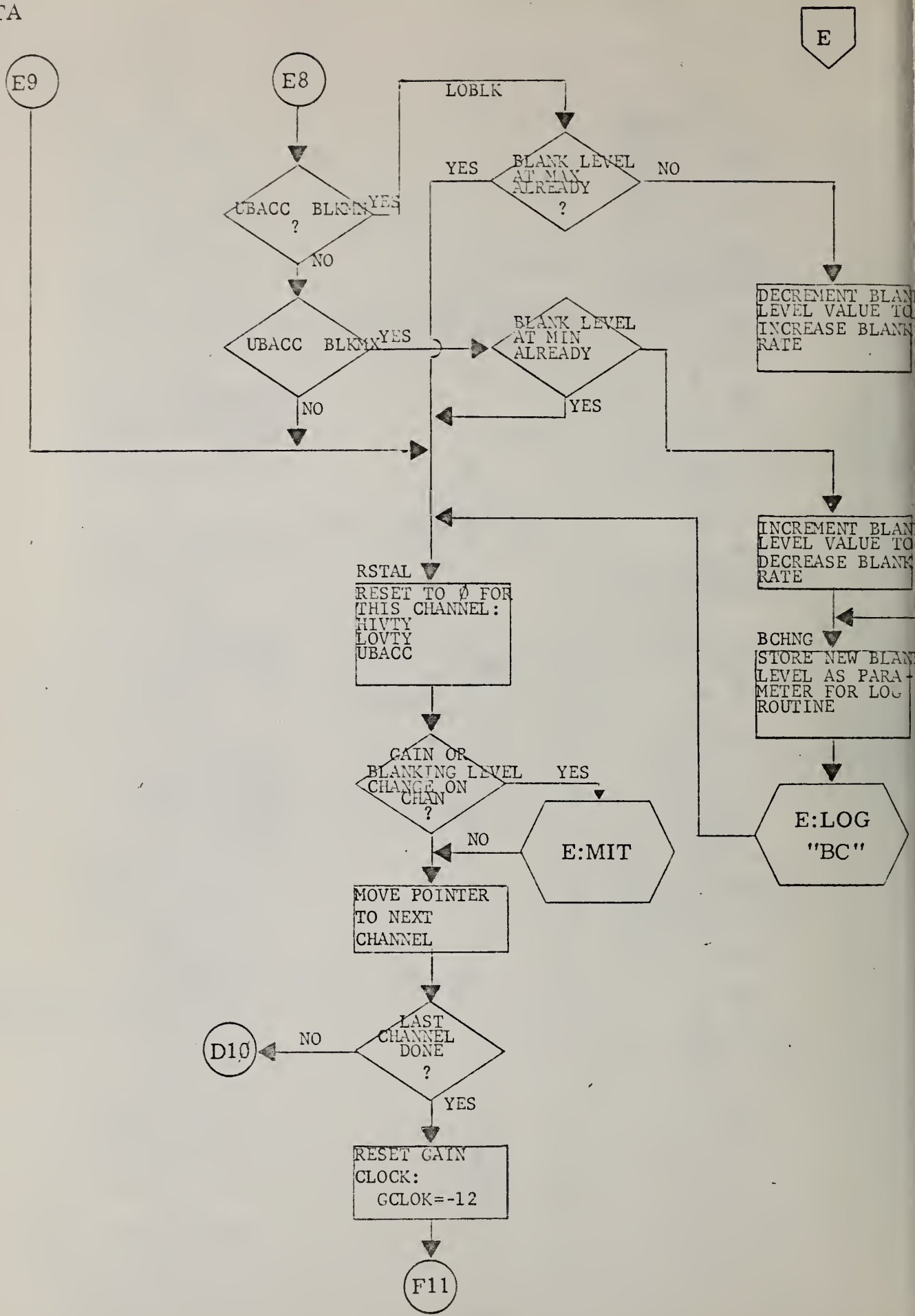
PARAMETER	SIZE	DESCRIPTION
LSIGM	14	Value of SIGMA during previous 90 second interval.
XBAR	14	Average phase value during previous 90 second interval, used as average phase value in standard deviation computation (see Section 12.3.1).
WINMX	14	Upper bounds for current data windows of the data compression algorithm (see Section 12.3.2).
WINMN	14	Lower bounds for current data windows of the data compression algorithm (see Section 12.3.2).
DELTA	14	One-half the current window width, minimum value = 1 msec. WINMX = CENTR + DELTA WINMN = CENTR - DELTA
K	2	Double precision constant = 1.5. Used to compute DELTA; DELTA = K * LSIGM
UBACC	14	Sums last percent blanked value of each ten second segment over a two minute interval.
CFLAG	1	Bit 0 = 1 if an adjustment is needed for the gain or blanking level on the current channel.
BLKMN	1	= $B9_{16}$, minimum acceptable blanking percentage, = 4.1%.
BLKMX	1	= $A9_{16}$, maximum acceptable blanking percentage, = 4.5%
GCLOK	1	Counts ten-second time segments for two minutes to control entry to gain and blanking level control sections of the program.
TCLOK	1	Counts ten-second time segments for 90 seconds to control entry to the tracking rate control section of the program.
TRMAX	1	= 14_{16} (equivalent of 1.25 microseconds) maximum acceptable value of SIGMA for a good tracking rate setting.
TRMIN	1	= 08_{16} (equivalent of .50 microseconds) minimum acceptable value of SIGMA for a good tracking rate setting.
CENTR	14	The center of the current data window, also the last compressed data point encountered for each channel.

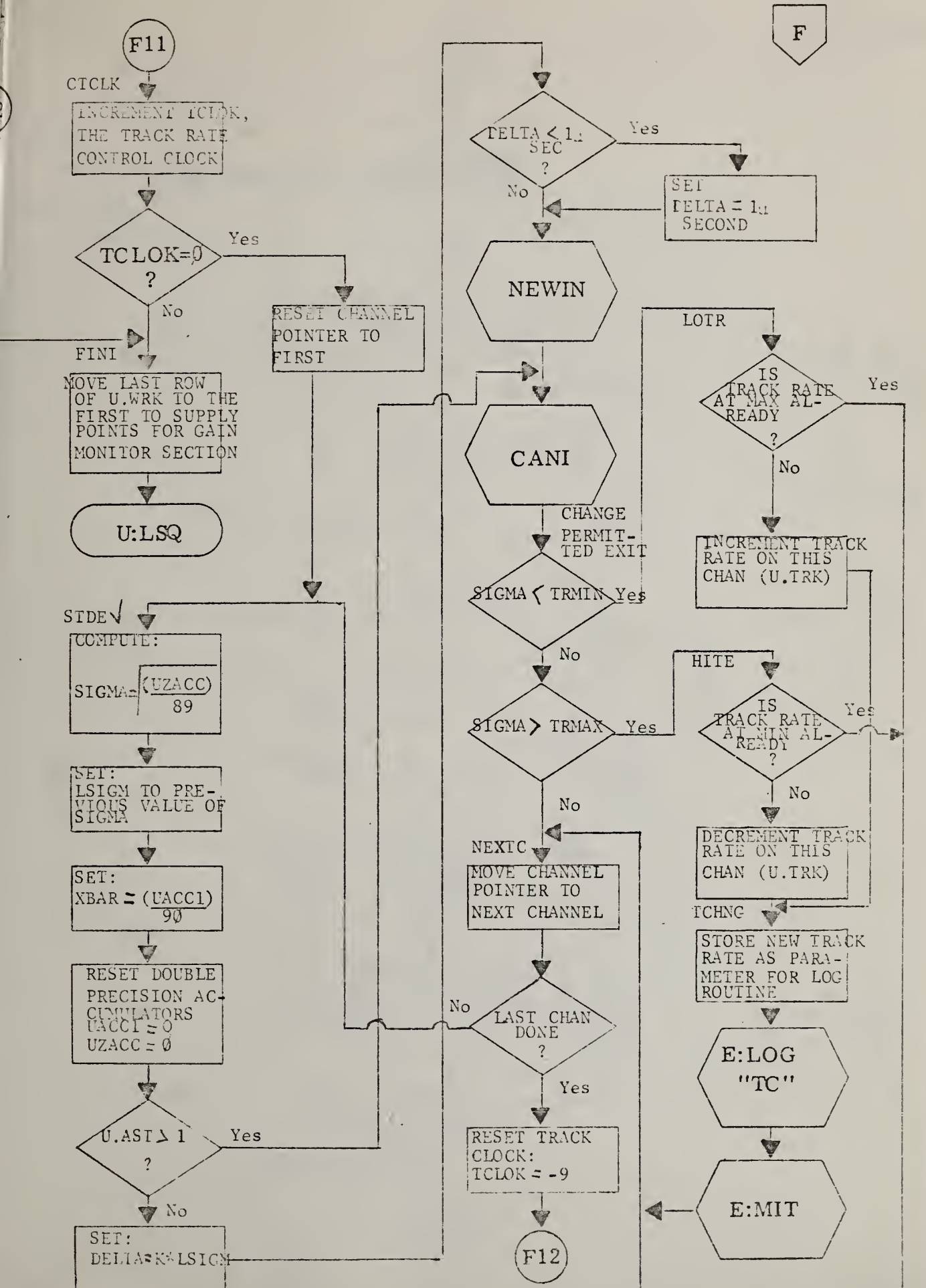

U:RTA
A5
A
INITIALIZE CHAN POINTER (R6)
RTA1
INITIALIZE SAMPLE POINTER (R13)
RESET TO Ø: BAD AVERAGE FLAG (MUBAV) SATURATION TALLY (SATTY) DROP TALLY (DRPTY)
RTA2
SET POINTER TO NEXT AMPLITUDE VALUE FOR CURRENT CHANNEL
AMP < AMPMN ?
YES
NO
AMP > AMPMX ?
YES
NO
A1
NXTSM
MOVE SAMPLE POINTER TO NEXT SAMPLE
LAST SAMPLE ?
NO
YES
HOLD LAST VALUE AS CHAN'S CURRENT U.AMP
B2
LOVAL
INCREMENT CHAN'S LO VALUE TALLY (LOVTY)
AMP < AMPDP
NO
A1
YES
INCREMENT DROP TALLY (DRPTY)
DRPTY=3 ?
NO
YES
Set MUBAV= -1
SUBSTITUTE PREVIOUS SECOND'S PHASE VALUE FOR CURRENT
INCREMENT CHAN'S HI VALUE TALLY (HIVTY)
AMP > SATUR ?
NO
A1
INCREMENT SATURATION TALLY (SATTY)
SATTY=6 ?
NO
YES
Set: MUBAV= +1

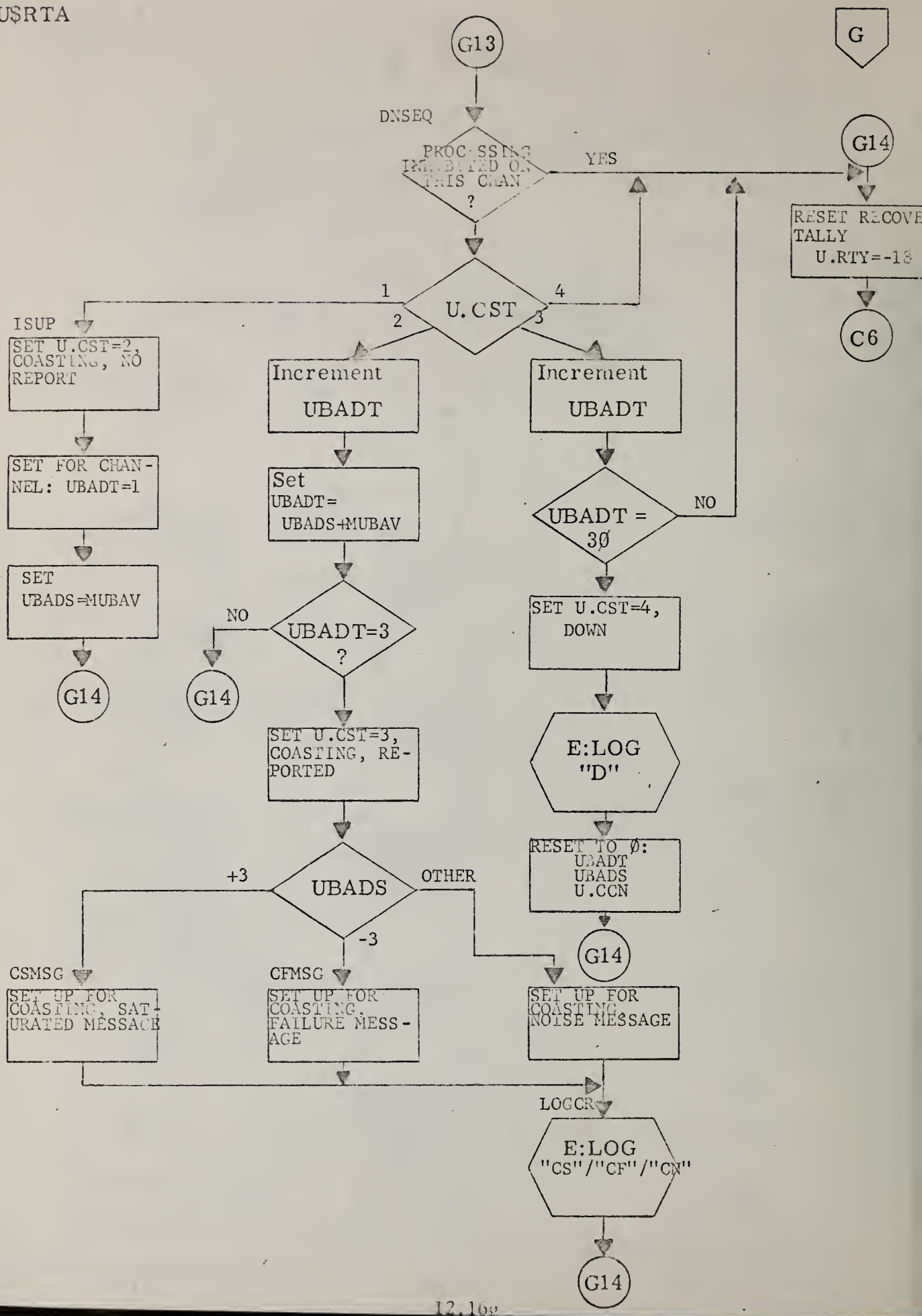

B2
B
G13
NO
MUBAV=0 ?
YES
IS THIS CHAN UP? (U.CST=1)
YES
NO
IS PROCESSING INHIBITED ON CHANNEL ?
C6
NO
INCREMENT CHAN'S RECOVERY TALLY U.RTY
RECOVERY COMPLETED? (U.RTY=Ø)
NO
YES
SET-UP TO GENERATE UP MESSAGE
E:LOG "U"
SET CHAN STATUS TO UP. (U.CST=1)
IS FORMER CHAN STATUS=DOWN? (U.CST=+)
YES
RESET TO Ø: TRIPSER FLAG (U.TRF) BAD POINT TALLY (UBADT) BAD POINT SUM (UBADS) COMP. POINT COUNT (U.CPC) SET: U.FAC=U.LTF
MFAZ1
SET UP POINTER TO CHAN'S TIME FOR FIRST POINT
INITIALIZE TO Ø R1Ø,11 AS SUMMER FOR POINTS R12, 13 AS SUMMER FOR (POINTS)2
B4
MFAZ3
GET NEXT SAMPLE OF PHASE FROM U,WRK
CYCLE SHIFT BIT SET FOR THIS POINT ?
YES
NO
CLEAR SHIFT BIT &SET BIT IN TEMP REGISTER
ADD U.CCN TO SAMPLE TO COMPENSATE FOR PREVIOUS CYCLE SHIFTS
PHASE POINT <WINMN ?
YES
NO
COMPR
PHASE POINT >MINMX ?
YES
NO
NEWIN
MFAZ2
EXTEND PHASE VALUE TO DOUBLE PRECISION
C3

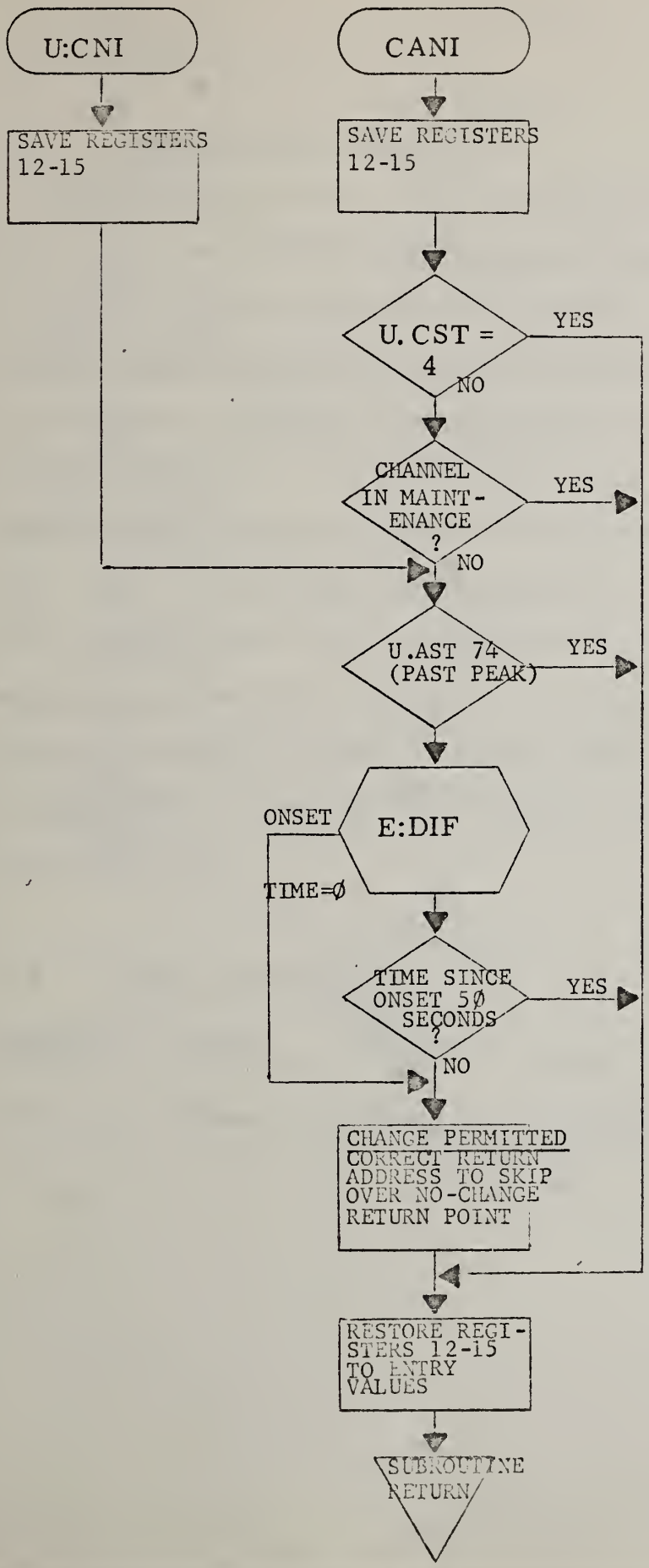

C3
DOUBLE PRE-CISION PHASE VALUE TO R10, R11
COMPUTE (PHASE-XBAR)² WHERE XBAR IS PRE-VIOUS 90 SEC AVG FOR CHANNEL
DOUBLE PRECISION ADD (PHASE-XBAR)² TO R12, R13
IS BIT SET IN TEMP REG FOR SHIFT ?
Yes
No
SET: U.CCN=U.CCN + U.CYC FOR THIS CHANNEL
Clear U.CYC
MOVE POINTER TO NEXT PHASE SAMPLE ON THIS CHANNEL
LAST SAMPLE DONE ?
No
B4
Yes
UPDATE SUM OF POINTS AC-CUMULATOR UACC1=UACC1+ (R10,R11)
UPDATE SUM OF SQUARES AC-CUMULATOR U2ACC=U2ACC + (R12, R13)
C
COMPUTE 10 SECOND PHASE AVERAGE 10 (R10, R11)
C6
STORE 10 SECOND AVERAGE IN NEXT ROW OF U.LST FOR LEAST SQUARES SLOPE COMPUTATION
PICK UP LAST BLANKING RATE SAMPLE AND ADD TO CHAN'S AC-CUMULATOR UBACC=UBACC+ (VALUE)
NXTCH
MOVE POINTER TO NEXT CHANNEL
LAST CHANNEL DONE ?
No
A5
Yes
MOVE LEAST SQUARE TABLE POINTER (U.LSP) TO NEXT ROW OF U.LST
D7

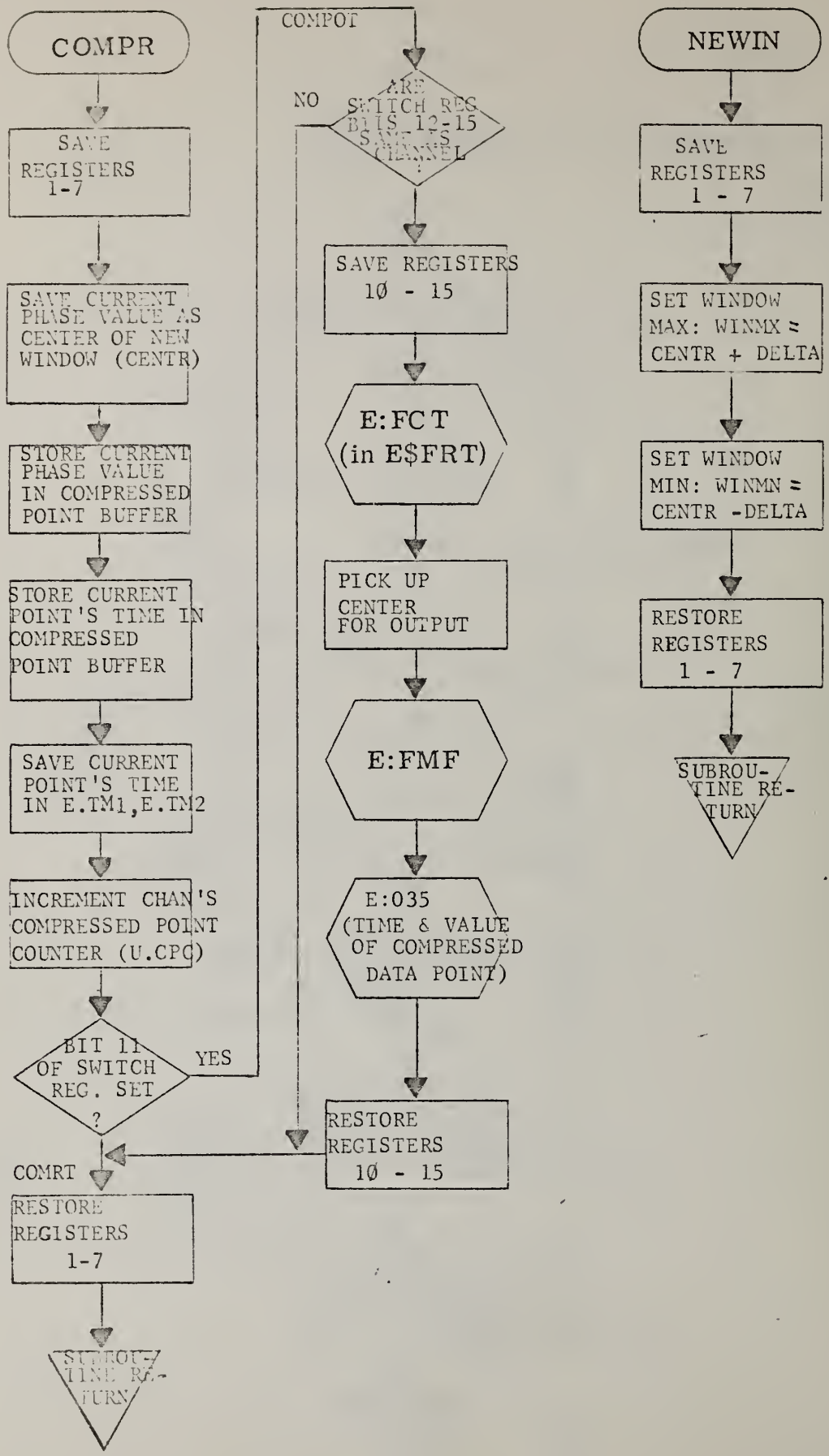

D
D10
D7
INCREMENT GAIN CONTROL CLOCK GCLOK
GCLOK=Ø ?
NO
YES
INITIALIZE CHAN POINTER
RTLOP
CANI
NO CHANGE PERMITTED EXIT
CHANGE PERMITTED EXIT
LOVTY > 9Ø ?
YES
NO
HIVTY > 9Ø
YES
NO
E8
LOGAN
GAIN AT MAX ALREADY ?
YES
NO
INCREMENT U.GAN FOR THIS CHANNEL
HIGAN
GAIN AT MIN ALREADY
NO
DECREMENT U.GAN FOR THIS CHANNEL
GCHNG
STORE NEW GAIN VALUE AS PARAMETER FOR LOG ROUTINE
E:LOG "GC"


E
E9
E8
LOBLK
UBACC BLKMN ?
YES
NO
BLANK LEVEL AT MAX ALREADY ?
YES
NO
DECREMENT BLANK LEVEL VALUE TO INCREASE BLANK RATE
UBACC BLKMX ?
YES
NO
BLANK LEVEL AT MIN ALREADY
YES
INCREMENT BLANK LEVEL VALUE TO DECREASE BLANK RATE
RSTAL
RESET TO Ø FOR THIS CHANNEL:
HIVTY
LOVTY
UBACC
BCHNG
STORE NEW BLANK LEVEL AS PARAMETER FOR LOG ROUTINE
GAIN OR BLANKING LEVEL CHANGE ON CHAN ?
YES
NO
E:MIT
E:LOG "BC"
MOVE POINTER TO NEXT CHANNEL
LAST CHANNEL DONE ?
NO
D10
YES
RESET GAIN CLOCK:
GCLOK=-12
F11


F11
CTCLK
INCREMENT TCLOK, THE TRACK RATE CONTROL CLOCK
TCLOK=0 ?
Yes
No
RESET CHANNEL POINTER TO FIRST
FINI
MOVE LAST ROW OF U.WRK TO THE FIRST TO SUPPLY POINTS FOR GAIN MONITOR SECTION
U:LSQ
STDE√
COMPUTE: SIGMA=√(UZACC)/89
SET: LSIGM TO PREVIOUS VALUE OF SIGMA
SET: XBAR=(UACC1)/90
RESET DOUBLE PRECISION ACCUMULATORS UACC1=0 UZACC=0
U.AST>1 ?
Yes
No
SET: DELTA=K*LSIGM
F
DELTA<1u SEC ?
Yes
No
SET DELTA=1u SECOND
NEWIN
CANI
CHANGE PERMITTED EXIT
SIGMA<TRMIN
Yes
No
SIGMA>TRMAX
Yes
No
NEXTC
MOVE CHANNEL POINTER TO NEXT CHANNEL
LAST CHAN DONE ?
No
Yes
RESET TRACK CLOCK: TCLOK=-9
F12
LOTR
IS TRACK RATE AT MAX ALREADY ?
Yes
No
INCREMENT TRACK RATE ON THIS CHAN (U.TRK)
HITE
IS TRACK RATE AT MIN ALREADY ?
Yes
No
DECREMENT TRACK RATE ON THIS CHAN (U.TRK)
TCHNG
STORE NEW TRACK RATE AS PARAMETER FOR LOG ROUTINE
E:LOG "TC"
E:MIT


G13
G
DNSEQ
PROCESSING INHIBITED ON THIS CHAN ?
YES
G14
RESET RECOVE TALLY
U.RTY=-18
C6
1
2
3
4
U.CST
ISUP
SET U.CST=2, COASTING, NO REPORT
SET FOR CHAN-NEL: UBADT=1
SET UBADS=MUBAV
G14
Increment UBADT
Set UBADT= UBADS+MUBAV
NO
UBADT=3 ?
G14
SET U.CST=3, COASTING, RE-PORTED
Increment UBADT
UBADT = 3Ø
NO
SET U.CST=4, DOWN
E:LOG "D"
RESET TO Ø: UBADT UBADS U.CCN
G14
+3
UBADS
OTHER
-3
CSMSG
SET UP FOR COASTING, SAT-URATED MESSAGE
CFMSG
SET UP FOR COASTING, FAILURE MESS-AGE
SET UP FOR COASTING, NOISE MESSAGE
LOGCR
E:LOG "CS"/"CF"/"CN"
G14


U:CNI
SAVE REGISTERS 12-15
CANI
SAVE REGISTERS 12-15
U. CST = 4
YES
NO
CHANNEL IN MAINT-ENANCE ?
YES
NO
U.AST 74 (PAST PEAK)
YES
ONSET
E:DIF
TIME=Ø
TIME SINCE ONSET 5Ø SECONDS ?
YES
NO
CHANGE PERMITTED CORRECT RETURN ADDRESS TO SKIP OVER NO-CHANGE RETURN POINT
RESTORE REGI-STERS 12-15 TO ENTRY VALUES
SUBROUTINE RETURN


COMPR
SAVE REGISTERS 1-7
SAVE CURRENT PHASE VALUE AS CENTER OF NEW WINDOW (CENTR)
STORE CURRENT PHASE VALUE IN COMPRESSED POINT BUFFER
STORE CURRENT POINT'S TIME IN COMPRESSED POINT BUFFER
SAVE CURRENT POINT'S TIME IN E.TM1,E.TM2
INCREMENT CHAN'S COMPRESSED POINT COUNTER (U.CPC)
BIT 11 OF SWITCH REG. SET ?
YES
NO
COMPOT
ARE SWITCH REG BITS 12-15 SAME AS CHANNEL ?
SAVE REGISTERS 10 - 15
E:FCT (in E$FRT)
PICK UP CENTER FOR OUTPUT
E:FMF
E:035 (TIME & VALUE OF COMPRESSED DATA POINT)
RESTORE REGISTERS 10 - 15
COMRT
RESTORE REGISTERS 1-7
SUBROU-TINE RE-TURN
NEWIN
SAVE REGISTERS 1 - 7
SET WINDOW MAX: WINMX = CENTR + DELTA
SET WINDOW MIN: WINMN = CENTR -DELTA
RESTORE REGISTERS 1 - 7
SUBROU-TINE RE-TURN

13. U$LSQ

13.1 Functional Description

Two parameters are used by the trigger detection and waveform analysis programs (U$TGR and U$WFA) in processing U data signals in real time. While selected phase values are stored for use by U$RTA in its data compression scheme (see Section 12.3.2), the waveform analysis algorithm used by NUSTAD also relies on information regarding the trends in the phase data. The values used to determine these trends are derived from the short term estimates of the phase slope. NUSTAD uses a Least Squares Estimation as a maximum likelihood fit to determine this short term (1ØØ second) slope value. Each ten seconds, after U$RTA passes control to U:LSQ, the slope estimate for the preceding 1ØØ seconds is computed and stored in U.SLP for for each channel. When completed, control is passed to U$TGR for trigger detection.

13.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
U:TGR	U$TGR	Trigger detection routine, next step in processing current ten-second data segment.

13.3 Computational Methods--Least Squares Algorithm

The short term slope estimate is made by NUSTAD by applying a least squares fit to ten-second segment average phase values over a period of 1ØØ seconds. The formula for such a slope estimate is:

$$\text{SLOPE} = \frac{\Sigma T_n \ \Sigma Y_n - K \Sigma T_n Y_n}{(\Sigma T_n)^2 - K \Sigma T_n^2} \qquad (1)$$

Where: K is the number of average values considered, currently = 1Ø (i.e. 1ØØ seconds)

The sums are taken between the limits of n = 1 and K

T_n is the time value (in seconds) for the nth average value

Y_n is the 1Ø second phase average at time T_n

Since the actual value of T_n is immaterial to the computation, and samples are taken at uniform intervals, assume the interval value A = 1Ø seconds and assign T_1 = zero. Then we can determine T_n as follows:

$$T_n = A(n - 1) \qquad (2)$$

Then it follows:

$$\Sigma T_n = \frac{AK\ (K - 1)}{2} \qquad (3)$$

and

$$\Sigma T_n^2 = \frac{A^2 K^2 (K - 1)(2K - 1)}{6} \qquad (4)$$

Substituting these values in (1), we determine:

$$\text{SLOPE} = \frac{\frac{AK(K - 1)\Sigma Y_n}{2} - AK \Sigma (n - 1)Y_n}{\frac{A^2 K^2 (K-1)}{4} - \frac{A^2 K^2 (K - 1)(2K - 1)}{6}} \qquad (5)$$

Which simplifies as follows:

$$\text{SLOPE} = \frac{\dfrac{AK(K-1)\,\Sigma Y_n - 2AK\,\Sigma(n-1)Y_n}{2}}{\dfrac{3A^2K^2(K-1) - 2A^2K^2(K-1)(2K-1)}{12}} \qquad (6)$$

$$\text{SLOPE} = \frac{6AK[(K-1)\,\Sigma Y_n - 2\,\Sigma(n-1)Y_n]}{A^2K^2(K-1)\,[3K-1) - 2(2K-1)]} \qquad (7)$$

$$\text{SLOPE} = \frac{12[\,\Sigma\frac{(K-1)}{2}Y_n - \Sigma(n-1)Y_n]}{AK(K-1)(-K-1)} \qquad (8)$$

Since our selection of the starting point is immaterial, a unit adjustment in n (i.e., let n = n-1, changing the limits of summation from n = Ø to K-1) will not affect the computation:

$$\text{SLOPE} = \frac{-12\left[\Sigma\frac{-(K-1)}{2}Y_n = \Sigma nY_n\right]}{-AK(K^2-1)} \qquad (9)$$

$$\text{SLOPE} = \frac{12}{AK(K^2-1)} \sum_{n=0}^{K-1} \left[n - \frac{(K-1)}{2}\right] Y_n \qquad (10)$$

The leading factor is a series of constants, where:

A = 1Ø seconds (the interval between averages)

K = 1Ø intervals (resulting in a 1ØØ second slope estimate)

These values are combined with a scaling adjustment to give the slope in microseconds/minute (at equation (1Ø)) the result is in microseconds/second) reducing the leading factor to:

$$\frac{12 * 6Ø}{1Ø * 1Ø * 99} = \frac{72Ø}{99ØØ} = .Ø727272$$

The expression in brackets ranges from $-\frac{(K-1)}{2}$ to $+\frac{(K-1)}{2}$ in unit steps, or the set of points (-4.5, -3.5, -2.5, ... +2.5, +3.5, +4.5) for the ten intervals currently used by NUSTAD.

To simplify internal representation of these constant values (primarily eliminating the need for both integer and fractional representation causing mixed multiplications which result in wasted time for a real-time system), the leading factor is multiplied by ten, and the factor in the brackets is divided by ten (this also results in steps of .10 rather than one between the bracket factors). In NUSTAD, these values are given the following names:

TUFAC = .727272 (the leading factor, adjusted)

TUMAX = .45 (the maximum value for the bracket expression adjusted

TUWDF = .1Ø (the incremental step between successive values for the brackets expression adjusted)

TUWAT The variable which corresponds to the brackets expression, assuming the values of -.45, -.35, -.25, ... +.25, +.35, +.45

13.4 Data Formats

13.4.1 U.LST and U.LSP

To compute a new least squares slope estimate at each ten-second interval, it is necessary to have the previous ten-phase averages available for each channel. This results in a 1Ø by 14 word matrix called U.LST. To eliminate a lot of data shuffling within the matrix, it is designed to be wrapped-around, using a pointer called U.LSP to indicate where the "oldest" values are located. This is convenient as the U.LSP also indicates where the next values are to be stored, giving double duty to the single value. U.LST may be pictured as shown in Figure 13.1. U.LSP can be represented as n * 14, where n ranges from Ø to 9, corresponding to the relative location of the "oldest" average value ($Y_Ø$ in the derivation of Section 13.3) for channel A.

		CHANNEL					
		A	B	C	D	E	.....
	T_I	U.LST	U.LST+1	U.LST+2	U.LST+3	U.LST+4	.....
	T_{II}	U.LST+14	U.LST+15	U.LST+16	U.LST+17	U.LST+18	.....
RELATIVE	T_{III}	U.LST+28	U.LST+29	U.LST+3Ø	U.LST+31	U.LST+32	.....
TIME	.	.					
SEPARATED	.	.					
BY TEN	.	.					
SECONDS	.	.					
	$T_{\overline{X}}$	U.LST+126	U.LST+127	U.LST+128	U.LST+129	U.LST+13Ø	.....

Figure 13.1 Structural Organization of U.LST

13.4.2 TUWAT, TUWDF, TUMAX, and TUFAC

The interval values of U$LSQ which represent totally fractional values are represented in the following format:

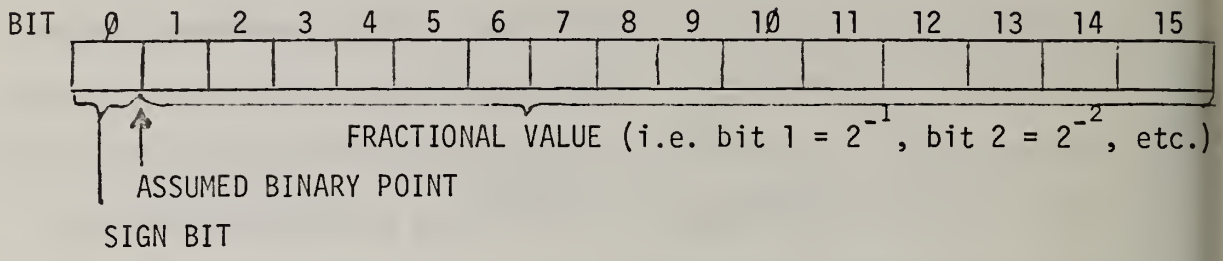


Figure 13.2 Internal Representation of Fractional Values

13.4.3 U.SLP

The computed value of slope is stored in U.SLP as a value in microseconds per minute, and may be interpreted as follows:

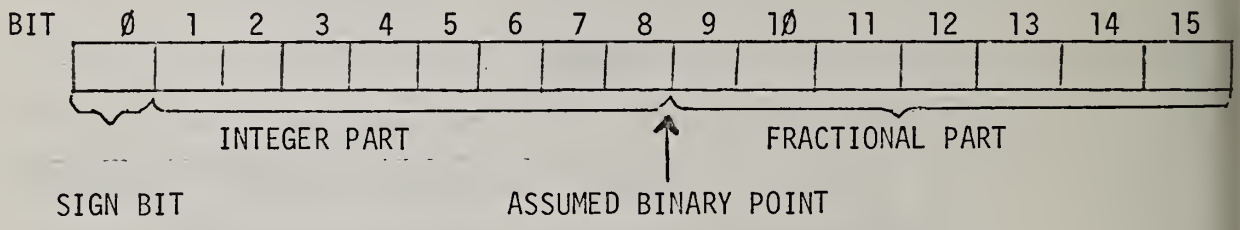


Figure 13.3 Representation of Slope in U.SLP

13.5 Input Parameter Descriptions

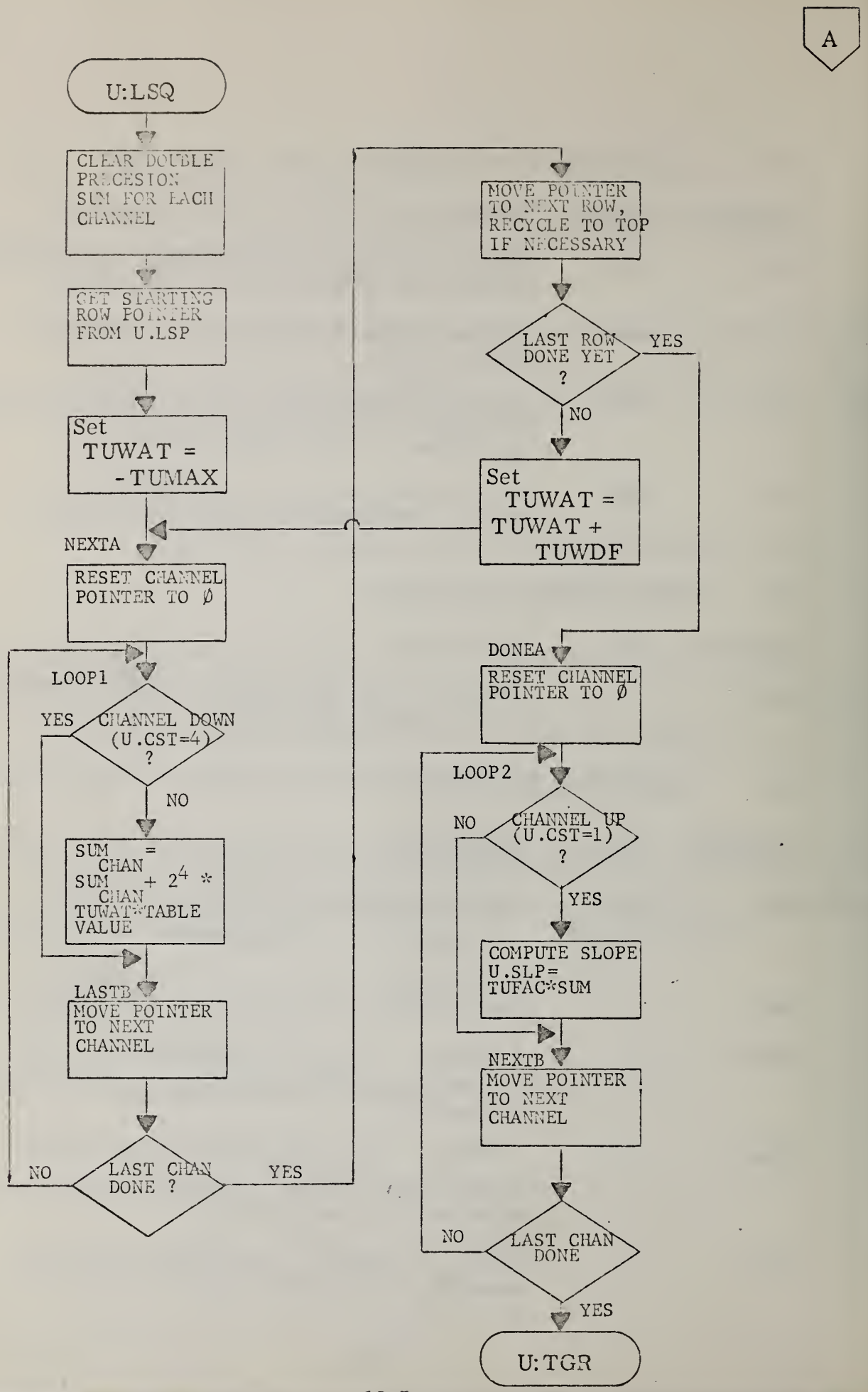
PARAMETER	PROGRAM	DESCRIPTION
U.LST	U$DAT	Table of ten-second phase averages for last 1ØØ seconds, see Section 13.4 for description.
U.LSP	U$DAT	Pointer to base of oldest row in U.LST (see Section 13.4)
U.CST	U$DAT	Channel status, used to indicate validity of input data based on amplitude monitoring program evaluation.
U.SLP	U$DAT	Computed slope estimate in microseconds per minute. Indicates short term data trends.

13.6 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
U.LSQ		Entry point for least squares slope computation routine (see Section 13.1).

13.7 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
SUM	28	Double precision accumulator for the term $n - \frac{(K-1)}{2} Y_n$ in equation (1) of Section 13.3.
TUWAT	1	The "brackets expression" value (see Section 13.3).
TUWDF	1	$= ØCCC_{16} = .1Ø_{1Ø}$; the incremental step value for the "brackets expression" of equation (1Ø), Section 13.3.
TUMAX	1	$= 3999_{16} = .45_{1Ø}$; the absolute value of the extreme limits of the "brackets expression" of equation (1Ø), Section 13.3.
TUFAC	1	$=5D17_{16} = .727272_{1Ø}$; the "leading factor" of equation (1Ø), Section 13.3.


A
U:LSQ
CLEAR DOUBLE PRECESION SUM FOR EACH CHANNEL
GET STARTING ROW POINTER FROM U.LSP
Set TUWAT = -TUMAX
NEXTA
RESET CHANNEL POINTER TO Ø
LOOP1
YES
CHANNEL DOWN (U.CST=4) ?
NO
SUM CHAN = SUM CHAN + 2^4 * TUWAT*TABLE VALUE
LASTB
MOVE POINTER TO NEXT CHANNEL
NO
LAST CHAN DONE ?
YES
MOVE POINTER TO NEXT ROW, RECYCLE TO TOP IF NECESSARY
LAST ROW DONE YET ?
YES
NO
Set TUWAT = TUWAT + TUWDF
DONEA
RESET CHANNEL POINTER TO Ø
LOOP2
NO
CHANNEL UP (U.CST=1) ?
YES
COMPUTE SLOPE U.SLP= TUFAC*SUM
NEXTB
MOVE POINTER TO NEXT CHANNEL
NO
LAST CHAN DONE
YES
U:TGR

14. U$TGR

14.1 Functional Description

14.1.1 U.TGR (U Signal Trigger Detection Routine)

After the sensor parameter control is completed by U:RTA, and the values needed by the waveform analysis programs are determined by U:RTA and U:LSQ, U:LSQ passes control to U:TGR to begin signal processing. The waveform analysis consists of recognizing key characteristics of the incoming waveform, computing descriptive parameter values based on data values at the key points and comparing the computed values against predetermined criteria.

The initial problem in the waveform analysis algorithm development was to readily recognize a significant phase excursion from the long term trend (see Figures 15.1, 15.2, and 15.3 for the onset portion of the waveforms). The technique finally chosen was to designate a predetermined number of compressed data points in the same direction as the signal onset. NUSTAD uses the standard deviation of the incoming signal to determine the window width in the data compression algorithm and thus effectively eliminating the effects of the background noise in signal processing. The selection of compressed points which consistently increase or decrease becomes a fair indication of short term monotonic trends. The number of points required to recognize an onset, also known as triggering the waveform (hence U:TGR), is stored

in U.TRL (the U Signal Trigger Limit). This value is normally set as five, but may be reset to other values during other portions of the waveform processing. Since the phase excursion should be somewhat sudden, NUSTAD requires that the time difference between the first and last points in the triggering sequence be less than TRTIM (Trigger Time) seconds, currently set at 3Ø.

The progress in the waveform analysis is reflected by the value of a parameter called U.AST (U Signal Alarm Status). The values which this variable may take are represented graphically in Figures 15.1, 15.2, and 15.3 for the three signal types which must be recognized. While seeking an onset, U.AST will be set to one. When U:TGR identifies an onset, it sets U.AST to either two or three, reflecting the direction of the phase excursion and in so doing, triggers further waveform processing by U:WFA (U Signal Waveform Analysis).

The status during the trigger detection process is maintained in a parameter called U.TRF (U Signal Trigger Flag) for each sensor channel and takes on the following values:

a. U.TRF = Ø. No compressed data points have been encountered yet. This value can occur only upon initial startup, or after a channel comes up, as thereafter, compressed data points will always have occurred at sometime in the past.

b. U.TRF = 1. One compressed data point has been encountered. Again, this value will only occur as a channel comes up. Since two points are required to determine direction, nothing significant can

happen until a second point arrives. At that time, the direction is determined and U.TRF set to two or three to indicate an advance or retard trend, respectively.

c. U.TRF = 2. Two or more compressed data points have been encountered, each point with a phase value numerically smaller than the previous. NUSTAD considers these points as being in the ADVANCE direction. The number of points currently encountered in the possible triggering sequence is contained in TRCNT (Trigger Counter). As long as points continue the decreasing value trend, U.TRF will remain set at two, until TRLIM (Trigger Limit) points have been counted. At this time, U.TRF may be set to four, after additional processing as described in paragraph (e) below.

d. U.TRF = 3. U.TRF is set to three when two or more compressed data points have been encountered, each point with a phase value numerically greater than the previous. NUSTAD considers these points as being in the RETARD direction. U.TRF set to three is the counterpart of U.TRF set to two for data trends in the opposite direction. See Figures 15.1 and 15.2 for this contrast.

e. U.TRF = 4. When TRCNT reaches TRLIM, sufficient data have been encountered to trigger the waveform analysis. However, at this point, the timing requirement is checked by comparing the time differences between the first and last points against TRTIM. If this check is successful, the trigger is considered valid, U.TRF is set to four, and U.AST is set to the previous value of U.TRF (either two or three,

indicating the type of signal under consideration). On the other hand, if the time difference is greater than TRTIM, the points are "slipped," making the previous second point the current first, and TRCNT one short of reaching TRLIM. If the next compressed point is again in the same direction, the time duration will be checked on the new first and last points.

If at any time after U.TRF reaches two or three, a point is encountered which is in the opposite direction from that under consideration, the value of U.TRF is reversed to three or two, respectively, and the two most recent points are established as the first two in the new potential triggering sequence.

When discussing the compression algorithm, Section 12.3.2, we said that a tolerance of ± DELTA is placed about the last value used. For the timing and phase values at onset, NUSTAD uses the first point in the triggering sequence for the "onset phase value," and the time of the second point as the "onset time." Figure 14.1 will intuitively explain the rationale behind using these values. Remember that DELTA is assigned a minimum value of one microsecond and typically won't significantly exceed this.

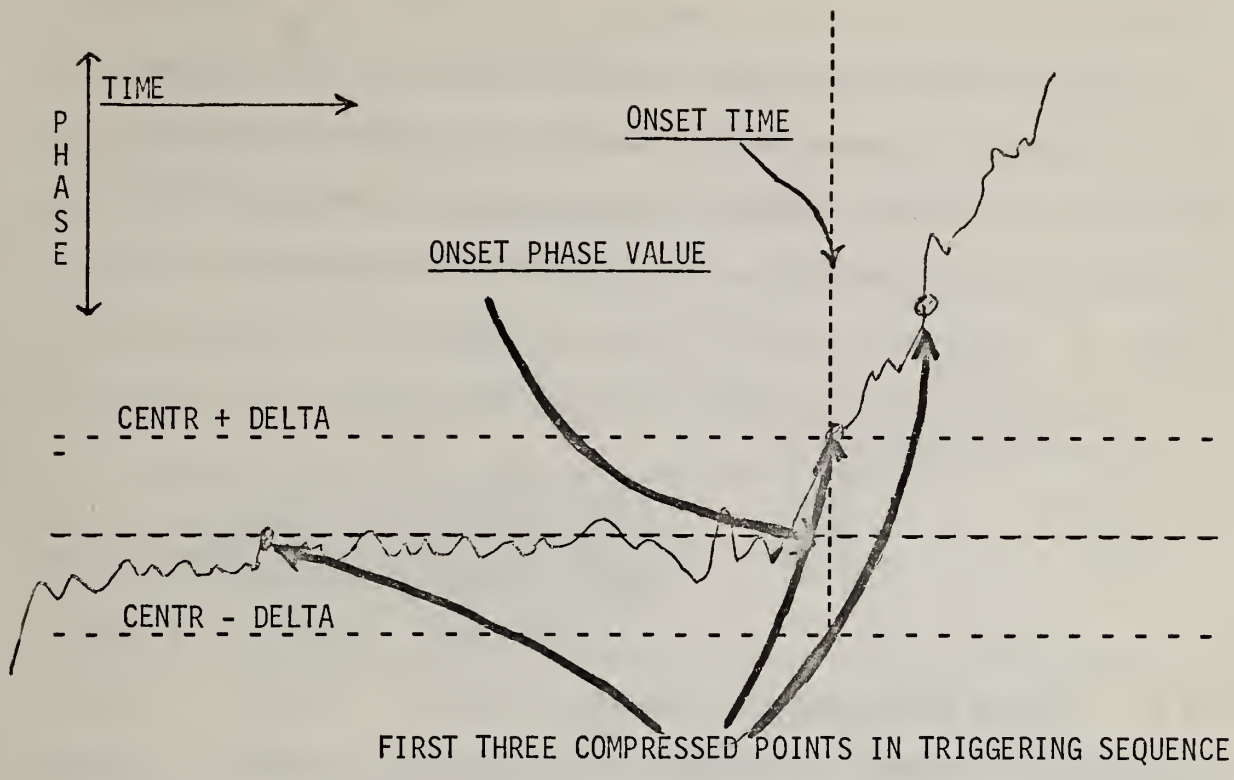


Figure 14.1 Onset Value Determination

14.1.2 U:GET (Compressed Data Point Retrieval Subroutine)

U:GET is a subroutine by which U:TGR and U:WFA retrieve compressed data points from the compressed data buffer (U.CMP). By manipulating the return location, the subroutine identifies the absence of compressed points for the desired channel when the buffer is empty.

A counter (GETCN--Get Counter) is used to point to the next data point (consisting of three computer words, one of phase and two of BCD time) in the buffer. When the compressed point counter (U.CPS) reaches zero, GETCN is reset to zero to effectively empty the buffer.

The calling sequence is:

```
BLM,14          U:GET     (DESIRED CHANNEL IS IN R6)
BRU             NONE      (RETURN LOCATION IF NO COMPRESSED POINTS)
.....                     (RETURN WITH PHASE IN R11, BCD TIME IN
                           R12, 13)
```

14.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:COT	E$DIF	Converts the BCD time characters to the binary count of seconds.
E:DIF	E$DIF	Used to determine the time difference in seconds between two time values, one in binary and the other in BCD characters.
U:WFA	U$WFA	The program dedicated to the waveform analysis after onset has been identified by U:TGR.
U:RP2	U$REP	That portion of the Reportable Signal Description message generator which initiates reports for Part II of the RSD to conclude the report message.

14.3 Data Formats

14.3.1 TRBUF

The compressed data points of a potential trigger are stored in a buffer called TRBUF (Trigger Buffer). Each entry requires three

computer words, the first gives the phase value, and the next two give the BCD characters of the DOY/TOD group. Since the buffer is purged by U:TGR and/or U:WFA each ten seconds, it is designed to hold a maximum of ten entries at any one time, for each channel. This amounts to 3Ø words per channel for 14 channels, or 42Ø words. The ten entries for each channel are arranged in continuous memory locations. A 14-element table called TRBFP (Trigger Buffer Pointer) indicates the first location (of the 3Ø) used by each sensor channel.

14.4 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
U.CPC	U$DAT	Channel compressed point counter
U.CPP	U$DAT	Pointers to the beginning of each channel's section of U.CMP.
U.AST	U$DAT	Channel waveform analysis status, indicates point in signal to which processing has progressed.
U.CDT	U$WFA	The phase value of a likely candidate in the peak detection algorithm.
U.CDM	U$WFA	The DOY/TOD group for a candidate in the peak detection algorithm.
U.AMP	U$DAT	Amplitude estimate for current ten second segment.
U.OAM	U$DAT	Amplitude value assigned as amplitude at onset.
U.DIU	U$DAT	The diurnal slope estimate, an estimate of the long term trends in phase deviation.

14.4 Input Parameter Descriptions (continued)

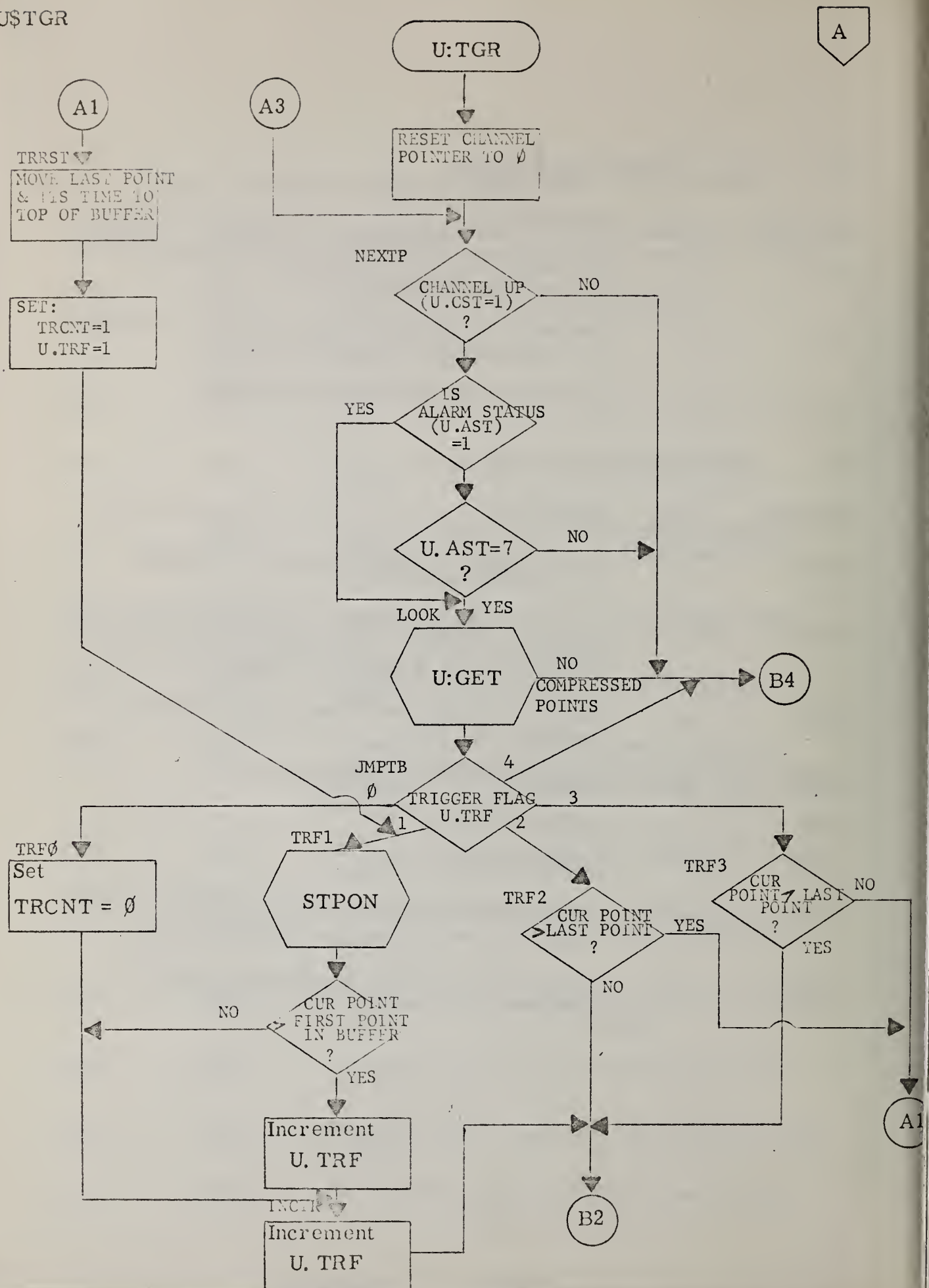
PARAMETER	PROGRAM	DESCRIPTION
U.ODI	U$DAT	The diurnal slope value assigned at onset.
U.OFZ	U$DAT	Phase value at onset.
U.OTM	U$DAT	Time of onset, binary count of seconds for day.
U.OTB	U$DAT	Time of onset, BCD characters for DOY/TOD group.
U.CST	U$DAT	Channel status, used to indicate validity of input data based on amplitude monitoring program evaluation.
U.OSG	U$DAT	The standard deviation of the incoming phase signal assigned to the onset.
U.SIG	U$RTA	Computed standard deviation of incoming phase (see Section 12.3.1).
U.DTM	U$DAT	Parameter used by E$DIF to permit finding time difference between any two values (program designed to find difference between onset time and given value).
U.END	U$DAT	Bits used to flag conditions under which signal processing was terminated.
U.CLS	U$DAT	Flag to indicate which set of criteria was passed; =1 for class A criteria, +2 for class B, +3 for COCO signal.
U.LTF	U$DAT	The longer time constant factor for the digital filter of the diurnal estimate.
U.FAC	U$DAT	The update factor used in the digital filter for the diurnal estimate.
U.LFZ	U$WFA	The most recent compressed data point for each channel.
U.LTM	U$WFA	The DOY/TOD group for U.LFZ for each channel.

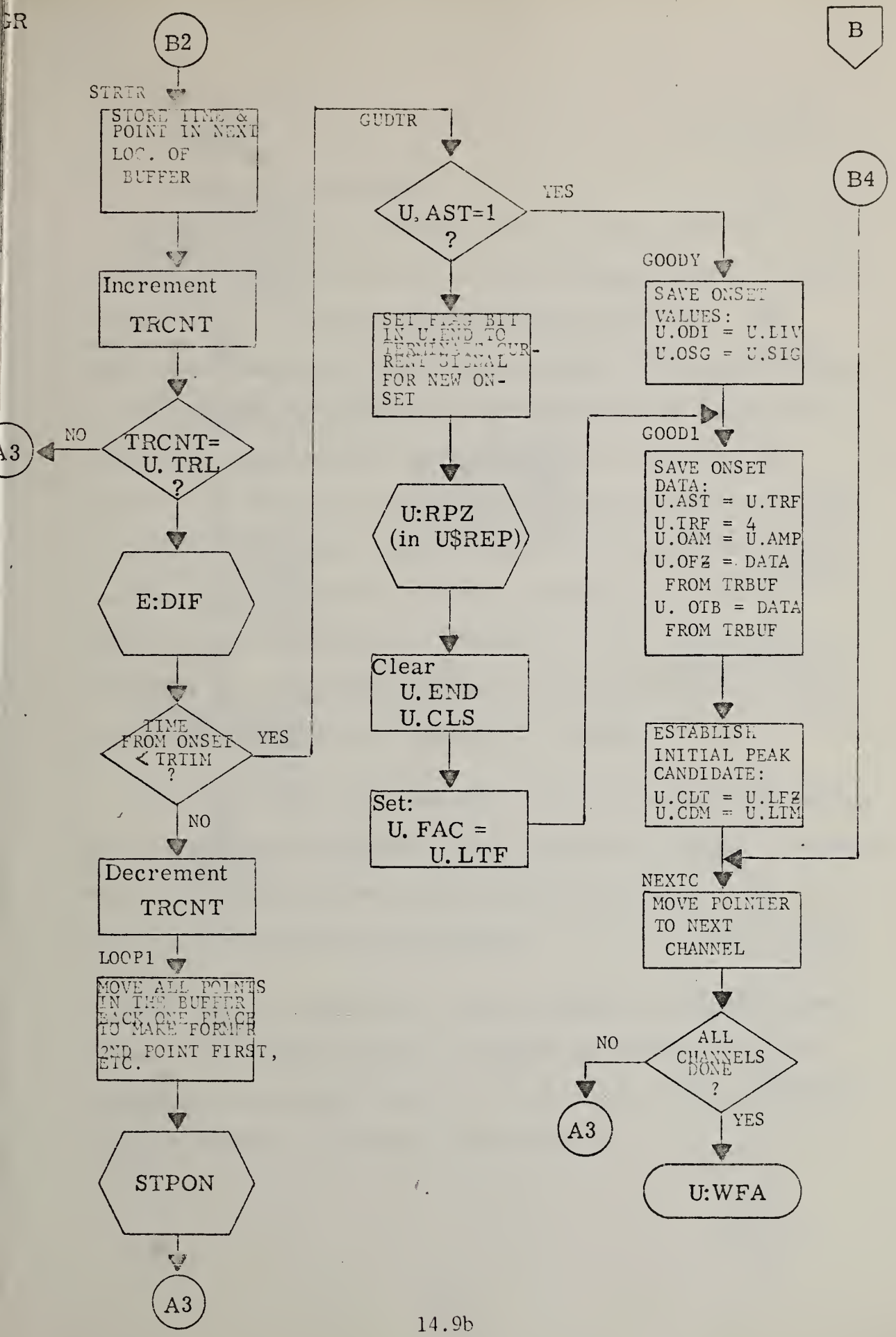
14.5 Output Parameter Descriptions

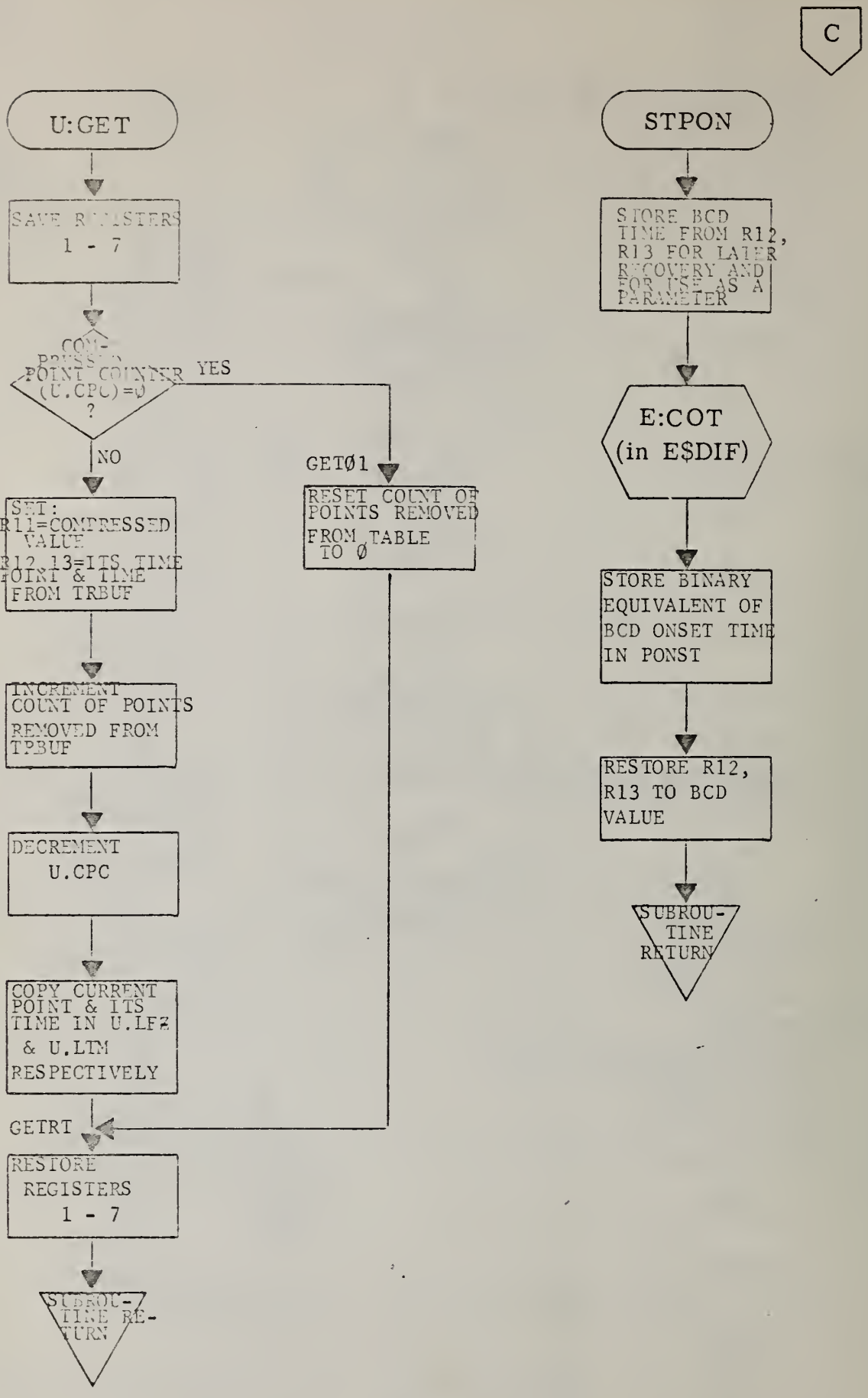
PARAMETER	SIZE	DESCRIPTION
U.TRF	14	The status flag of processing of triggering sequence (see Section 14.1.1).
U.TRL	14	The count of compressed points required to trigger waveform analysis (see Section 14.1.1).
U.TGR		Entry point for onset detection program.

14.6 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
TRCNT	14	Count of points currently under consideration for potential onset.
TRBUF	420	Buffer for compressed data points in possible triggering sequence. Three words per data point x 14 channels x 1Ø points per channel.
TRBFP	14	Pointer to first word of each sensor channel's partition of TRBUF.
PONST	28	Binary value for possible onset time.
TEMP	1	Working storage.
TEMP1	1	Working storage.
TRTIM	1	$=30_{1Ø}$; maximum number of seconds permitted between first and last points of triggering sequence.
GETCN	14	Counters used to point to next data point in compressed data point buffers.


A
U:TGR
A1
A3
TRRST
MOVE LAST POINT & ITS TIME TO TOP OF BUFFER
RESET CHANNEL POINTER TO Ø
NEXTP
CHANNEL UP (U.CST=1) ?
NO
SET:
TRCNT=1
U.TRF=1
YES
IS ALARM STATUS (U.AST) =1
U. AST=7 ?
NO
LOOK
YES
U:GET
NO COMPRESSED POINTS
B4
JMPTB
Ø
4
TRIGGER FLAG U.TRF
3
1
2
TRFØ
Set TRCNT = Ø
TRF1
STPON
TRF2
CUR POINT > LAST POINT ?
YES
NO
TRF3
CUR POINT > LAST POINT ?
NO
YES
NO
CUR POINT = FIRST POINT IN BUFFER ?
YES
Increment U. TRF
INCTR
Increment U. TRF
B2
A1


B2
STRTR
STORE TIME & POINT IN NEXT LOC. OF BUFFER
Increment TRCNT
TRCNT= U. TRL ?
NO
A3
E:DIF
TIME FROM ONSET < TRTIM ?
YES
NO
Decrement TRCNT
LOOP1
MOVE ALL POINTS IN THE BUFFER BACK ONE PLACE TO MAKE FORMER 2ND POINT FIRST, ETC.
STPON
A3
GUDTR
U, AST=1 ?
YES
SET FLAG BIT IN U.END TO TERMINATE CURRENT SIGNAL FOR NEW ONSET
U:RPZ (in U$REP)
Clear U. END U. CLS
Set: U. FAC = U. LTF
B
B4
GOODY
SAVE ONSET VALUES:
U.ODI = U.DIV
U.OSG = U.SIG
GOOD1
SAVE ONSET DATA:
U.AST = U.TRF
U.TRF = 4
U.OAM = U.AMP
U.OFZ = DATA FROM TRBUF
U. OTB = DATA FROM TRBUF
ESTABLISH INITIAL PEAK CANDIDATE:
U.CDT = U.LFZ
U.CDM = U.LIM
NEXTC
MOVE POINTER TO NEXT CHANNEL
ALL CHANNELS DONE ?
NO
A3
YES
U:WFA


C
U:GET
SAVE REGISTERS 1 - 7
COM-PRESSED POINT COUNTER (U.CPC)=Ø ?
YES
NO
GETØ1
RESET COUNT OF POINTS REMOVED FROM TABLE TO Ø
SET: R11=COMPRESSED VALUE R12,13=ITS TIME POINT & TIME FROM TRBUF
INCREMENT COUNT OF POINTS REMOVED FROM TPBUF
DECREMENT U.CPC
COPY CURRENT POINT & ITS TIME IN U.LPZ & U.LTM RESPECTIVELY
GETRT
RESTORE REGISTERS 1 - 7
SUBROU-TINE RE-TURN
STPON
STORE BCD TIME FROM R12, R13 FOR LATER RECOVERY AND FOR USE AS A PARAMETER
E:COT (in E$DIF)
STORE BINARY EQUIVALENT OF BCD ONSET TIME IN PONST
RESTORE R12, R13 TO BCD VALUE
SUBROU-TINE RETURN

15. U$WFA

15.1 Functional Description

The last program entered (after U:RTA, U:LSQ, and U:TGR) at the end of each ten-second interval is U:WFA (U Signal Waveform Analysis). Whereas U:TGR is responsible for detecting signal onsets, U:WFA handles the remainder of the waveform analysis. This consists of progressing through the waveform, recognizing key points, determining whether the characteristics for the section just completed meet predetermined criteria, and permitting the processing to continue if they do. The primary vehicle for determining the point in the waveform, and which section of U:WFA to execute, is a flag called U.AST (U Signal Alarm Status). Figures 15.1, 15.2, and 15.3 will illustrate the values U.AST will take during the various sections of the three waveforms which NUSTAD will recognize.

Upon entry, some status checking is done, and waveform processing is performed for those channels which are not down. U.AST is examined, and control is transferred to that portion of the program responsible for the current section of the waveform.

When U.AST = 1, there is no signal currently in progress. The diurnal slope estimate (U.DIU) is updated (see Section 15.3.1) and processing is considered complete for that channel. When all channels are done, control is returned to the scheduler.

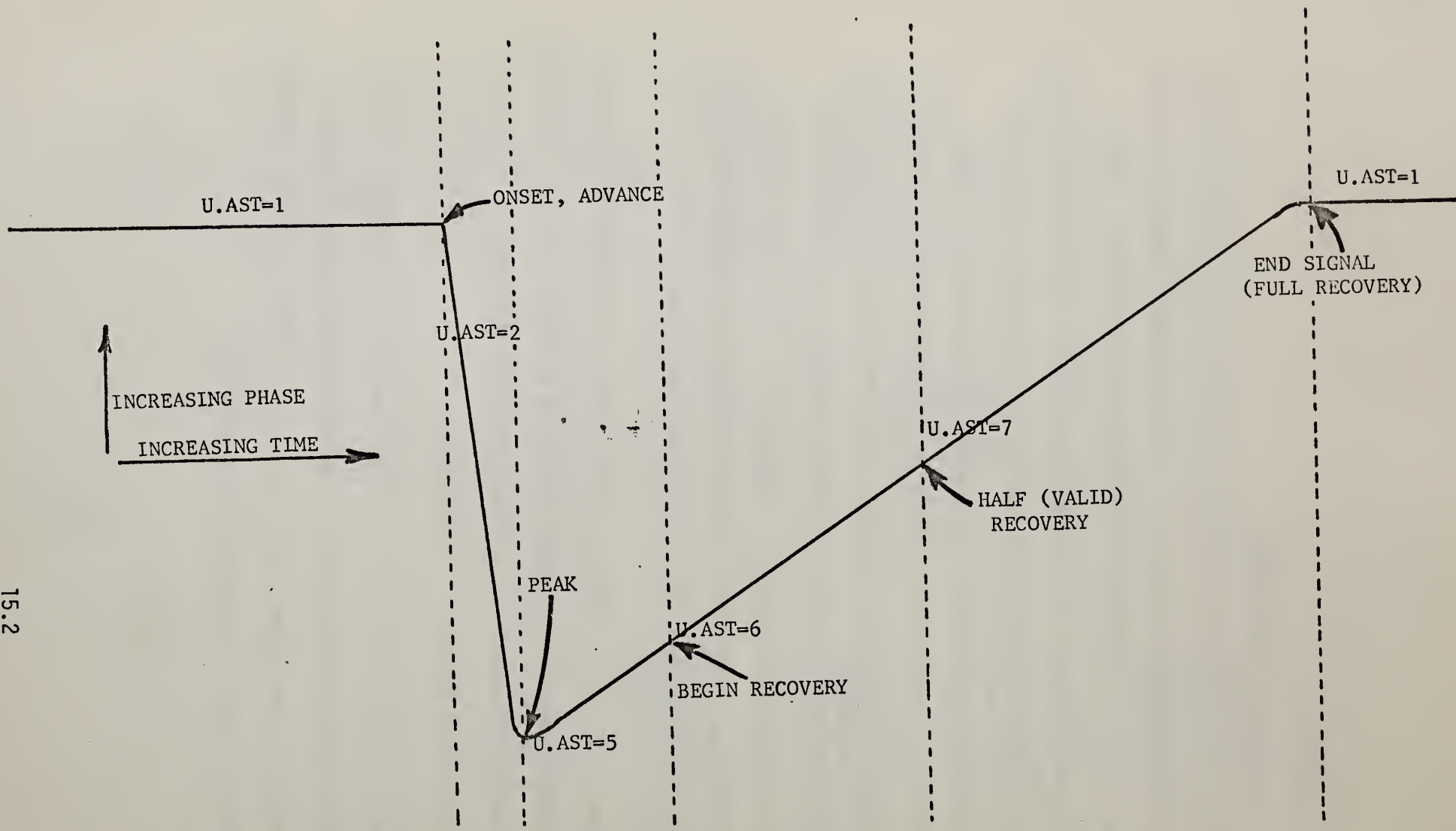


Figure 15.1 WAVEFORM PROCESSING FOR ADVANCE SIGNAL

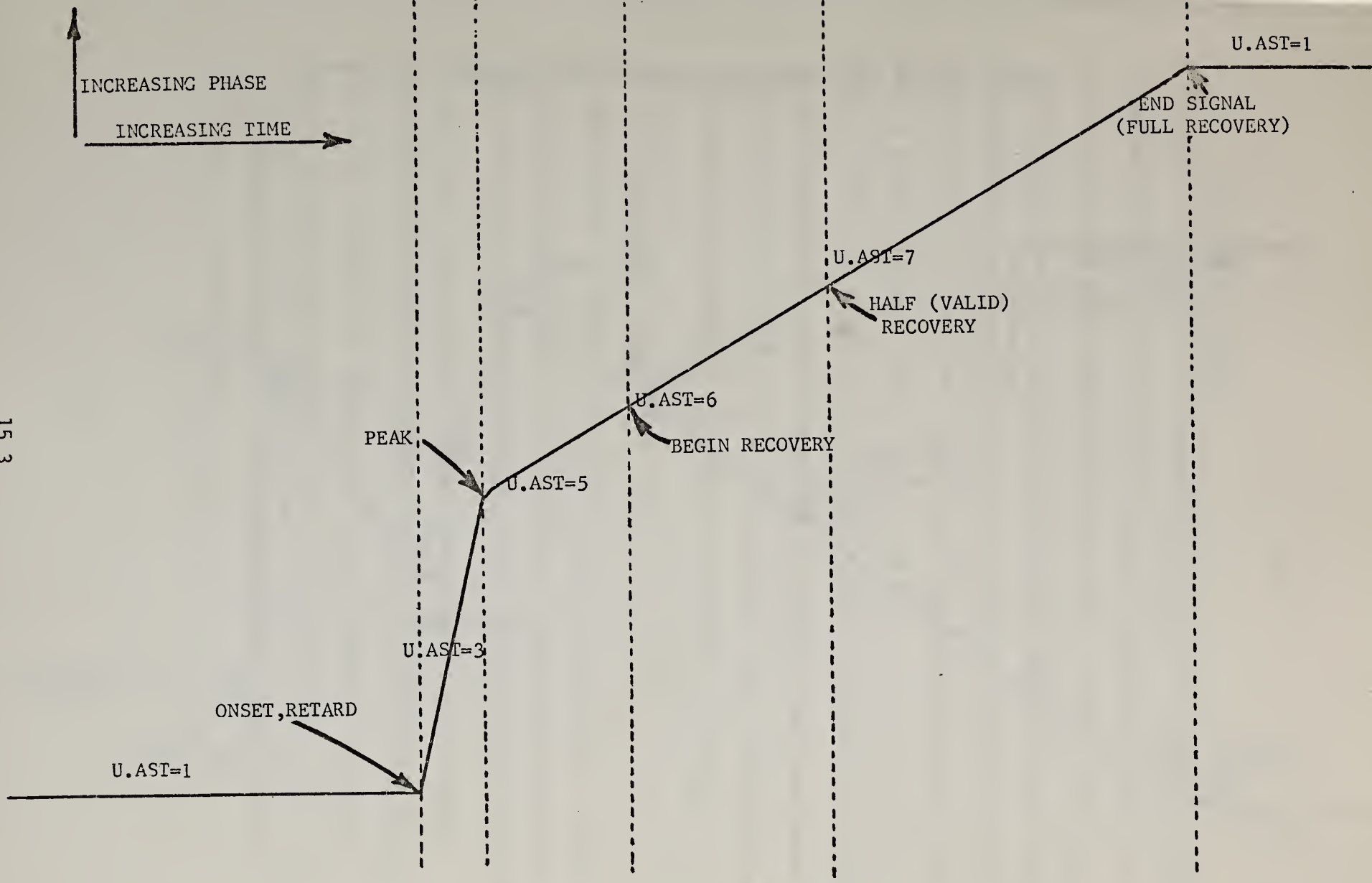


Figure 15.2 WAVEFORM PROCESSING FOR RETARD SIGNAL

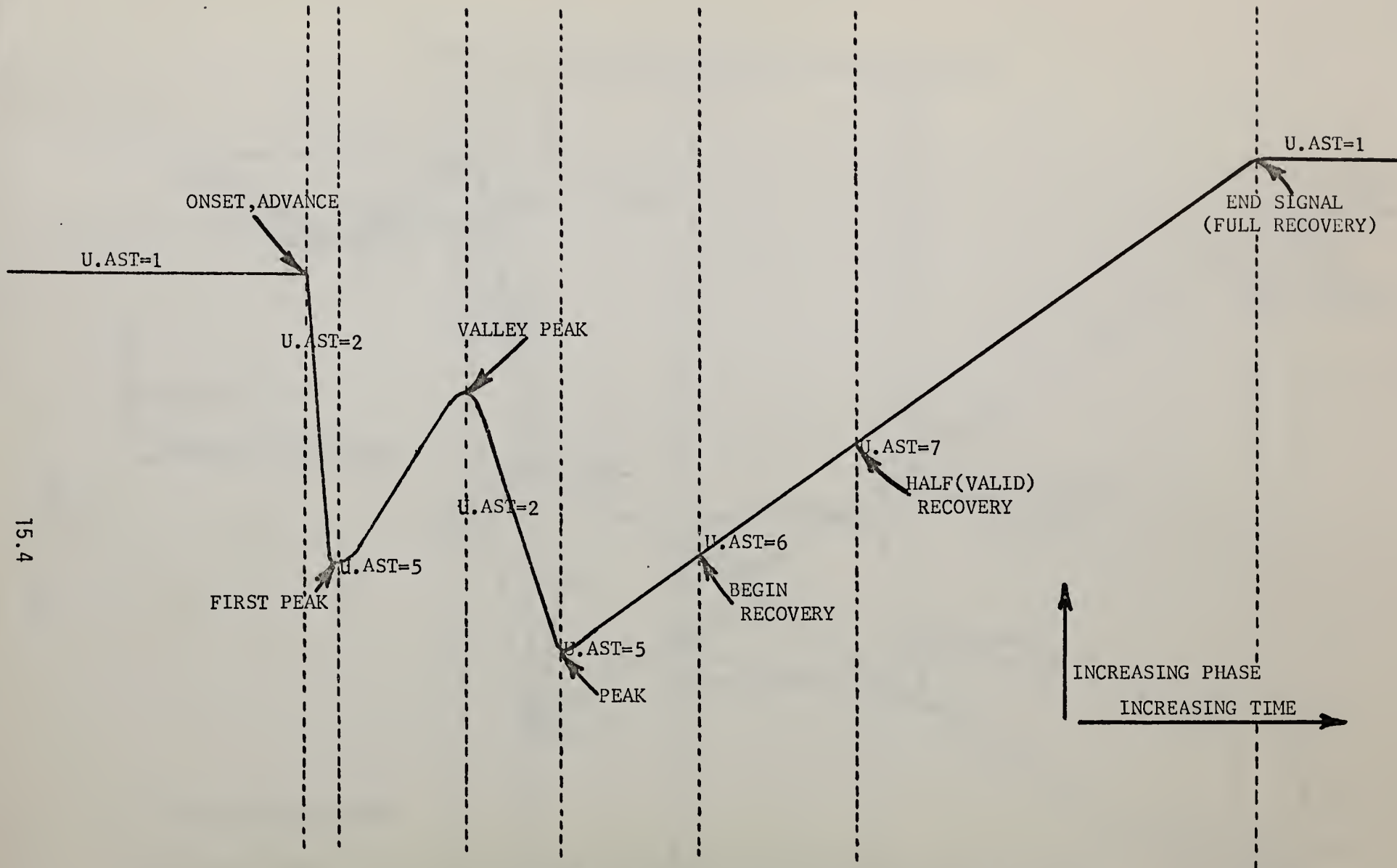


Figure 15.3 WAVEFORM PROCESSING FOR MULTIPLE PEAK ADVANCE SIGNAL

15.1.1 Peak Search, Advance

When U.AST = 2, U:TGR has detected an onset in the advance direction (decreasing numeric values) and the section of U:WFA called UAST2 will seek the signal's peak. The minimal phase value is considered the peak, so the search consists of merely determining the smallest numeric value. The smallest value encountered is held in U.CDT, the candidate for the position of signal peak, until four consecutive compressed points follow with a greater numeric value to confirm the point. If no point meeting these restrictions is encountered with T1 seconds (currently established as ten minutes), the signal is rejected and U.AST is reset to 1 to again try to determine a signal onset. When a possible peak is confirmed, control is passed to the section of the program called PVALC (see below).

15.1.2 Peak Search, Retard

When U.AST = 3, U:TGR has detected an onset in the retard direction (increasing numeric values) and the section of U:WFA called UAST3 will seek this signal's peak. The inflection point where the slope of the retard signal reduces significantly is considered the peak. NUSTAD computes the slope between the onset point and each succeeding compressed data point, and seeks the maximum such value. When four consecutive onset to current point slopes fall under 75% of the maximum slope, the peak has been confirmed. As in UAST2, the T1 second limit is enforced and control is passed to PVALC when successful.

15.1.3 Peak Validity Check

PVALC is tasked to determine whether the onset characteristics between the now identified onset and peak meet the predetermined criteria. The phase offset, compensating for the long term trend at onset, and the average rate of onset are computed (see Section 15.3.2). These values are applied against the following standards, and U.CLS is set accordingly:

U.CLS = 1 if:

Onset rate (W.ONR) not less than one of the following values, based on the tracking rate (U.TRK):

PONLO (6 microseconds/minute) for tracking rates Ø, 1, or 2.
PONMD (1Ø microseconds/minute) for tracking rates 3, 4, or 5.
PONHI (2Ø microseconds/minute) for tracking rates 6, 7, 8, or 9.

And the phase offset was not less than 1Ø microseconds.

U.CLS = 2 if:

Signal was in the advance direction.

And the onset rate was not less than 3 microseconds/minute.

And the phase offset was not less than 2 microseconds.

If the computed onset rate (W.ONR) and phase offset (W.OST) do not meet these cirteria, the signal is rejected as being impulsive noise. If either of the sets of criteria are passed, U.AST is set to 5 and processing continues.

15.1.4 Begin Recovery

When U.AST = 5, a valid peak has been encountered, and control is passed to the section of U:WFA called UAST5 to seek out the beginning of the phase recovery portion of the waveform. At peak, the long term trend estimate (U.DIU) was reset to the onset value (U.ODI). Recovery begins

when the phase begins a trend in the retard direction. This is identified when U.DIU, operating with U.FAC = .1Ø, exceeds the onset value (U.ODI) by ALPHA (currently set to .3 mircoseconds/minute). If this occurs within T2 seconds (currently set at 2Ø minutes) after onset, the beginning of recovery is confirmed and U.AST is set to six. If not, it's another reason to reject the signal.

15.1.5 Valid Recovery

When U.AST = 6, recovery has begun. The next key point in the waveform is the half, also known as valid, recovery point. This is reached when the following conditions have been met:

a. The phase has recovered within the following limits:

(1) ADVANCE SIGNAL, to within half of the difference between onset and peak (Figure 15.1).

(2) RETARD SIGNAL, to within half of the difference between peak and one cycle above onset (Figure 15.2).

(3) MULTIPLE PEAK ADVANCE SIGNAL, to at least three microseconds from the final peak value (Figure 15.3).

b. Ten minutes (T3, the minimum time for full slope recovery) has elapsed since onset without the current long term trend (U.DIU) recovering to within BETA (currently .2 microseconds/minute) of the long term trend estimate at onset (U.ODI).

All the while we are attempting to process this part of the waveform, the possibility of a multiple peak signal exists. Therefore, the maximum

phase value and its time are saved. In the event an advance signal fails to meet point b, above, U.AST is reset to two to attempt to find another peak while the signal class (U.CLS) and direction (U.ODR) are set to 3 to indicate a multiple peak advance signal. When UAST2 finds another peak, the previous reporting criteria are ignored and U.AST will again be set to five. If any other type signal fails point b, above, the signal is rejected. When the above points are satisfied, U.AST is set to seven to search for the end of the signal. At this time, the first part of the report generator is called (U:RP1) to report on the waveform between onset and the valid recovery point (see Section 17.1, U:REP).

15.1.6 Terminate Recovery

When U.AST = 7, the signal is considered valid and the first part of the report message (called the RSD, Reportable Signal Description) is output to the logging teleprinter via U:REP. The final task of the analysis program is to termine processing on the current signal, which may be done in one of several ways:

a. NORMAL TERMINATION. When the phase recovers to within TREC (currently set at three) microseconds of the onset value AND the long term trend estimate (U.DIU) recovers to within BETA (.2 microseconds/minute) of the long term trend estimate at onset (U.ODI).

b. TIME LAPSED TERMINATION. When T4 seconds (currently set at one hour) passes since onset.

c. SECOND ONSET DISCOVERED. While U.AST = 7, U:TGR will be permitted to look for new signals which may occur on the tail end of the current signal. During this period, though, the number of points required to trigger a new signal (U.TRL) is set to eight, requiring more certainty in calling a phase excursion a probable signal, and terminating the processing of the current signal.

d. SIGNAL LOST. If the channel should go down while U.AST is either 6 or 7, the chance that a reportable signal was in progress is sufficient to warrant generating a RSD with the notation that the signal was terminated because of signal drop out.

15.1.7 Signal Rejection

When a signal is rejected for any reason, a flag called REASN is set to a value corresponding to the reason, and a part of U:WFA called FAIL is entered to reset flags and variables to permit NUSTAD to begin looking for a new signal on that sensor channel. If the operator has switch register bit 1Ø set, the failure will be indicated for the operator on the ASR 35 teleprinter, under the following format:

DDD TTTTTT C Rn

Where DDD is a three character DOY
TTTTTT is a six character TOD
C is the sensor channel indicator (A thru N)
R indicates a rejected signal
n is the reason, interupted as follows:

1 Excessive time, onset to peak.
2 Retard signal fails offset criteria.
3 Advance signal fails secondary offset criteria.
4 Advance signal fails secondary onset rate criteria.
5 Excessive time, onset to beginning recovery.
6 Slope recovery too soon after onset.
7 Recovery rate greater than onset rate.

Table 15.1 Signal Rejection Message Format

After each section completes what processing it can with the data available, the diurnal slope estimate is up dated for that channel and U:WFA goes on to the next sensor channel.

When U:WFA completes all processing, control is returned to the operating system at the scheduler reentry point (E:SKD).

15.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
U:RP1	U$REP	Generates Part I of RSD at valid signal point in waveform.
U:RP2	U$REP	Generates Part II of RSD at final recovery point in waveform.
U:GET	R$TGR	Routine to retrieve compressed data from the compressed data point buffer.
E:DIF	E$DIF	Computes the time difference between onset and later point in time.
E:SKD	E$SKD	Operating system scheduler entry point.
E:COT	E$DIF	Converts the BCD time characters to the binary count of seconds.
E:035	E$T35	Transfers output message to buffer before transmission to the ASR 35.
E:FRT	E$FRT	Reads current BCD time and reformats for output message.

15.3 Computational Methods

15.3.1 Digital Filter in Diurnal Estimate Algorithm

The least squares slope estimate described in Section 13.3 is used to determine the short term (1ØØ second) trends of the input phase samples. These short term estimates are put through a long time constant first order digital filter to provide the long term trend estimate which NUSTAD labels the diurnal slope (U.DIU).

The first order digital filter performs the arithmetic manipulation

$$y_{(nT)} = (1-K)y_{(nT-T)} = Kx_{(nT)} \qquad (1)$$

Where

$y_{(nT)}$ is the filter output at time $t = nT$

$y_{(nT-T)}$ is the previous filter output

$x_{(nT)}$ is the filter input at time $t = nT$

K is the constant with limits such that $\emptyset < K < 1$

T is the time between samples

The filter is depicted in Figure 15.4, with Z^{-1} denoting the T second delay.

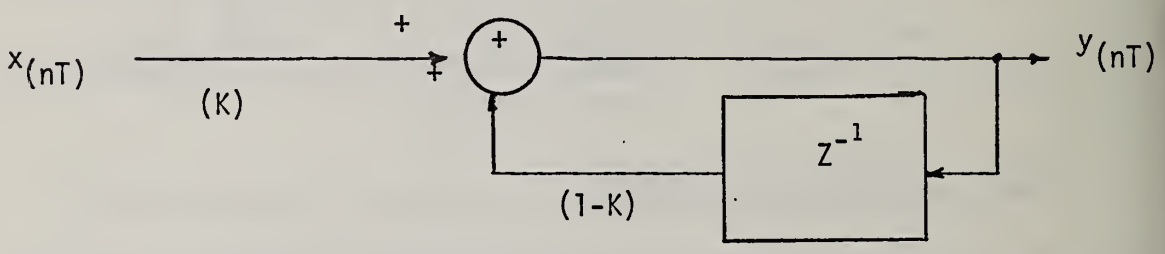


Figure 15.4 First Order Digital Filter

Equation (1) is rewritten to reduce the number of multiplication operations required during real time execution:

$$y_{(nT)} = y_{(nT-T)} = K\,(x_{(nT)} - y_{(nT-T)}) \qquad (2)$$

The characteristics of the first order digital filter will be considered by examining the filter's response to step and impulsive inputs. For the step input, consider the following conditions applied to equation (2):

$$y_{(\emptyset)} = \emptyset$$

$$x_{(nT)} = \begin{cases} \emptyset & n=\emptyset \\ 1\emptyset & n\neq\emptyset \end{cases}$$

Figure 15.5 displays the response over ten minutes (6ØØ seconds) for the two values used by NUSTAD (K = .Ø5 and K = .1Ø) as well as two greater values to illustrate the relationship of K to the response time. In all cases $y_{(nT)}$ approaches $x_{(nT)} = 1\emptyset$ as n increases, but does it slower for smaller K.

The conditions imposed for the impulsive response are:

$$y_{(\emptyset)} = \emptyset$$

$$x_{(nT)} = \begin{cases} 1\emptyset & n=2\emptyset \\ \emptyset & n\neq2\emptyset \end{cases}$$

Figure 15.6 illustrates the response of the first order digital filter to an impulse and plots its response over a period of 5 minutes. Note that the effect of the impulse is lessened by smaller values of K; i.e., the maximum offset is directly proportional to K. However, the decay time increases with decreasing K. Also note the similarity between the impulse and step responses shown in Figures 15.5 and 15.6 and those of a first order analog filter (low pass RC filter).

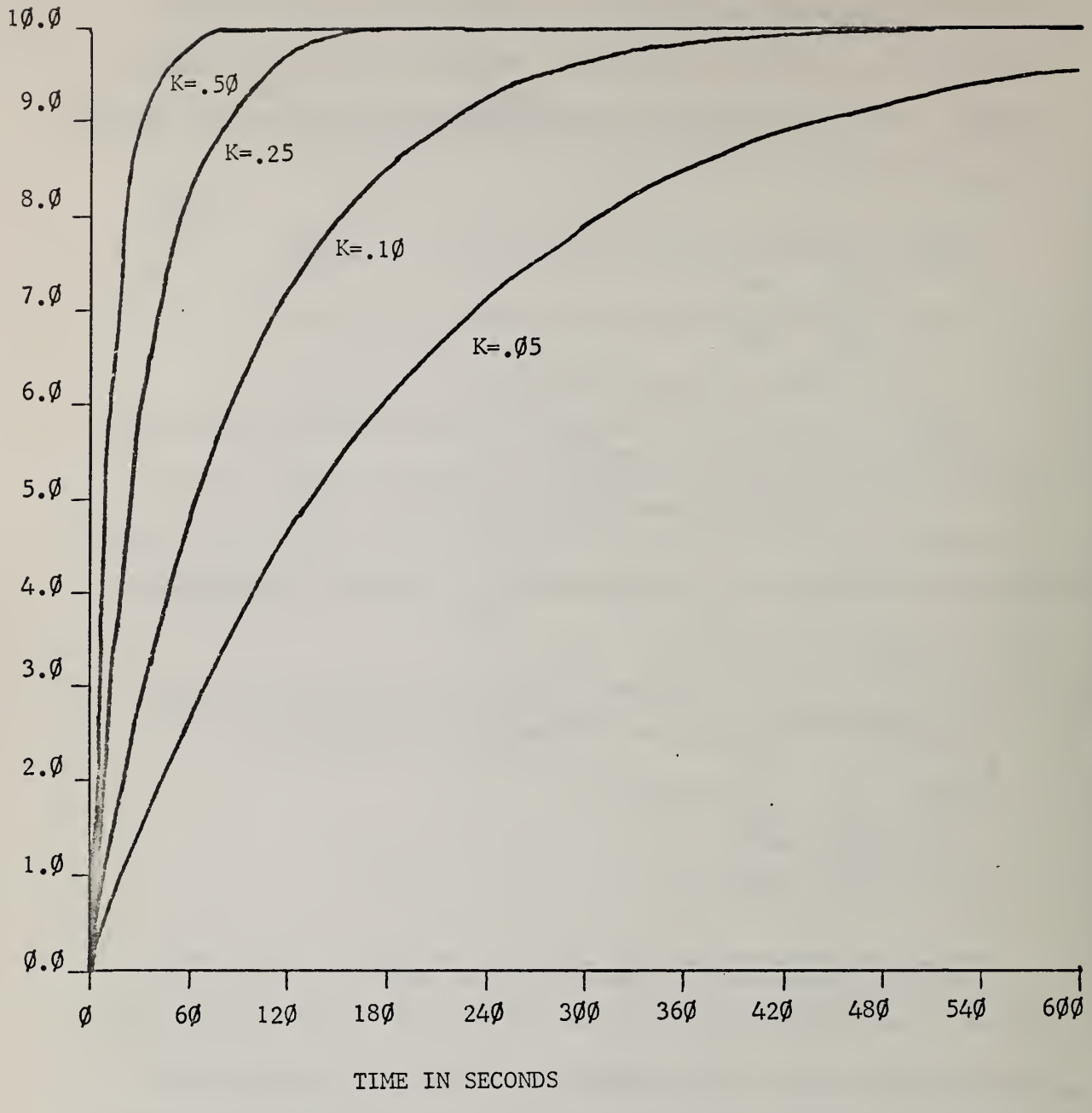


Figure 15.5 Step Response of First Order Digital Filter

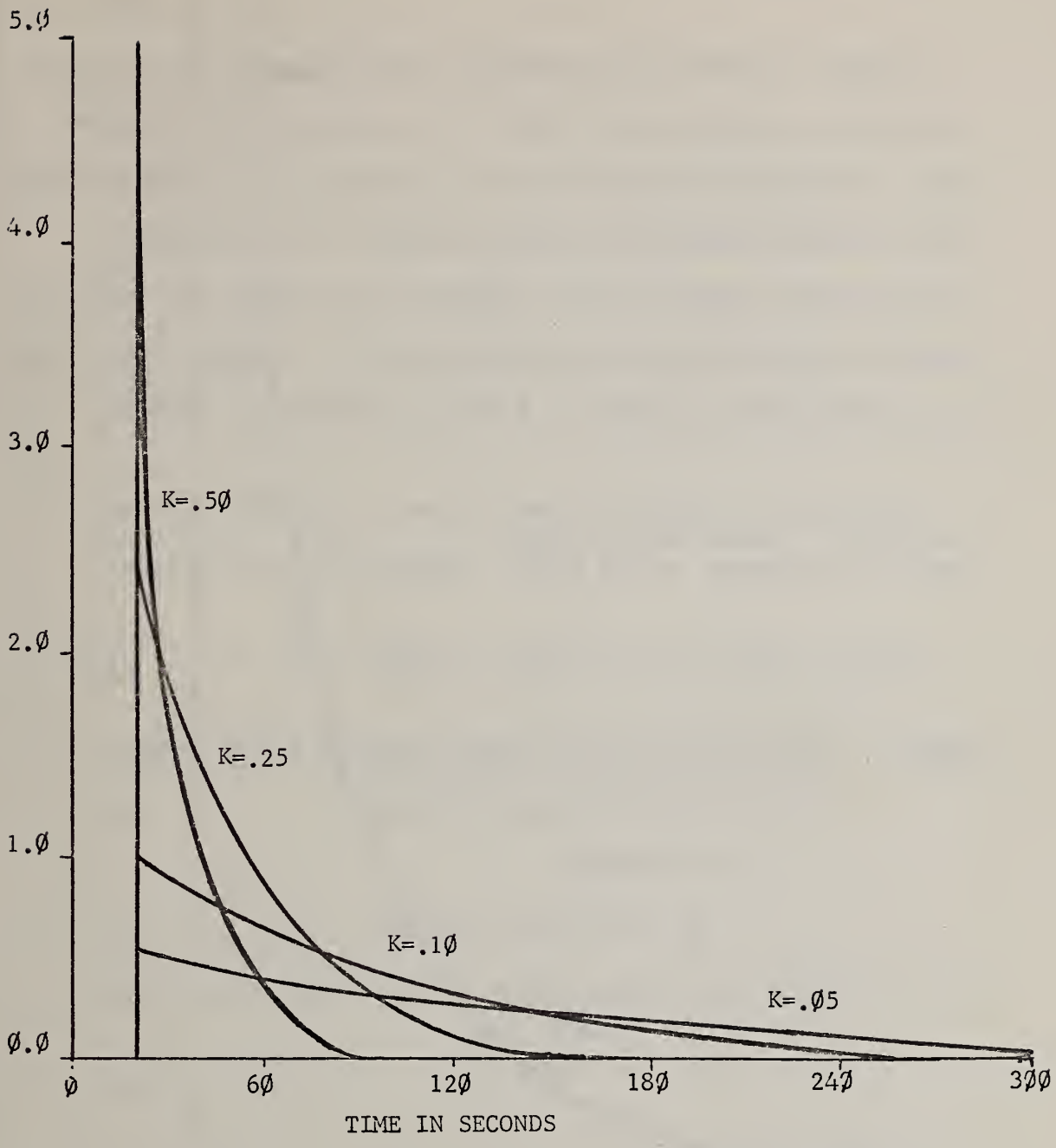


Figure 15.6 Impulse Response of First Order Digital Filter

Engineers unfamiliar with digital filters of this type generally request data concerning the filter's time constant (TC). For the sake of comparison to analog devices, Figure 15.7 is included to show the relationship between the values assigned K and a computed equivalent time constant (TC). The curve was arrived at by plotting the time at which 83% of the maximum offset of a stepped input signal was reached versus the value of K used in equation (2) above.

In NUSTAD, the digital filter is used to determine the long term trend estimate, called U.DIU. Equation (2) then becomes:

$$U.DIU = U.DIU + U.FAC * (U.SLP - U.DIU) \qquad (3)$$

where: U.DIU is the diurnal slope (long term trend) estimate

U.FAC is the filter update factor:

= .Ø5 normally

= .1Ø while seeking recovery

U.SLP is the least squares slope estimate from U:LSQ.

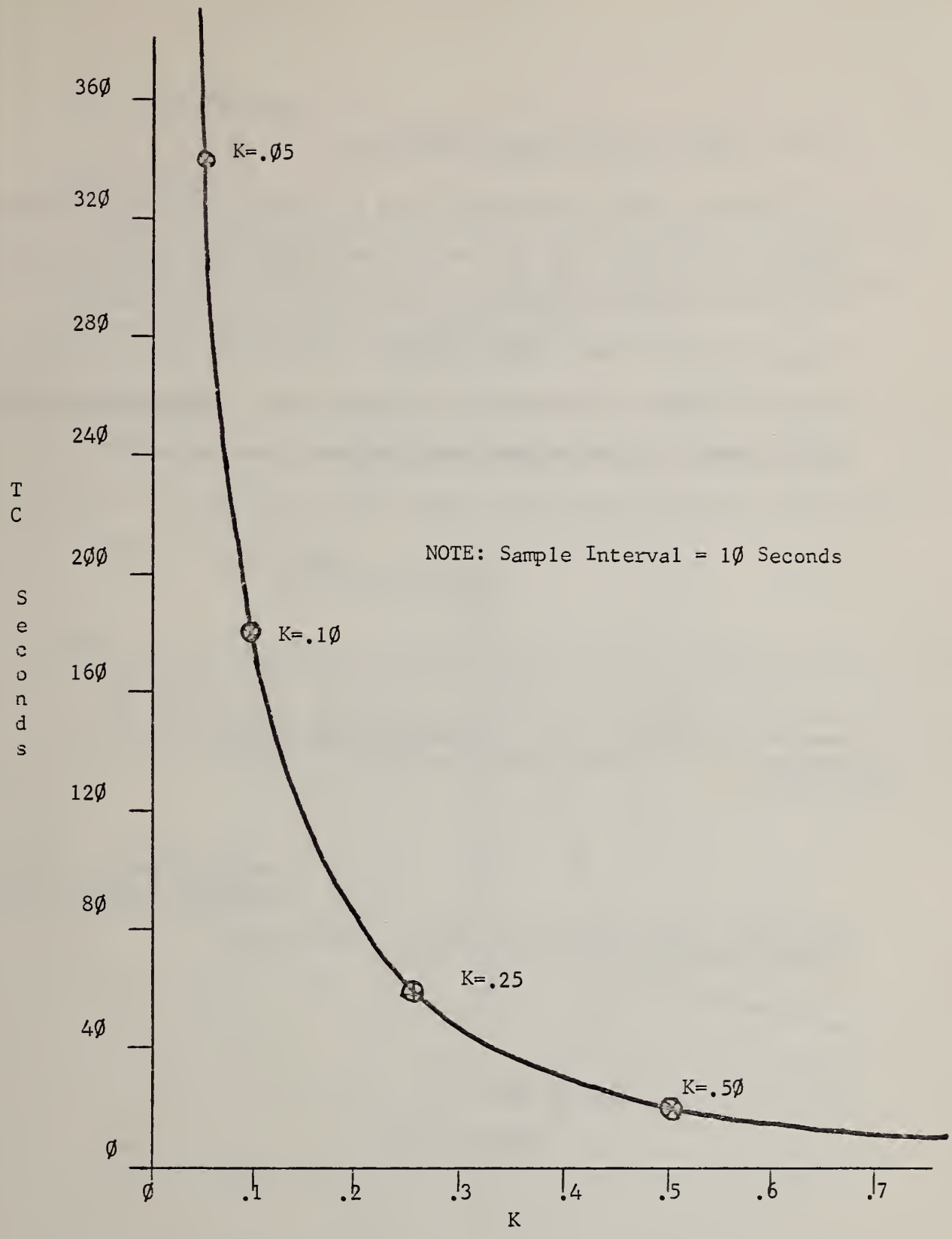


Figure 15.7 Relationship Between K and Filter Time Constant (TC)

15.3.2 Offset and Onset Rate Computation

The phase offset between onset and peak consists of the difference between the phase values at onset and peak, minus the product of the long term trend estimate at onset multiplied by the time interval between onset and peak. This attempts to cancel the effect of the long term trends in determining the phase offset. That value divided by the amount of time between onset and peak gives the onset rate.

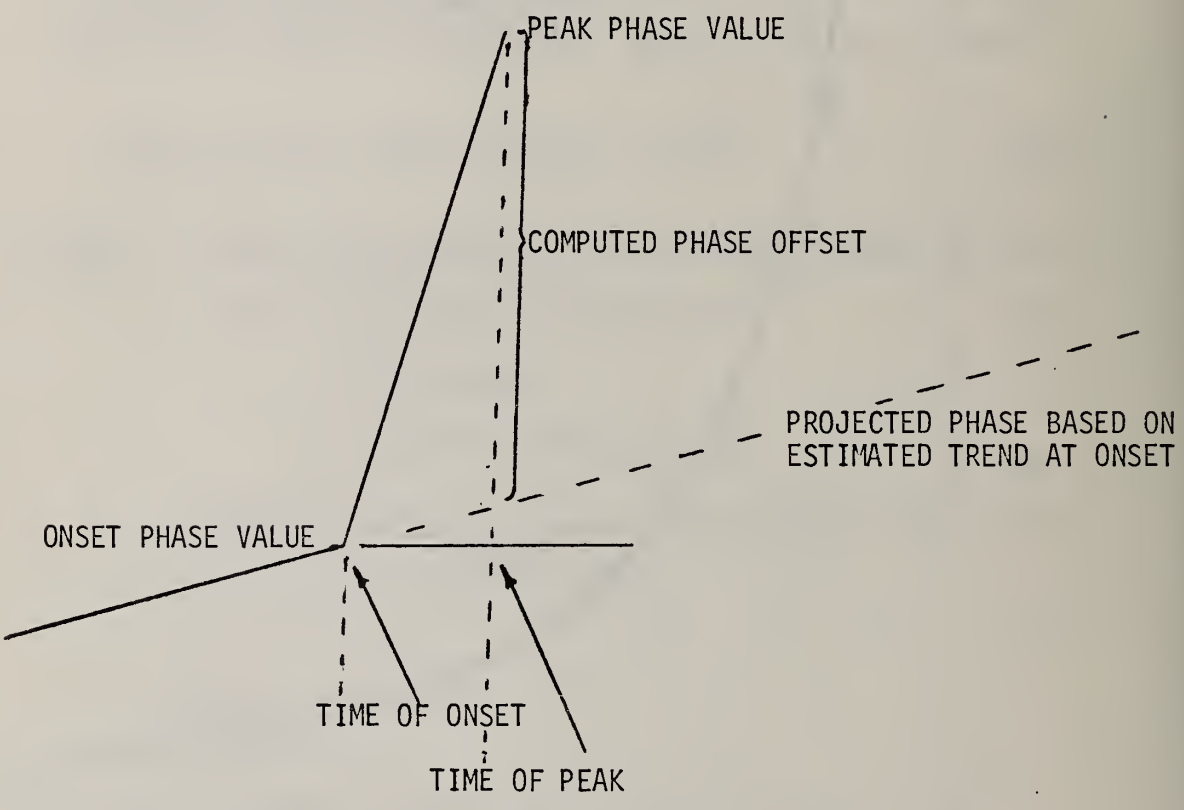


Figure 15.8 Phase Offset Computation

15.4 Data Formats

15.4.1 U.DIU

Since the long term slope estimates are the result of filtering the short term slope estimates (U.SLP), the data format will be the same. See Section 13.4.3 for the format of U.SLP.

15.4.2 U.ONR

Unlike the slope representation used for U.SLP and U.DIU (see Section 13.4.3), the average onset rate between onset and peak (W.ONR) uses the following format:

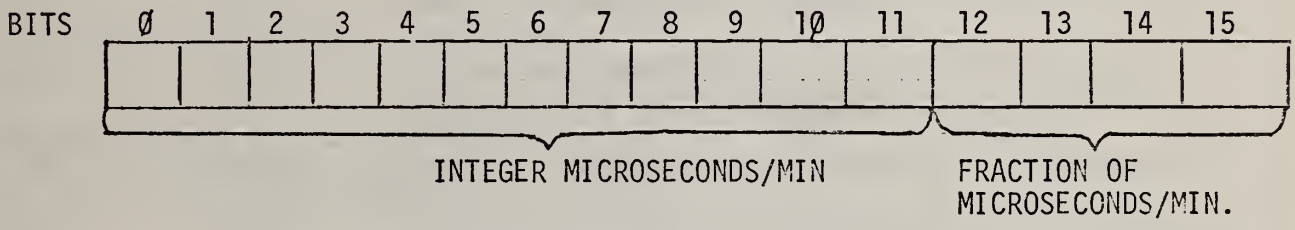


Figure 15.9 Format of Computed Onset Rate (W.ONR)

15.5 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
U.CST	U$DAT	Channel status, used to indicate validity of input data based on amplitude monitoring program evaluation.
U.AST	U$DAT	Channel waveform analysis status, indicates point in signal to which processing has progressed.
U.SLP	U$DAT	Computed slope estimate in microseconds per minute. Indicates short term data trends.
U.DIU	U$DAT	The diurnal slope estimate, an estimate of the long term trends in phase deviation.
U.FAC	U$DAT	The update factor used in the digital filter for the diurnal estimate.
U.CTM	U$DAT	Two words of BCD time for the last samples read; i.e., the current time for the ten-second segment.
U.CLS	U$DAT	Flag to indicate which set of criteria was passed: =1 for class A criteria, =2 for class B, =3 for COCO signal.
W.PFZ	U$DAT	Phase value at signal peak.
W.PTM	U$DAT	BCD time of peak value.
W.PAM	U$DAT	Signal amplitude at peak.
W.OST	U$DAT	Computed phase offset, onset to peak (see Section 15.3.2)
W.ONR	U$DAT	Average onset rate, onset to peak.
W.LPK	U$DAT	Phase value of first peak of multiple peak advance signal.
W.LTM	U$DAT	Time of first peak of multiple peak advance signal.
W.VPK	U$DAT	Phase value of valley peak of multiple peak advance signal.

15.5 Input Parameter Descriptions (continued)

PARAMETER	PROGRAM	DESCRIPTION
W.VTM	U$DAT	Time of valley peak of multiple peak advance signal.
W.RFZ	U$DAT	Phase value at valid recovery point.
W.RTM	U$DAT	Time of valid recovery point.
W.RAM	U$DAT	Signal amplitude at valid recovery point.
U.END	U$DAT	Bits used to flag conditions under which signal processing was terminated.
U.OFZ	U$DAT	Phase value at onset.
U.ODI	U$DAT	Long term data trend estimate (U.DIU) at onset.
U.BGF	U$DAT	The shorter time constant factor for the digital filter of the diurnal estimate.
U.LTF	U$DAT	The longer time constant factor for the digital filter of the diurnal estimate.
U.TRK	U$DAT	Current tracking rate settings for the channels.
U.ODR	U$DAT	Direction of onset, =1 for advance, =2 for retard, =3 after second peak of multiple peak advance signal.
U.OTM	U$DAT	Time of onset, binary count of seconds.
E.IOF	E$T35	Parameter word used in calling E:035.
U.AMP	U$DAT	Amplitude estimate for current ten-second segment.
U.DTM	U$DAT	Parameter used by E$DIF to permit finding time differences between any two values (program designed to find difference between onset time and given value).
W.LAM	U$DAT	Signal amplitude at first peak of multiple peak advance signal.
W.VAM	U$DAT	Signal amplitude at valley peak of multiple peak advance signal.

15.5 Input Parameter Descriptions (continued)

PARAMETER	PROGRAM	DESCRIPTION
U.FRQ	E$LOG	Current sensor frequency for each sensor channel.
U.TRF	U$TGR	Status flag of processing of triggering sequence.
U.TRL	U$TGR	Count of compressed points requied to trigger waveform analysis.

15.6 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
U:WFA		Entry point for waveform analysis program.
U.LFZ	14	The phase value of the last compressed data point encountered on each channel.
U.LTM	28	The BCD character time of the last compressed data point encountered on each channel.
U.CDT	14	The "candidate" peak phase value used in searching for waveform peaks.
U.CDM	28	The BCD character time of the "candidate" peak points.
U.CCL		Label used to externally reference CYCLE, the number of microseconds in one cycle for the frequencies of each channel.

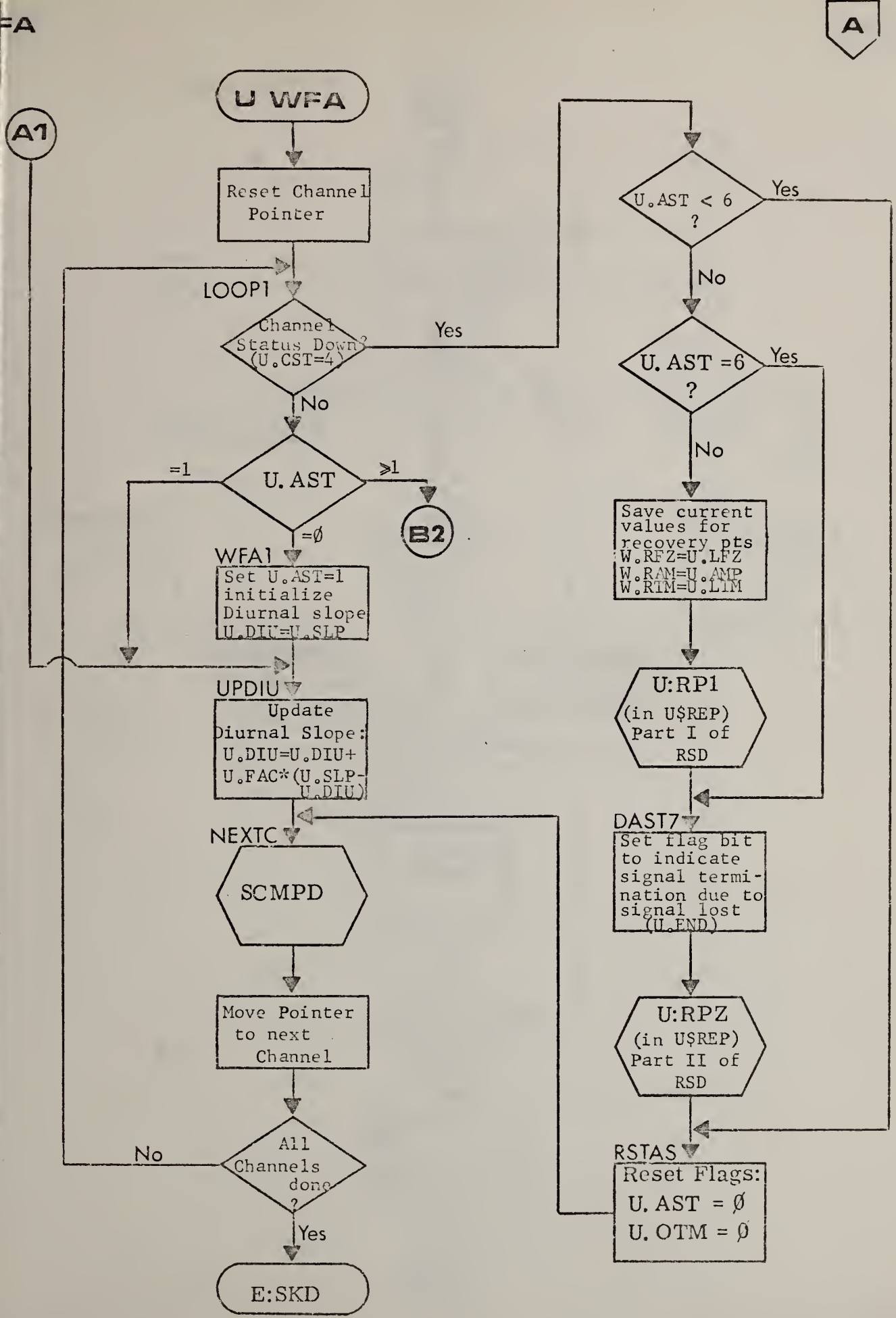
15.7 Internal Data Descriptions

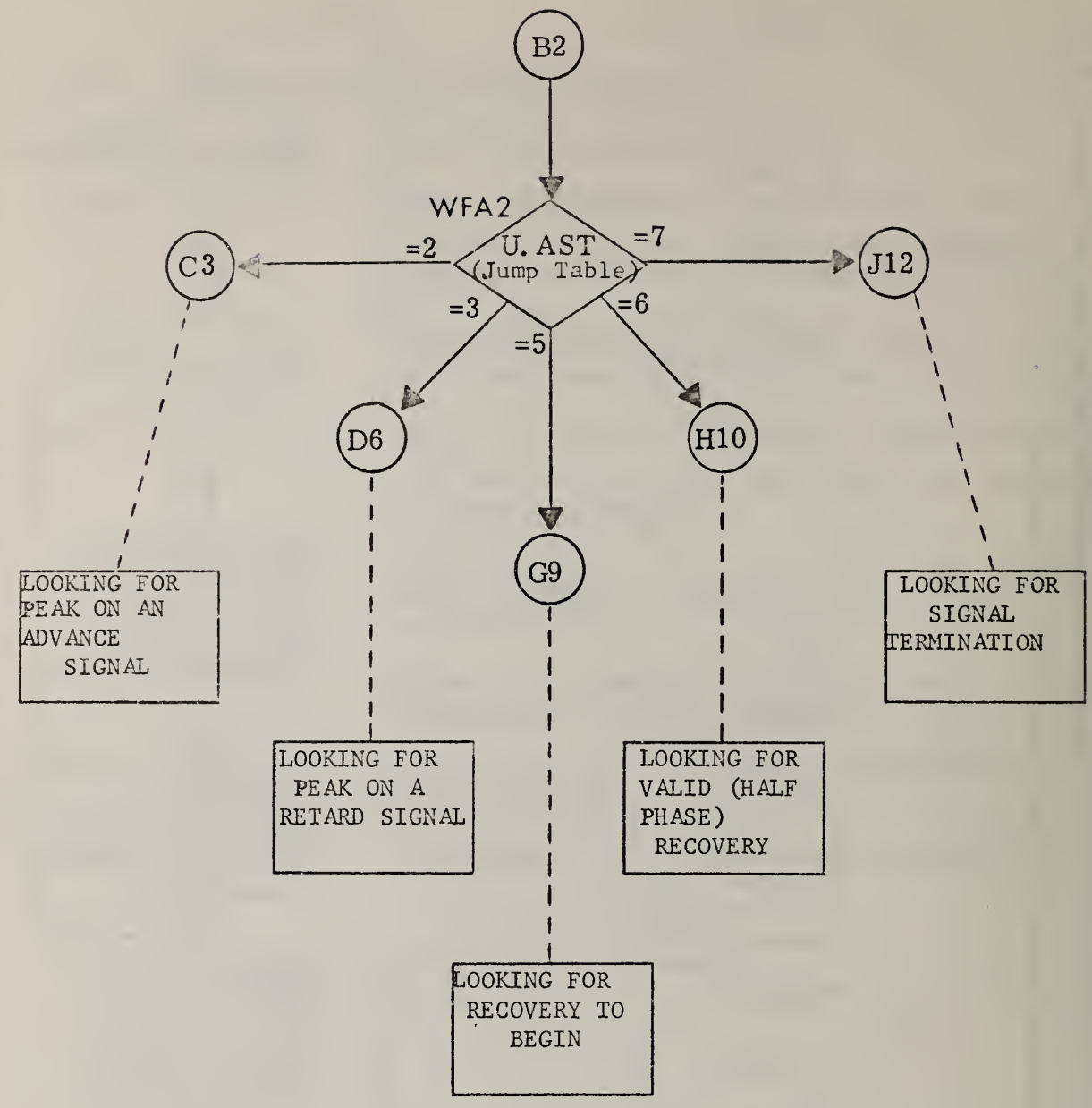
PARAMETER	SIZE	DESCRIPTION
SLOPE	14	Slope value computed in section UAST3 to determine the inflection point of a retard signal in recognizing signal peak.
CFIRM	14	Counter used by peak detection routines to confirm the recognition of a signal peak.

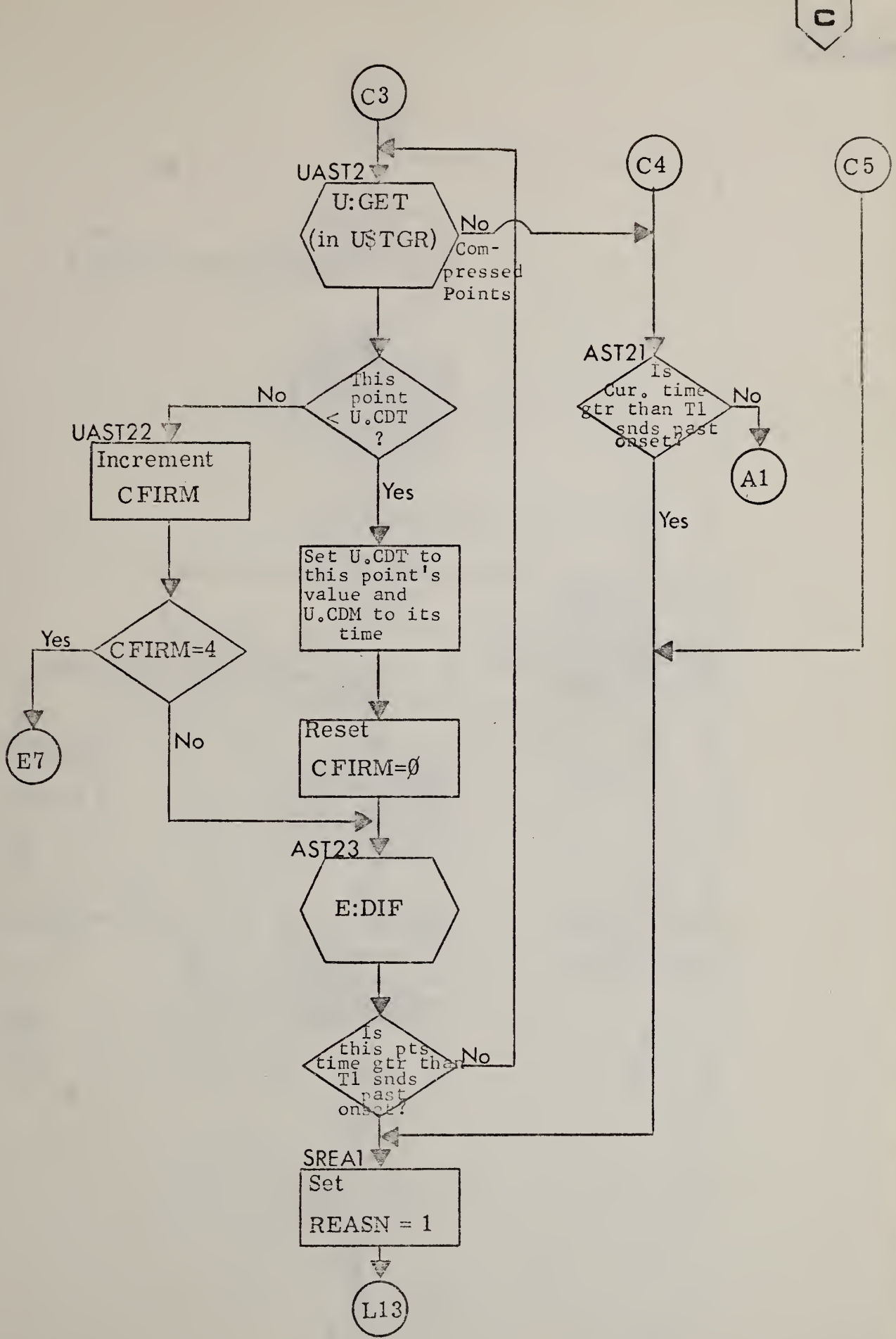
PARAMETER	SIZE	DESCRIPTION
TEMP TEMP2	2 1	Working storage.
T1	1	$=6ØØ_{1Ø}$; Max time allowed from onset to peak (1Ø minutes)
T2	1	$=12ØØ_{1Ø}$; Max time allowed from onset to beginning of recovery (2Ø minutes)
T3	1	$=6ØØ_{1Ø}$; Minimum time allowed for signal duration onset to full recovery (1Ø minutes)
T4	1	$=36ØØ_{1Ø}$; Max time allowed for signal duration onset to full recovery (one hour)
POFF	1	$=16Ø_{1Ø}$; (1Ø microseconds) Primary offset criteria
PONHI	1	$=14Ø_{16}$; (2Ø microseconds/minute) Primary onset rate criteria for high tracking rates; i.e., U.TRK=6,7,8, or 9
PONMD	1	$=ØA Ø_{16}$; (1Ø microseconds/minute) Primary onset rate criteria for medium tracking rates; i.e., U.TRK=3,4, or 5
PONLO	1	$=Ø6Ø_{16}$; (6 microseconds/minute) Primary onset rate criteria for low tracking rates; i.e., U.TRK=Ø,1, or 2
SOFF	1	$=32_{1Ø}$; (2 microseconds) Secondary offset criteria
SONRT	1	$=Ø3Ø_{16}$; (3 microseconds/minute) Secondary onset rate criteria, all tracking rates.
LOPEK	1	$=8Ø_{1Ø}$; (5 microseconds) Minimum allowed offset for first peak in multiple peak advance signal.

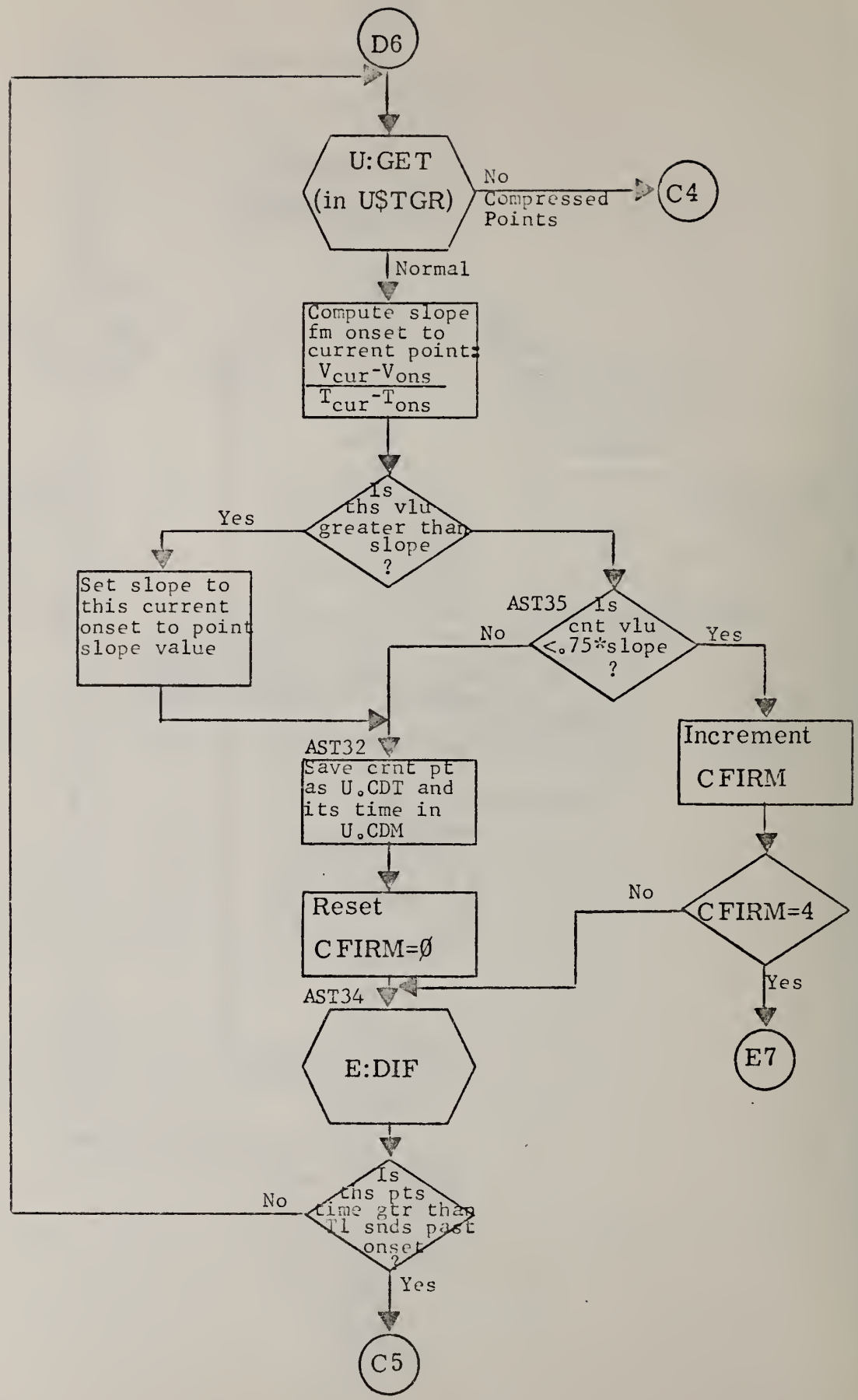
15.7 Internal Data Descriptions (continued)

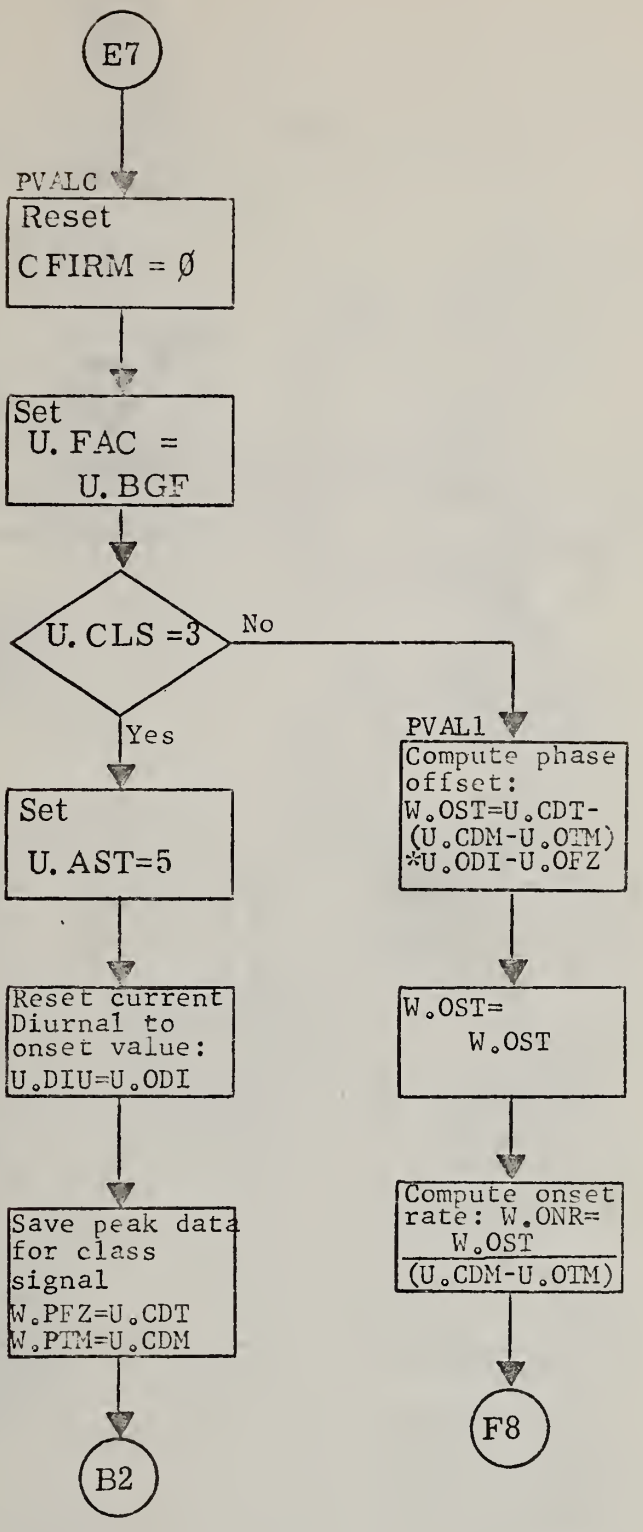
PARAMETER	SIZE	DESCRIPTION
TREC	1	$=48_{10}$; (3 microseconds) Point to which phase must approach onset phase, or next cycle for retard signals, for recovery to be considered complete.
ALPHA	1	$=38_{10}$; (.3 microseconds/minute) Point to which U.DIU must exceed U.ODI for beginning of recovery.
BETA	1	$=26_{10}$; (.2 microseconds/minute) Point to which U.DIU must return toward U.ODI for slope recovery to be considered complete.
RCMIN	14	Microseconds from peak which signal must recover before recovery is considered valid. (See Section 15.1.5.)
CYCLE	14	Number of microseconds in one cycle at the frequency to which each sensor is tuned.
REASN	14	Flag indicating why signal was rejected (see Section 15.1.7).
FLMSG	10	"123 123456 C R_2"; signal rejection message.

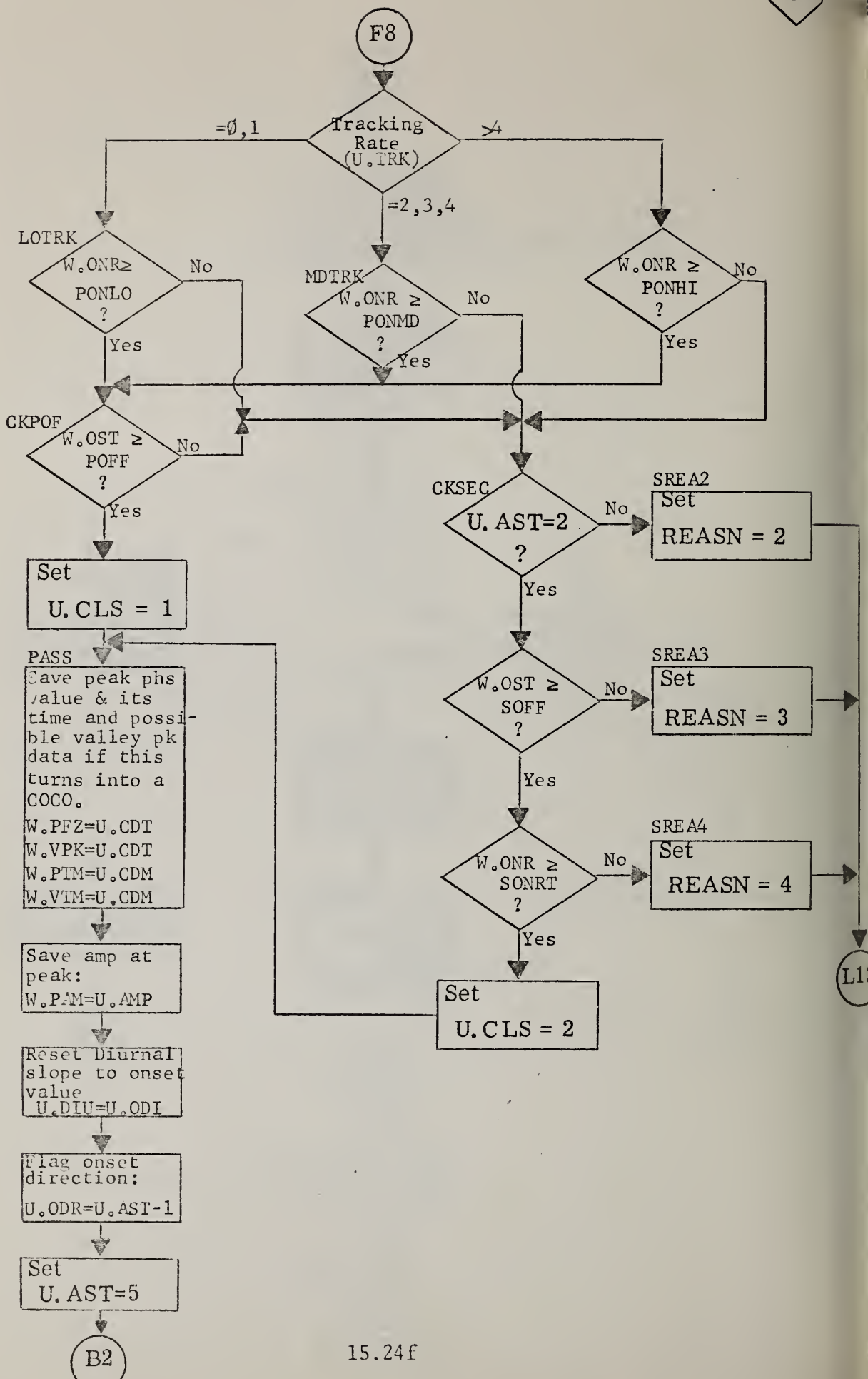

A
A1
U WFA
Reset Channel Pointer
LOOP1
Channel Status Down? (U.CST=4)
Yes
No
U.AST
=1
≥1
=Ø
B2
WFA1
Set U.AST=1 initialize Diurnal slope U.DIU=U.SLP
UPDIU
Update Diurnal Slope: U.DIU=U.DIU+ U.FAC*(U.SLP-U.DIU)
NEXTC
SCMPD
Move Pointer to next Channel
All Channels done ?
No
Yes
E:SKD
U.AST < 6 ?
Yes
No
U. AST =6 ?
Yes
No
Save current values for recovery pts W.RFZ=U.LFZ W.RAM=U.AMP W.RTM=U.LTM
U:RP1 (in U$REP) Part I of RSD
DAST7
Set flag bit to indicate signal termination due to signal lost (U.END)
U:RPZ (in U$REP) Part II of RSD
RSTAS
Reset Flags: U. AST = Ø U. OTM = Ø

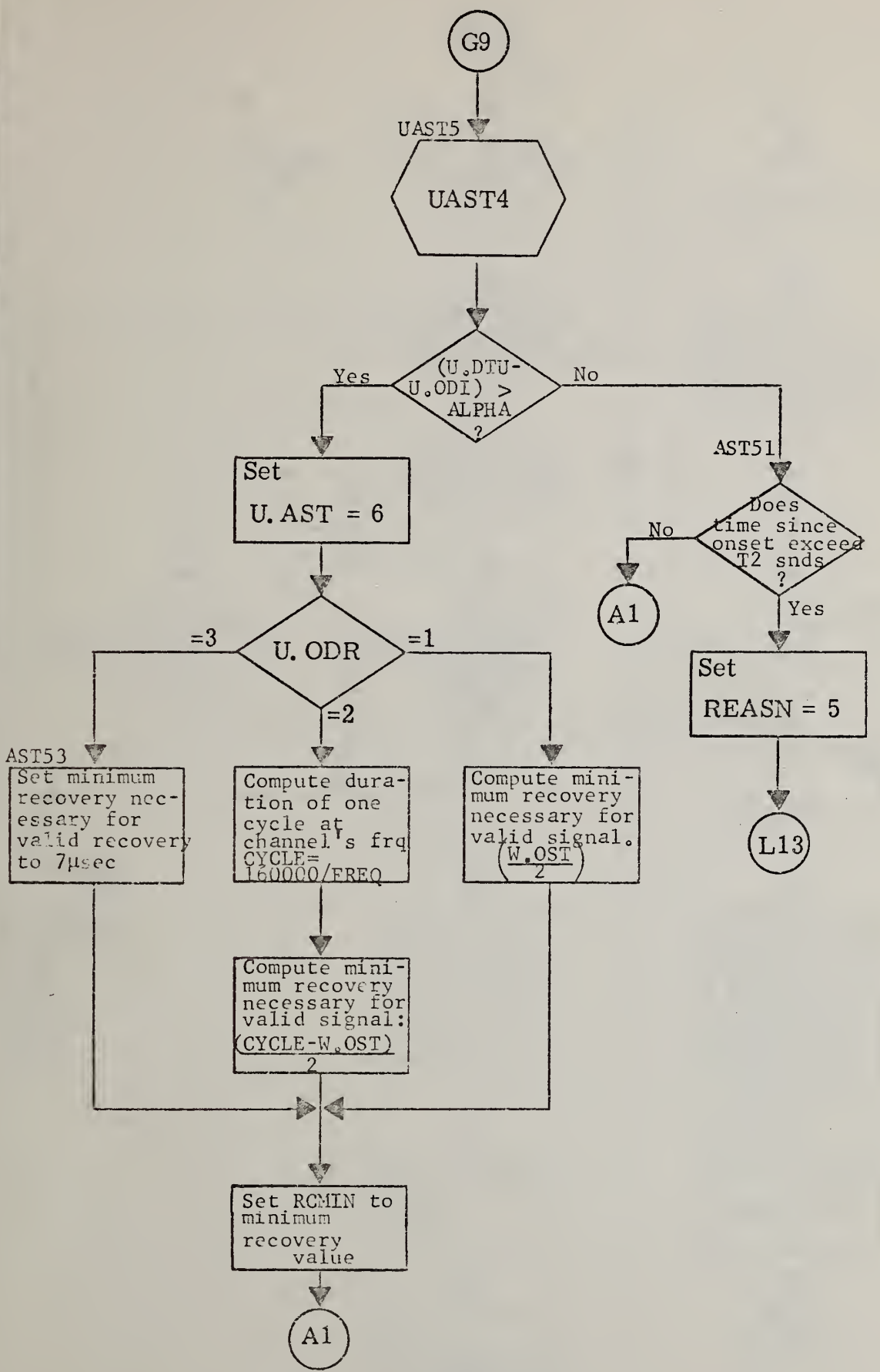

B2
WFA2
U. AST
(Jump Table)
=2
=3
=5
=6
=7
C3
D6
G9
H10
J12
LOOKING FOR PEAK ON AN ADVANCE SIGNAL
LOOKING FOR PEAK ON A RETARD SIGNAL
LOOKING FOR RECOVERY TO BEGIN
LOOKING FOR VALID (HALF PHASE) RECOVERY
LOOKING FOR SIGNAL TERMINATION

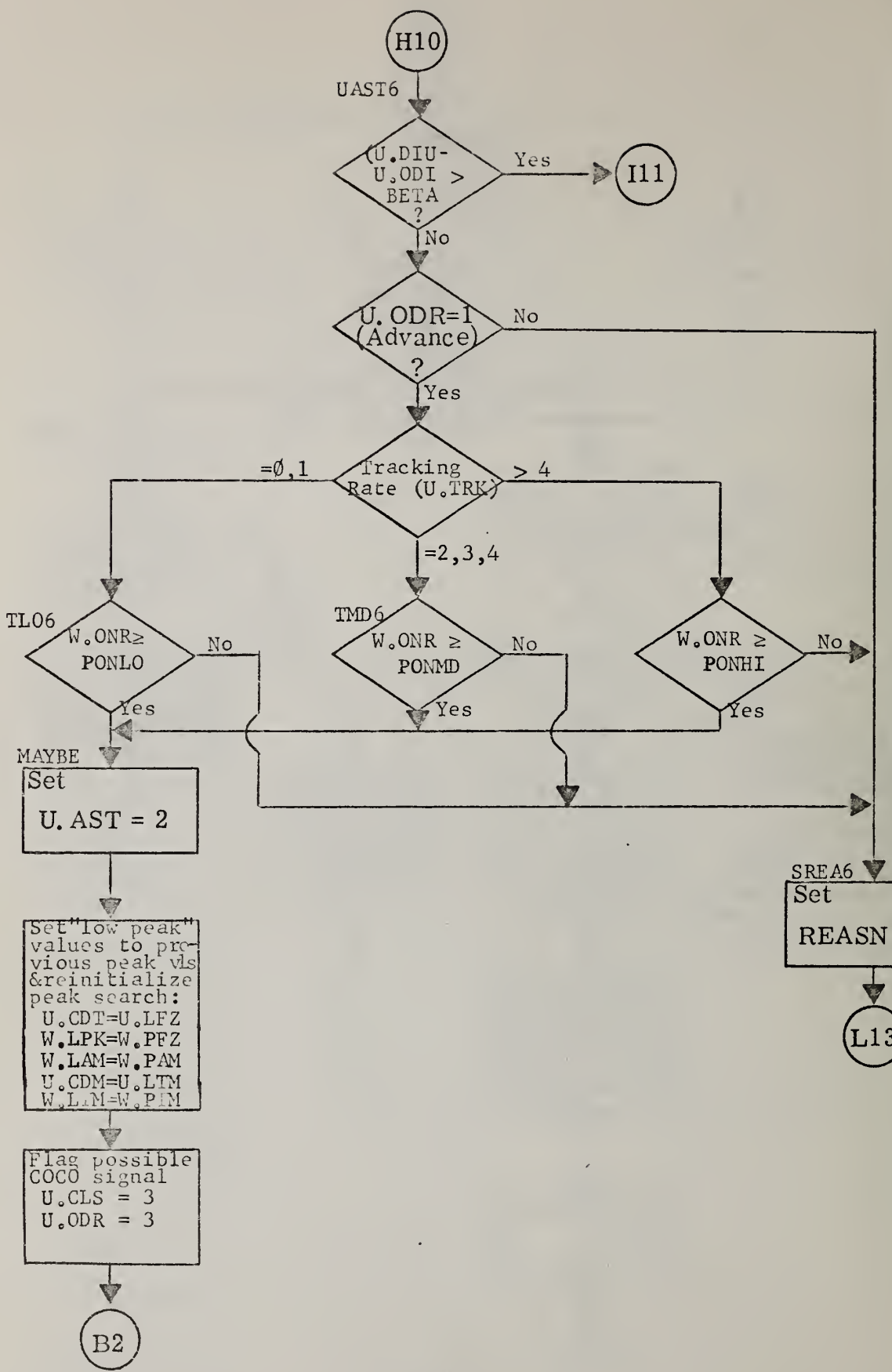

C
C3
UAST2
U:GET
(in USTGR)
No
Com-
pressed
Points
C4
C5
AST21
Is
Cur. time
gtr than T1
snds past
onset?
No
A1
Yes
This
point
< U.CDT
?
No
UAST22
Increment
CFIRM
Yes
Set U.CDT to
this point's
value and
U.CDM to its
time
Yes
CFIRM=4
E7
No
Reset
CFIRM=Ø
AST23
E:DIF
Is
this pts
time gtr than
T1 snds
past
onset?
No
SREA1
Set
REASN = 1
L13

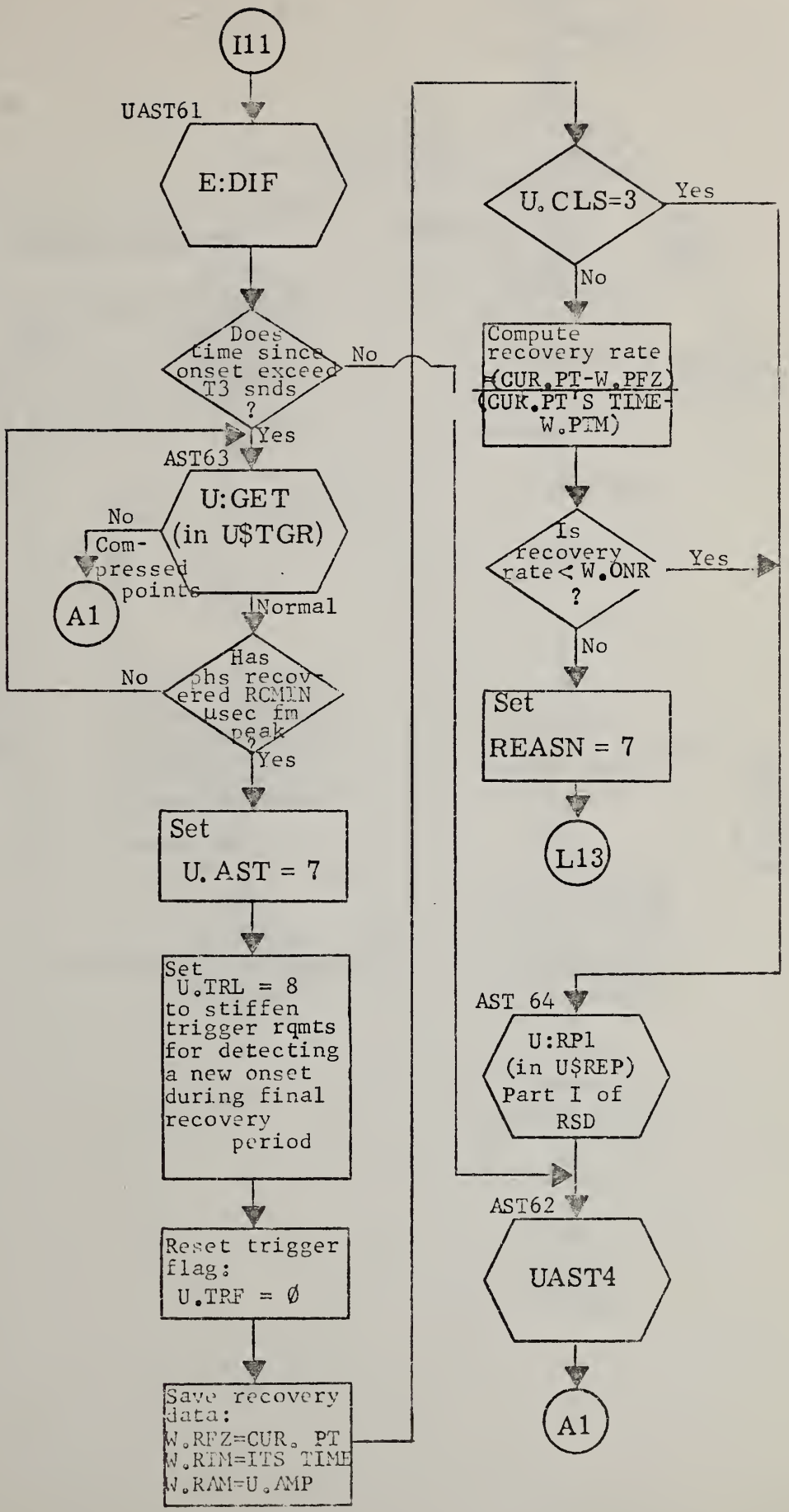

D6
U:GET
(in U$TGR)
No
Compressed
Points
C4
Normal
Compute slope
fm onset to
current point:
Vcur-Vons
Tcur-Tons
Is
ths vlu
greater than
slope
?
Yes
Set slope to
this current
onset to point
slope value
AST35
Is
cnt vlu
<.75*slope
?
No
Yes
Increment
CFIRM
AST32
Save crnt pt
as U.CDT and
its time in
U.CDM
Reset
CFIRM=Ø
No
CFIRM=4
Yes
E7
AST34
E:DIF
Is
ths pts
time gtr than
T1 snds past
onset
?
No
Yes
C5

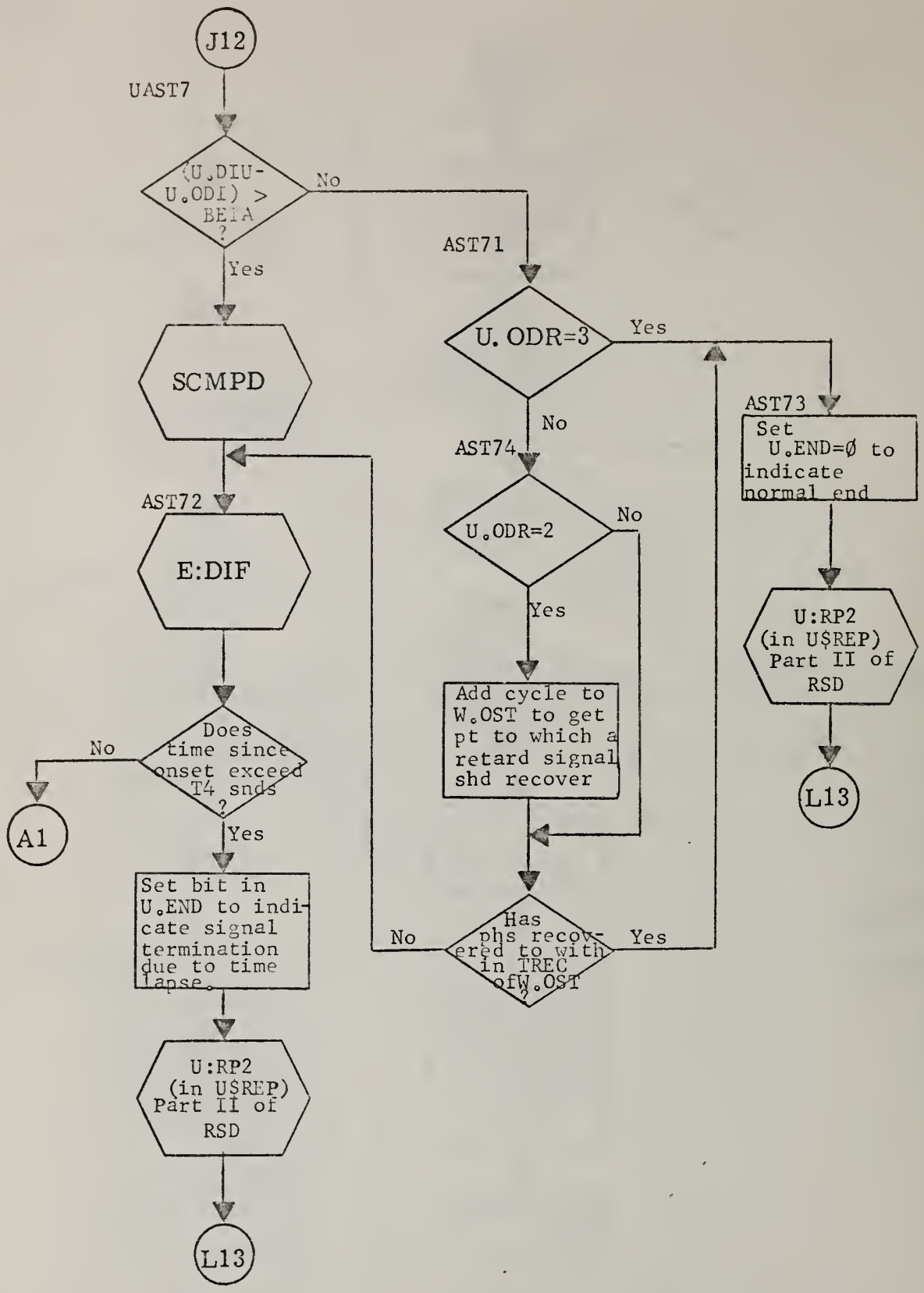

E7
PVALC
Reset
CFIRM = ∅
Set
U. FAC =
U. BGF
U. CLS =3
No
Yes
Set
U. AST=5
Reset current
Diurnal to
onset value:
U.DIU=U.ODI
Save peak data
for class
signal
W.PFZ=U.CDT
W.PTM=U.CDM
B2
PVAL1
Compute phase
offset:
W.OST=U.CDT-
(U.CDM-U.OTM)
*U.ODI-U.OFZ
W.OST=
W.OST
Compute onset
rate: W.ONR=
W.OST
(U.CDM-U.OTM)
F8


F8
Tracking Rate (U.TRK)
=Ø,1
=2,3,4
>4
LOTRK
W.ONR≥ PONLO ?
No
Yes
MDTRK
W.ONR ≥ PONMD ?
No
Yes
W.ONR ≥ PONHI ?
No
Yes
CKPOF
W.OST ≥ POFF ?
No
Yes
CKSEC
U. AST=2 ?
No
Yes
SREA2
Set REASN = 2
Set U.CLS = 1
PASS
Save peak phs value & its time and possible valley pk data if this turns into a COCO.
W.PFZ=U.CDT
W.VPK=U.CDT
W.PTM=U.CDM
W.VTM=U.CDM
W.OST ≥ SOFF ?
No
Yes
SREA3
Set REASN = 3
W.ONR ≥ SONRT ?
No
Yes
SREA4
Set REASN = 4
Set U.CLS = 2
Save amp at peak:
W.PAM=U.AMP
Reset Diurnal slope to onset value
U.DIU=U.ODI
Flag onset direction:
U.ODR=U.AST-1
Set U.AST=5
B2
L13

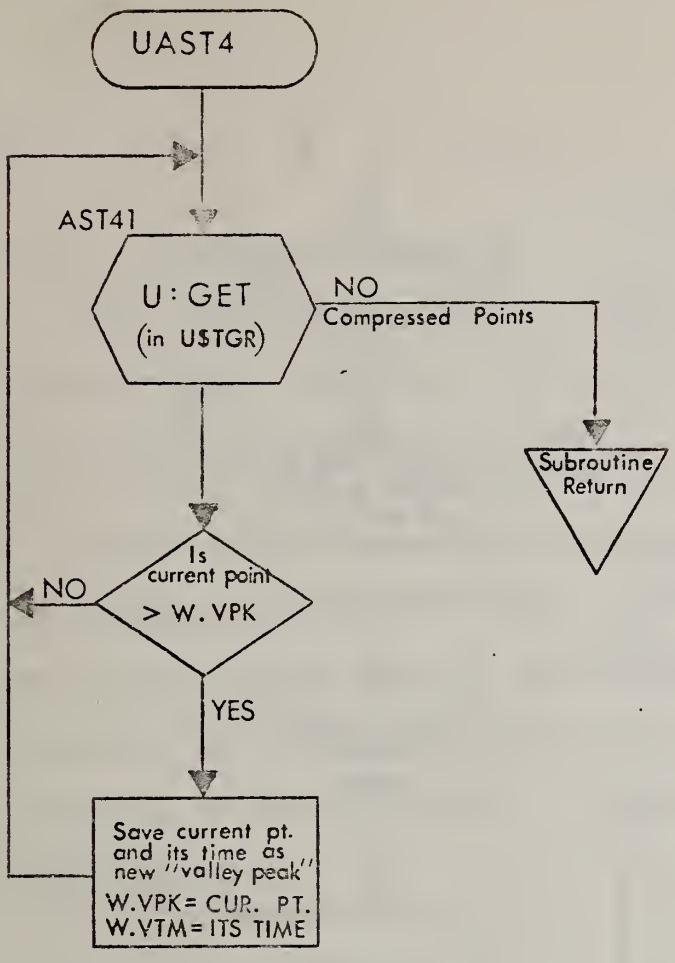

G9
UAST5
UAST4
(U.DTU-U.ODI) > ALPHA ?
Yes
No
Set U.AST = 6
AST51
Does time since onset exceed T2 snds ?
No
A1
Yes
Set REASN = 5
L13
U.ODR
=3
=1
=2
AST53
Set minimum recovery necessary for valid recovery to 7μsec
Compute duration of one cycle at channel's frq CYCLE= 160000/FREQ
Compute minimum recovery necessary for valid signal. (W.OST/2)
Compute minimum recovery necessary for valid signal: (CYCLE-W.OST)/2
Set RCMIN to minimum recovery value
A1

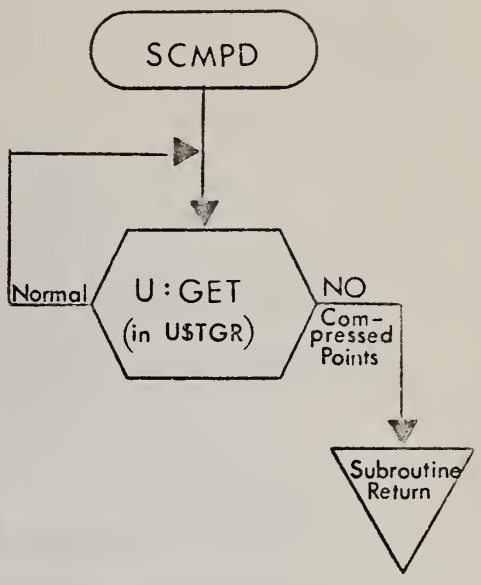

H10
UAST6
(U.DIU-U.ODI > BETA ?
Yes
I11
No
U. ODR=1 (Advance) ?
No
Yes
Tracking Rate (U.TRK)
=Ø,1
> 4
=2,3,4
TL06
W.ONR≥ PONLO
No
Yes
TMD6
W.ONR ≥ PONMD
No
Yes
W.ONR ≥ PONHI
No
Yes
MAYBE
Set U. AST = 2
Set"low peak" values to previous peak vls &reinitialize peak search:
U.CDT=U.LFZ
W.LPK=W.PFZ
W.LAM=W.PAM
U.CDM=U.LTM
W.LPM=W.PPM
Flag possible COCO signal
U.CLS = 3
U.ODR = 3
B2
SREA6
Set REASN = 6
L13

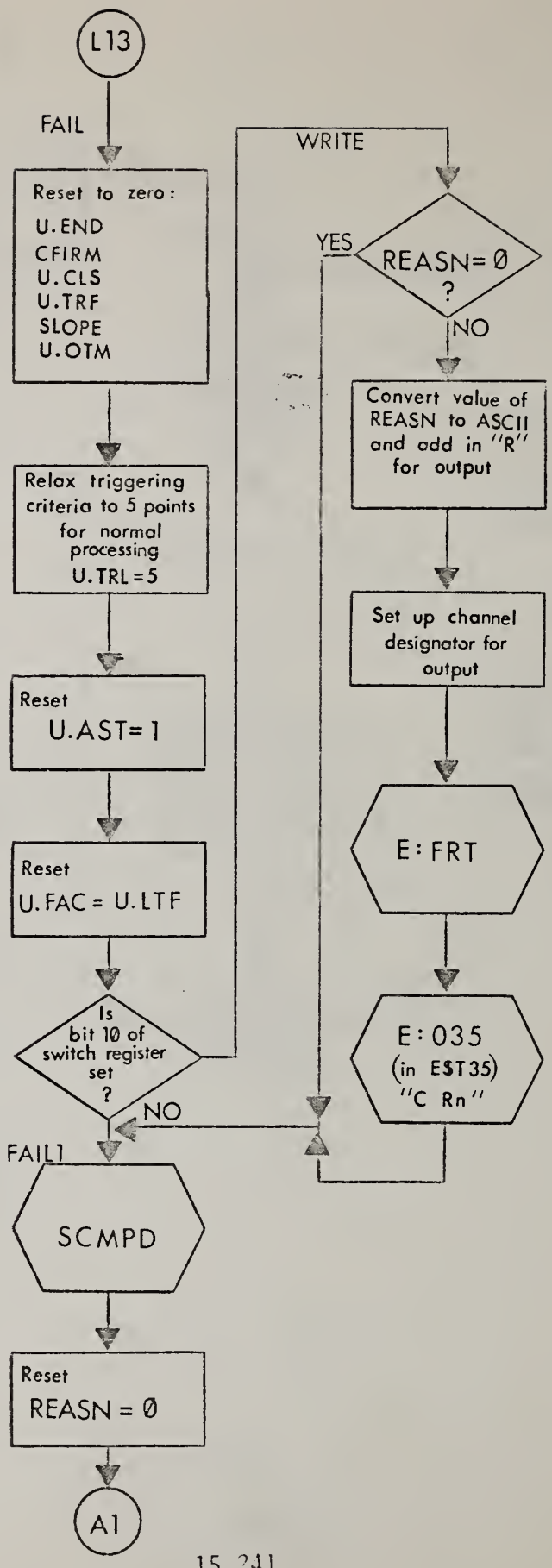

I11
UAST61
E:DIF
Does time since onset exceed T3 snds ?
No
Yes
AST63
U:GET (in U$TGR)
No
Com-pressed points
A1
Normal
Has phs recov-ered RCMIN µsec fm peak ?
No
Yes
Set U.AST = 7
Set U.TRL = 8 to stiffen trigger rqmts for detecting a new onset during final recovery period
Reset trigger flag: U.TRF = Ø
Save recovery data: W.RFZ=CUR. PT W.RTM=ITS TIME W.RAM=U.AMP
U.CLS=3
Yes
No
Compute recovery rate (CUR.PT-W.PFZ) / (CUR.PT'S TIME-W.PTM)
Is recovery rate < W.ONR ?
Yes
No
Set REASN = 7
L13
AST 64
U:RP1 (in U$REP) Part I of RSD
AST62
UAST4
A1


J12
UAST7
(U.DIU-U.ODI) > BETA ?
No
Yes
SCMPD
AST72
E:DIF
Does time since onset exceed T4 snds ?
No
A1
Yes
Set bit in U.END to indicate signal termination due to time lapse.
U:RP2 (in U$REP) Part II of RSD
L13
AST71
U. ODR=3
Yes
No
AST74
U.ODR=2
No
Yes
Add cycle to W.OST to get pt to which a retard signal shd recover
Has phs recovered to within TREC ofW.OST ?
No
Yes
AST73
Set U.END=Ø to indicate normal end
U:RP2 (in U$REP) Part II of RSD
L13

K


UAST4
AST41
U:GET
(in U$TGR)
NO
Compressed Points
Subroutine Return
Is current point > W.VPK
NO
YES
Save current pt. and its time as new "valley peak"
W.VPK= CUR. PT.
W.VTM= ITS TIME


SCMPD
Normal
U:GET
(in U$TGR)
NO
Com-pressed Points
Subroutine Return


L13
FAIL
Reset to zero:
U.END
CFIRM
U.CLS
U.TRF
SLOPE
U.OTM
Relax triggering criteria to 5 points for normal processing
U.TRL=5
Reset
U.AST=1
Reset
U.FAC = U.LTF
Is bit 10 of switch register set ?
NO
FAIL1
SCMPD
Reset
REASN = Ø
A1
WRITE
YES
REASN=Ø ?
NO
Convert value of REASN to ASCII and add in "R" for output
Set up channel designator for output
E:FRT
E:035 (in EST35) "C Rn"

16. U$DAT

16.1 Functional Description

U$DAT contains no executable statements. It is a storage area where variables, flags, etc. are made available to the various applications programs in NUSTAD.

Because of the unique characteristics of this program in NUSTAD, the following write-up will differ slightly from those of the rest of the system. Section 16.2 will indicate the various formats which the parameters may assume. In Section 16.3, each of the parameters is described, and where applicable, a reference is made to its format as a subsection of 16.2.

16.2 Data Formats

16.2.1 Long and Short Term Trend Estimates

The lease squares slope estimate to approximate the short term data trend and the long term estimate for the data trends use the following format:

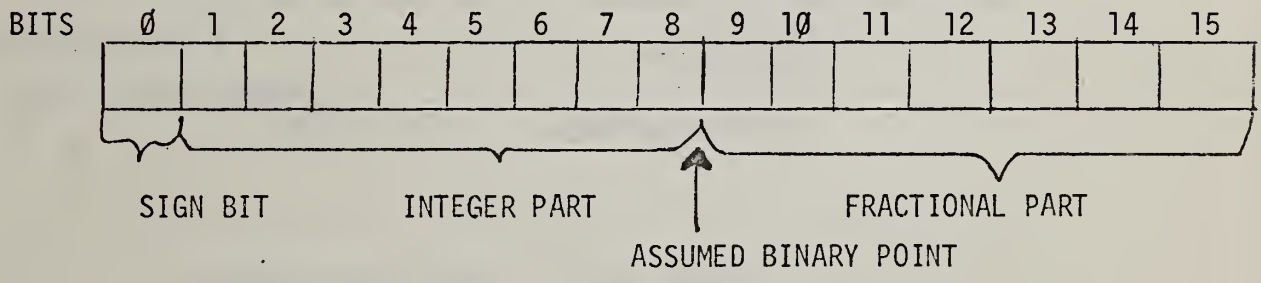


Figure 16.1 Trend Estimates Format

16.2.2 Pure Fractional Values

At several points in the programs, values which are purely fractional are required. These values use the following format:

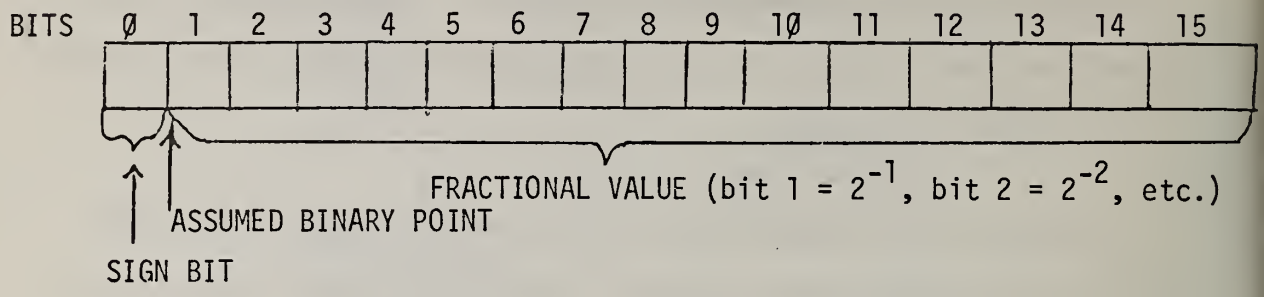


Figure 16.2 Fractional Value Format

16.2.3 Phase Values

The internal representation of the Phase values in the various programs, including such values as the phase offset between onset and peak of a waveform, and the standard deviation, is as follows:

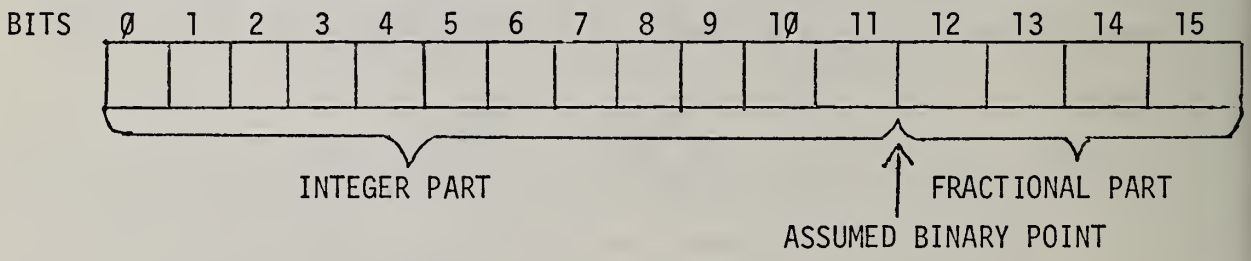
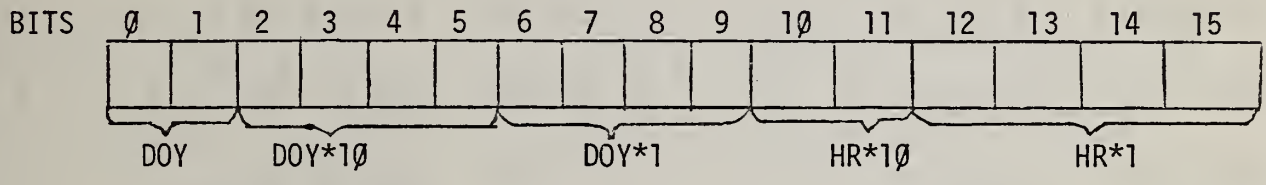


Figure 16.3 Phase Value Format

16.2.4 BCD Time

The DOY/TOD group is input from the WTC via the MODCOMP III IOIS using the following format. Since the representation is compact, and the conversion from BCD to ASCII is straightforward, the internal representation of most time values is kept in this same format.

FIRST WORD:



SECOND WORD:

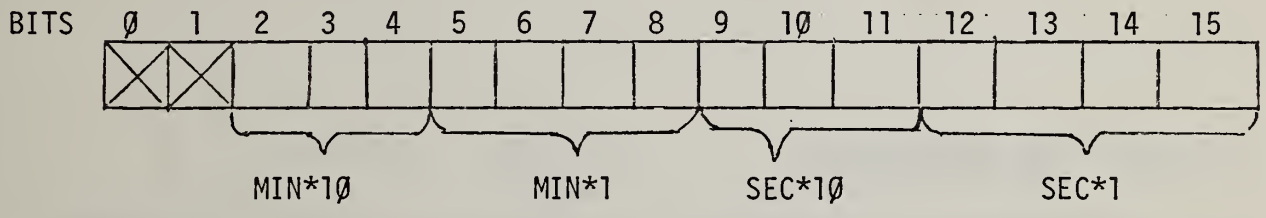


Figure 16.4 BCD Time Format

16.2.5 Binary Time

For ease in computation, the BCD time is occasionally converted to a form more compatible with binary arithmetic. This form consists of the equivalent of the TOD value represented as a binary count of seconds.

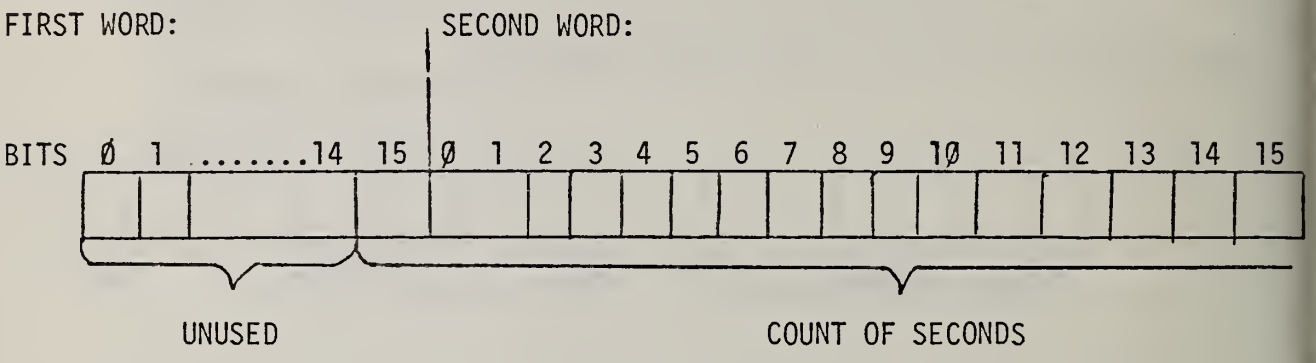


Figure 16.5 Binary Time Format

16.2.6 Amplitude Values

The internal representation of amplitude is an integer with a range from zero through $2Ø47_{1Ø}$ corresponding to amplitude values of from -2ØdB to +2ØdB.

16.2.7 U.WRK Buffer Format

After E.UIN collects ten seconds worth of data, it transfers that cata to the working buffer (U.WRK) and schedules the series of applications programs. The format of the data in U.WRK is as follows:

	CHANNEL	A	B	.....	N	(BCD TIME)
	t_{-1}	AMP FAZ BLL	AMP FAZ BLL	.....AMP FAZ BLL		WRD1 WRD2
T	$t_{-\emptyset}$	AMP FAZ BLL	AMP FAZ BLL	.....AMP FAZ BLL		WRD 1 WRD2
I	t_1	AMP FAZ BLL	AMP FAZ BLL	.....AMP FAZ BLL		WRD1 WRD2
M	t_2	AMP FAZ BLL	AMP FAZ BLL	.....AMP FAZ BLL		WRD1 WRD2
E	t_3	AMP FAZ BLL	AMP FAZ BLL	.....AMP FAZ BLL		WRD1 WRD2
	.	.....				
	.	.....				
	t_9	AMP FAZ BLL	AMP FAZ BLL	.....AMP FAZ BLL		WRD1 WRD2

Chan A AMP @ U.WRK; FAZ @ U.WRK+1; BLL @ U.WRK+2; etc.

Figure 16.6 Working Buffer (U.WRK) Format

16.2.8. U.CMP Buffer Format

U.CMP is a buffer of compressed data points encountered during the current ten-second interval. Each entry requires three computer words; one for the phase value and two for the BCD time. Each of the fourteen channels has room for ten entries, resulting in a buffer 3 x 14 x 1Ø, or 42Ø words, arranged as follows:

	PHASE	BCD TIME	
CHANNEL A	U.CMP U.CMP +3 U.CMP+6 .... U.CMP+27	U.CMP+1 U.CMP+4 U.CMP+7 U.CMP+28	U.CMP+2 U.CMP+5 U.CMP+8 U.CMP+29
CHANNEL B	U.CMP+3Ø U.CMP+33 U.CMP+36 .... U.CMP+57	U.CMP+31 U.CMP+34 U.CMP+37 U.CMP+58	U.CMP+32 U.CMP+35 U.CMP+38 U.CMP+59
CHANNEL C	U.CMP+6Ø	U.CMP+61	U.CMP+62

Figure 16.7 Compressed Point Buffer (U.CMP) Format

16.3 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
U.TRK	14	Current setting for sensor channel tracking rate. Value between Ø and 9 inclusive.
U.GAN	14	Current setting for sensor channel RF gain. Value between Ø and 24 inclusive.
U.BLL	14	Current setting for sensor channel blanking level. Value between Ø and 63 inclusive.
U.DIU	14	The diurnal slope, or long term data trend, estimate. Format as in 16.2.1 as microseconds/minute.
U.LTF	1	$=Ø666_{16}$; $(.Ø5_{1Ø})$. The longer time constant factor from the digital filter used in determining U.DIU.
U.BGF	1	$=ØCCC_{16}$; $(.1Ø_{1Ø})$. The shorter time constant factor from the digital filter used in determining U.DIU.
U.FAC	14	The current factor, set to either U.LTF or U.BGF, used in the digital filter for determining U.DIU.
U.LST	14Ø	A wrap-around buffer of ten-second phase averages used in computing the least squares slope estimate (see Section 13.4.1).
U.LSP	1	A pointer to the current row in U.LST (see Section 13.4.1).
U.SLP	14	The current short term phase trend estimate determined by the least squares slope computation described in Section 13.3.
U.WRK	484	The working buffer into which the data from the AIS and the DOY/TOD group from the IOIS are transferred for use by the applications programs (see Section 16.2.7).
U.CTM	Ø	The BCD time value read into the last two words of U.WRK; hence, the current time of the current ten-second interval.

16.3 Output Parameter (continued)

PARAMETER	SIZE	DESCRIPTION
U.CMP	42Ø	The buffer of compressed data points (phase and BCD time) for each channel encountered during the current ten-second interval (see Section 16.2.8).
U.CPP	14	A table of pointers to the first word of each sensor channel's partition of U.CMP.
U.CPC	14	A counter for the number of compressed data points encountered on each sensor channel during the current ten-second interval.
U.CYC	14	A flag, set to +5Ø or - 5Ø microseconds (see Section 16.2.3) when a phase shift is induced by NUSTAD to indicate the direction of the shift. See E:UIN for complete details.
U.CCN	14	Accumulated sum of U.CYC to indicate the total effect of cycle shifts induced by NUSTAD.
U.IHB	14	Flag bit (BIT Ø) is set to inhibit processing on a sensor channel when a maintenance of INE condition exists on that channel.
U.RTY	14	Counter for consecutive ten-second intervals of "good" data required to bring a channel to the UP state.
U.CST	14	The channel's processing status, based on the results of the amplitude monitoring section of U:RTA; =1 for channel UP =2 for channel COASTING, with NO REPORT =3 for channel COASTING, REPORTED on logging teleprinter =4 for channel DOWN
U.AST	14	The channel's waveform analysis status, determined by the point in the signal to which processing has progressed; =1 while looking for onset =2 while looking for peak in the advance direction =3 while looking for peak in the retard direction =5 while awaiting recovery to begin =6 while looking for valid recovery point =7 while looking for end of signal

16.3 Output Parameter Descriptions (continued)

PARAMETER	SIZE	DESCRIPTION
U.CLS	14	The class of the waveform being processed; =1 for those meeting primary criteria =2 for those meeting secondary criteria =3 for multiple peak signals
U.END	14	Flag to indicate how processing terminated on waveform just completed; Bit Ø = Ø Normally = 1 Signal terminated due to channel going down Bit 1 = Ø Normally = 1 Time limit T4 exceeded, signal terminated Bit 2 = Ø Normally = 1 New onset terminates former signal
U.OTM	28	Signal onset time, binary (Section 16.2.5)
U.DTM	2	Dummy binary time used by E$DIF (Section 16.2.5)
U.OTB	28	Signal onset time, BCD (Section 16.2.4)
U.OAM	14	Signal amplitude at onset (Section 16.2.6)
U.OFZ	14	Phase value at onset (Section 16.2.3)
U.ODI	14	Long term phase trend estimate at onset (Section 16.2.1)
U.ODR	14	Direction of onset; =1 for advance =2 for retard =3 for advance, multiple peak
U.OSG	14	Standard deviation (U.SIG) at onset (Section 16.2.3)
W.PFZ	14	Phase value at peak (Section 16.2.3)
W.PTM	28	BCD time of peak (Section 16.2.4)
W.PAM	14	Signal amplitude at peak (Section 16.2.6)
W.OST	14	Phase offset, onset to peak (Section 16.2.3)
W.ONR	14	Average rate of onset, onset to peak (Section 16.2.3)

16.3 Output Parameter Descriptions (continued)

PARAMETER	SIZE	DESCRIPTION
W.LPK	14	Phase value at first peak of multiple peak signal (Section 16.2.3).
W.LTM	28	BCD time at first peak of multiple peak signal (Section 16.2.4).
W.LAM	14	Signal amplitude at first peak of multiple peak signal (Section 16.2.6).
W.VPK	14	Phase value at valley peak of multiple peak signal (Section 16.2.3).
W.VAM	14	Signal amplitude at valley peak of multiple peak signal (Section 16.2.6).
W.VTM	28	BCD time at valley peak of multiple peak signal (Section 16.2.4).
W.RFZ	14	Phase value at valid recovery (Section 16.2.3).
W.RTM	28	BCD time of valid recovery (Section 16.2.4).
W.RAM	14	Signal amplitude at valid recovery (Section 16.2.6).
U.AMP	14	Estimate of current signal amplitude based on the value from the last input of each ten second interval, (Section 16.2.6).

17. U$REP

17.1 Functional Description

When a signal meeting reporting criteria is encountered by U:WFA, a message called the REPORTABLE SIGNAL DESCRIPTION is generated in three parts for the station log. Each part is called in sequence as conditions dictate.

17.1.1 U:RP1 (Generator for Part I of RSD)

When U:WFA sets U.AST to seven, it considers the signal reportable and calls U:RP1 to generate the first part of the RSD and start it on its way to the ASR 28, the logging teleprinter. The first part of the RSD supplies the operator with a relatively detailed description of the waveform to the point where the recovery is considered valid. This information is intended for the operator's use only. After the message is generated and transferred to the ASR 28 output buffer via calls to E:028, control is returned to the calling program.

17.1.2 U:RP2 (Generator for Part II of RSD)

When signal processing terminates for a signal in progress, U:WFA will call U:RP2 to generate a followup to the message generated by U:RP1. This followup is the second part of the RSD and supplies the operator with the same type of information formerly output, but concerning the signal termination. When this part of the RSD is transferred to the output buffer, a flag bit is set in E.28F to signify that U:RP3 is to be scheduled

the next time the output buffer in E$T28 is empty. This procedure is a precaution against the lengthy U:RP3 message becoming disturbed in the wrap-around designed output buffer.

After the call to E:028 during which R:RP3 is effectively scheduled, control is returned to the calling program.

17.1.3 U:RP3 (Generator for Part III of RSD)

Each time the output buffer in E$T28 becomes empty, a flag bit is checked to determine whether there is a need to schedule U:RP3 (see Section 9.1.2). If the bit is set, due to a previous call to E:028 by either U:RP2 or U:RP3, U:RP3 is scheduled in the system scheduler. Control is thereafter made to U:RP3 from E:SKD.

Whereas Parts I and II of the RSD were designated for operator information, Part III is formatted for transmission over standard communications lines. Therefore, a series of null characters is generated before and after Part III of the RSD to create a leader on the data tape, and numeric characters are spelled out ("ONE" for 1, "TWO" for 2, etc.). When U:RP3 transfers its message to the ASR 28 output buffer in E$T28, it sets the flag bits in E.28F to cause U:RP3 to be rescheduled after the output buffer again becomes empty. In this way, only one Part III RSD message may be generated at a time.

When U:RP3 is finally entered with no further message to generate, a final call to E:028 is made to transmit two "LTR" characters without the flag bit set in E.28F.

U:RP3 returns control to the scheduler each time it completes execution.

17.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:FRT	E$FRT	Reformats BCD time from the WTC to ASCII for output.
E:BAD	E$BDC	Converts binary value to ASCII decimal characters.
E:FMF	E$FMF	Reformats phase values from internal binary representation to ASCII decimal for output.
E:FAM	M$STD	Reformats amplitude values from internal binary representation to ASCII decimal dB for output.
E:FCT	E$FRT	Reformats BCD time from memory to ASCII for output.
E:028	E$T28	Translates output message to BAUDOT code and stores in buffer before transmission to the ASR 28.
E:COT	E$DIF	Converts the BCD time characters to the binary count of seconds.
E:SKD	E$SKD	Operating system scheduler entry point.
E:BDC	E$BDC	Binary to BCD (decimal) conversion routine.
E:DIF	E$DIF	Computes the time difference between onset and later point in time.

17.3 Data Formats

17.3.1 U:RP1 Message Format

Part I of the RSD is generated by U:RP1 at the time when a reportable waveform is considered valid. The data applicable to the key points of the

waveform up to that point are output in tabular form as shown in Figure 17.1. The following describes the format of the message:

LINE 1:

DDD TTTTTT REPORTABLE SIGNAL DESCRIPTION, DET NNN

where: D indicates a digit of DOY

T indicates a digit of TOD

N indicates a digit of detachment number

```
024 213300  REPORTABLE SIGNAL DESCRIPTION, DET 215
002
CHAN B;FREQ 21.0 UNK;TR4;GN16:BL02;CARD5
SIGNAL TYPE: ALPHA    SIGMA 02.25
    DOY  TIME    PHASE     AMP     DIUR
ON  024 212231 &0033.37 -05.38   &000.0
PK  024 212254 &0016.37 -05.16
HR  024 213259 &0023.75 -05.60   &000.6
OFFSET: 0015.00
ONSET RATE:  039.1



025 104102  REPORTABLE SIGNAL DESCRIPTION, DET 215
013
CHAN C;FREQ 21.0 UNK;TR4;GN15:BL04;CARD1
SIGNAL TYPE: BRAVO    SIGMA 00.56
    DOY  TIME    PHASE     AMP      DIUR
ON  025 103052 &0070.31 -04.38   -000.2
PK  025 103120 &0091.43 -04.60
HR  025 104055 &0105.93 -04.38   &000.8
OFFSET: 0021.13
ONSET RATE:  045.4



024 223921  REPORTABLE SIGNAL DESCRIPTION, DET 215
005
CHAN B;FREQ 21.0 UNK;TR5;GN16:BL02;CARD5
SIGNAL TYPE: DELTA    SIGMA 00.50
    DOY  TIME    PHASE     AMP      DIUR
ON  024 222916 &0058.43 -05.08   -000.2
PK  024 223015 &0049.81 -05.32
HR  024 223921 &0053.56 -05.40   &000.3
OFFSET: 0003.50
ONSET RATE:  006.6
```

Figure 17.1 Three Examples of Part I of the RSD Message

LINE 2:

NNN

where: N indicates a digit of a three digit serial identification number, used to associate the three parts of the RSD with the signal.

LINE 3:

CHAN C;FREQ FF.F LLL;TRN;GNNNN;BLNN;CARDN

where: C indicates the sensor channel reporting

F indicates a digit of the sensor frequency

L indicates a letter of the call letters for that frequency, UNK used when no known call letters correspond to that frequency.

N indicates digits used to indicate the current values associated with the sensor's TRACKING RATE, RF GAIN, BLANKING LEVEL, and CARDIOID CONFIGURATION.

LINE 4:

SIGNAL TYPE: YYYYYY SIGMA SS.SS

where: Y indicates a letter in the signal type designator: (ALPHA, BRAVO, COCO, or DELTA)

S indicates a digit of the standard deviation of the input signal at onset.

LINE 5:

DOY TIME PHASE AMP DIUR

where: DOY is the column heading for the Day of Year data

TIME is the column heading for the Time of Day data

PHASE is the column heading for the Phase value data

AMP is the column heading for the signal amplitude data

DIUR is the column heading for the diurnal slope estimate data.

LINE 6: (data from onset)

ON DDD TTTTTT PPPPP.PP AAA.AA RRRR.R

where: ON indicates the line covers onset

D indicates a digit of DOY

T indicates a digit of TOD

P indicates a digit of phase value (microseconds)

A indicates a digit of amplitude value (dB)

R indicates a digit of diurnal slope estimate (mircoseconds/minute)

LINE 6a: (data for the first peak of COCO signal, not used with other tyeps)

IP DDD TTTTTT PPPPP.PP AAA.AA

where: 1P indicates the line covers the first peak

D indicates a digit of DOY

T indicates a digit of TOD

P indicates a digit of phase value (microseconds)

A indicates a digit of amplitude value (dB)

LINE 6b: (data for the valley peak of COCO signal, not used with others)

2P DDD TTTTTT PPPPP.PP AAA.AA

where: 2P indicates the line covers the valley peak

D indicates a digit of DOY

T indicates a digit of TOD

P indicates a digit of phase value (microseconds)

A indicates a digit of amplitude value (dB)

LINE 7: (data from signal peak)

PK DDD TTTTTT PPPPP.PP AAA.AA

where: PK indicates the line covers the signal peak

D indicates a digit of DOY

T indicates a digit of TOD

P indicates a digit of phase value (microseconds)

A indicates a digit of amplitude value (dB)

R indicates a digit of diurnal slope estimate (microseconds/minute)

LINE 9:

OFFSET: NNNN.NN

where: N indicates a digit of the computed phase offset, including the compensation for the diurnal slope estimate at onset, (microseconds)

LINE 1Ø:

ONSET RATE: NNN.N

where: N indicates a digit of the computed average rate of onset between onset and peak, (microseconds/minute)

17.3.2 U:RP2 Message Format

Part II of the RSD is generated by U:RP2 when processing is terminated on a current signal. Data concerning the reason for termination and applicable to the time of termination are output in the same basic format as Part I of the RSD. Figure 17.2 displays three examples of Part II of the RSD, and the following explains the format:

LINES 1 through 5 are the same as Part I.

LINE 6: (data from the time of signal termination)

FR DDD TTTTTT PPPPP.PP AAA.AA RRRR.R

where: FR indicates the line covers the time of final recovery

D indicates a digit of DOY

T indicates a digit of TOD

P indicates a digit of phase value (microseconds)

A indicates a digit of amplitude value (dB)

R indicates a digit of diurnal slope estimate (microseconds/minute)

LINE 7:

SIGNAL TERMINATED:

where: M is a letter from one of the following:

NORMALLY for normal signal termination
TIME LAPSE for signals that exceed one hour
SIGNAL LOST for signals when amplitude drops out
NEW ONSET for signals which lead into a new signal

```
024 214421  REPORTABLE SIGNAL DESCRIPTION, DET 215
002
CHAN B;FREQ 21.0 JNK;TR4;GN16:BL02;CARD5
SIGNAL TYPE: ALPHA    SIGMA 02.25
    DOY  TIME    PHASE     AMP      DIUR
FR  024 214359 &0033.37 -05.24   &000.2
SIGNAL TERMINATED: NORMALLY
```

```
025 110343  REPORTABLE SIGNAL DESCRIPTION, DET 215
013
CHAN C;FREQ 21.0 JNK;TR4;GN15:BL04;CARD1
SIGNAL TYPE: BRAVO    SIGMA 00.56
    DOY  TIME    PHASE     AMP      DIUR
FR  025 110339 &0116.00 -04.36   &000.0
SIGNAL TERMINATED: NORMALLY
```

```
024 224531  REPORTABLE SIGNAL DESCRIPTION, DET 215
005
CHAN B;FREQ 21.0 JNK;TR5;GN16:BL02;CARD5
SIGNAL TYPE: DELTA    SIGMA 00.50
    DOY  TIME    PHASE     AMP      DIUR
FR  024 224513 &0058.12 -04.43   &000.0
SIGNAL TERMINATED: NORMALLY
```

Figure 17.2 Three Examples of Part II of the RSD Message

17.3.3. U.RP3 Message Format

Whenever U:RP2 or U:RP3 transmits part of an RSD message to E:028 for output to the ASR 28 teleprinter, they set a flag bit in E.28F to cause E:T28 to reschedule U:RP3 when the output buffer next becomes empty. Part III of the RSD message is then generated using the following format, as illustrated in Figure 17.3.

LINE 1:

RSD (serial number)

where: The serial number is a three digit value used to identify the signal on this sensor channel. It is initialized each time NUSTAD is reloaded and incremented for each new RSD message generated. It allows the operator to associate the three parts of the RSD with the same signal.

(Class),(Type),(Frequency & Call Letters),(Path),DOY)

where: Class is either A or B corresponding to whether Class A or Class B criteria were met.

Type is one of the following: ALPHA, BRAVO, COCO, or DELTA

Frequency is the sensor frequency setting, given digitally, and the call letters are those associated with that frequency.

Path is either FRONT or BACK, based on the cardioid pattern.

DOY is the three digit DOY.

LINES 3 & 4: (Paragraph A)

A. (Onset time),(Offset),(Direction)
(Onset Rate),(Onset Amplitude)

```
 RSD ZERO ZERO TWO
A, ALPHA,21.0 JNK, BACK, ZERO TWO FOUR
  A. TWO ONE TWO TWO THREE ONE, ZERO ONE FIVE, ADVANCE
     ZERO THREE NINE, MINUS ZERO SIX DB
  B. PEAK ZERO ZERO THREE, MINUS ZERO SIX DB
  C. HALF ONE ZERO FOUR, MINUS ZERO SIX DB
  D. FULL TWO ONE FOUR, MINUS ZERO SIX DB
  E. FOUR, ZERO TWO TWO FIVE MICROSECONDS, ALPHA
```

```
 RSD ZERO ONE THREE
A, BRAVO,21.0 JNK, FRONT, ZERO TWO FIVE
  A. ONE ZERO THREE ZERO FIVE TWO, ZERO TWO ONE, RETARD
     ZERO FOUR FIVE, MINUS ZERO FIVE DB
  B. PEAK ZERO ZERO FOUR, MINUS ZERO FIVE DB
  C. HALF ONE ZERO ZERO, MINUS ZERO FIVE DB
  D. FULL THREE TWO SEVEN, MINUS ZERO FIVE DB
  E. FOUR, ZERO ZERO FIVE SIX MICROSECONDS, BRAVO
```

```
 RSD ZERO ZERO FIVE
B, DELTA,21.0 JNK, BACK, ZERO TWO FOUR
  A. TWO TWO TWO NINE ONE SIX, ZERO ZERO NINE, ADVANCE
     ZERO ZERO NINE, MINUS ZERO SIX DB
  B. PEAK ZERO ZERO NINE, MINUS ZERO SIX DB
  C. HALF ONE ZERO ZERO, MINUS ZERO SIX DB
  D. FULL ONE SIX ZERO, MINUS ZERO FIVE DB
  E. FIVE, ZERO ZERO FIVE ZERO MICROSECONDS, DELTA
```

Figure 17.3 Three Examples of Part III of the RSD Message

where: Onset time is the TOD at onset.

Offset is the phase offset computed between onset and peak, given in three digits to the nearest microsecond.

Direction is either ADVANCE or RETARD, the direction of onset.

Onset Rate is the average rate of onset to peak, given in three digits to the nearest microsecond per minute.

Onset Amplitude is the signal amplitude at onset to the nearest dB.

LINE 5: (Paragraph B)

B. (Time from onset to peak),(Peak Amplitude)

where: Time from onset to peak is given as three digits representing tenths of minutes.

Peak Amplitude is given to the nearest dB.

LINE 6: (Paragraph C)

C. HALF (Time fron onset to valid recovery),(Half recovery Amplitude)

where: Time is in three digits of tenths of minutes.

Amplitude is given in dB.

LINE 7: (Paragraph D)

D. FULL (Time from onset),(Amplitude at full recovery)

or

D. LOST (Phase offset remaining) MICROSECONDS,(Amplitude)

or

D. HOUR (Phase offset remaining) MICROSECONDS,(Amplitude)

or

D. (Phase offset remaining) MICROSECONDS,(Amplitude),SECOND ONSET

where: Time from onset is three digits of tenths of minutes.

Amplitude is given in dB.

Phase offset remaining is the phase difference between the current phase value and that needed for full recovery.

LINE 8: (Paragraph E)

E. (Tracking Rate),(Sigma at Onset) MICROSECONDS,(Type)

where: Tracking Rate is one digit value of sensor setting

Sigma is the onset standard deviation value

Type is repeated from Line 2, above.

17.4 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
E.BDF	E$BDC	Buffer of decimal digits from binary to decimal conversion.
U.FRQ	E$LOG	ASCII characters of sensor frequency settings.
U.TRK	U$DAT	Current setting for sensor channel tracking rate.
U.GAN	U$DAT	Current setting for sensor channel RF gain.
U.BLL	U$DAT	Current setting for sensor blanking level.
M.STA	M$ESC	Digital IOIS status word from sensor channel.
U.CLS	U$DAT	Waveform class corresponding to criteria met.
U.ODR	U$DAT	Direction of onset; =1 for advance; =2 for retard; =3 for multiple peak advance.
U.OSG	U$DAT	Standard deviation (U.SIG) at onset.
E.TM1 E.TM2	E$FRT	Two word BCD time used as parameter value for E:FCT.
E.28F	E$T28	Parameter word used in calling E:028.
U.AMP	U$DAT	Current signal amplitude estimate.

17.4 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
U.OTB	U$DAT	Signal onset time, BCD format.
U.OFZ	U$DAT	Phase value at onset.
U.OAM	U$DAT	Signal amplitude at onset.
U.ODI	U$DAT	Long term phase trend estimate at onset (U.DIU).
W.PFZ	U$DAT	Phase value at peak.
W.PAM	U$DAT	Signal amplitude at peak.
W.RTM	U$DAT	BCD time of valid recovery.
W.RFZ	U$DAT	Phase value at valid recovery.
W.RAM	U$DAT	Signal amplitude at valid recovery.
U.DIU	U$DAT	Current long-term phase trend (diurnal slope) estimate.
W.LTM	U$DAT	BCD time at first peak of multiple peak signal.
W.LPK	U$DAT	Phase value at first peak of multiple peak signal.
W.LAM	U$DAT	Signal amplitude at first peak of multiple peak signal.
W.VTM	U$DAT	BCD time at valley peak of multiple peak signal.
W.VPK	U$DAT	Phase value at valley peak of multiple peak signal.
W.VAM	U$DAT	Signal amplitude at valley peak of multiple peak signal.
W.OST	U$DAT	Phase offset, onset to peak.
W.ONR	U$DAT	Average rate of onset, onset to peak.
U.LFZ	U$WFA	Phase value of the last compressed data point encountered on each channel.
U.LTM	U$WFA	The BCD character time of the last compressed data point encountered on each channel.

17.4 Input Parameter Descriptions (continued)

PARAMETER	PROGRAM	DESCRIPTION
U.END	U$DAT	Flag to indicate how processing terminated on waveform just completed.
W.PTM	U$DAT	BCD time at peak.
U.DTM	U$DAT	Dummy binary time used by E$DIF.
U.OTM	U$DAT	Signal onset time, binary format.
U.CTM	U$DAT	BCD time of current ten-second interval.
E.BSG	E$BDC	ASCII characters for sign of output of E:BDC, binary to decimal conversion.
U.CCL	U$WFA	Number of microseconds in one cycle for the frequencies of each channel.

17.5 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
U:RP1		Entry point to routine to generate Part I of RSD.
U:RP2		Entry point to routine to generate Part II of RSD.
U:RP3		Entry point to routine to generate Part III of RSD.
U:UDR	1	Serial counter for reportable signals.

17.6 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
MSGØ1 MØ1S1	28	Part I & II of RSD, Line 1

17.6 Internal Data Descriptions (continued)

PARAMETER	SIZE	DESCRIPTION
MØ1S2 MØ1S3 MØ1S4 MØ1S5	62	Part I & II of RSD, Lines 2 through 5.
MSGØ2 MØ2S1 MØ2S2	22	Part I & II of RSD, buffer for lines of numeric data.
MSGØ3 MØ3S1 MØ3S2	20	Part I of RSD, Lines 9 & 1Ø.
MSGØ4 MØ4S1	19	Part II of RSD, Line 7.
LEADS	3	C/R followed by five L/F characters.
LEADR	27	Buffer of null characters for leader generation.
MSGØ5 MØ5S1	23	Buffer for Part III of RSD, Line 1.
MSGØ6 MØ6S1	82	Buffer for Part III of RSD, Lines 2 through 8.
CALTR	56	Table of frequencies and associated call letters.
LLABE	6	List of data line labels; "ON", "P1", "P2", "PK", "HR", and "FR".
UDRNO	14	Value of serial counter for signal on each channel.
LINEN	1	Pointer to current line number; entry in LLABE.
TYPEA	3	"ALPHA" in ASCII characters.
TYPEB	3	"BRAVO" in ASCII characters.
TYPEC	3	"COCO" in ASCII characters.

17.6 Internal Data Description (continued)

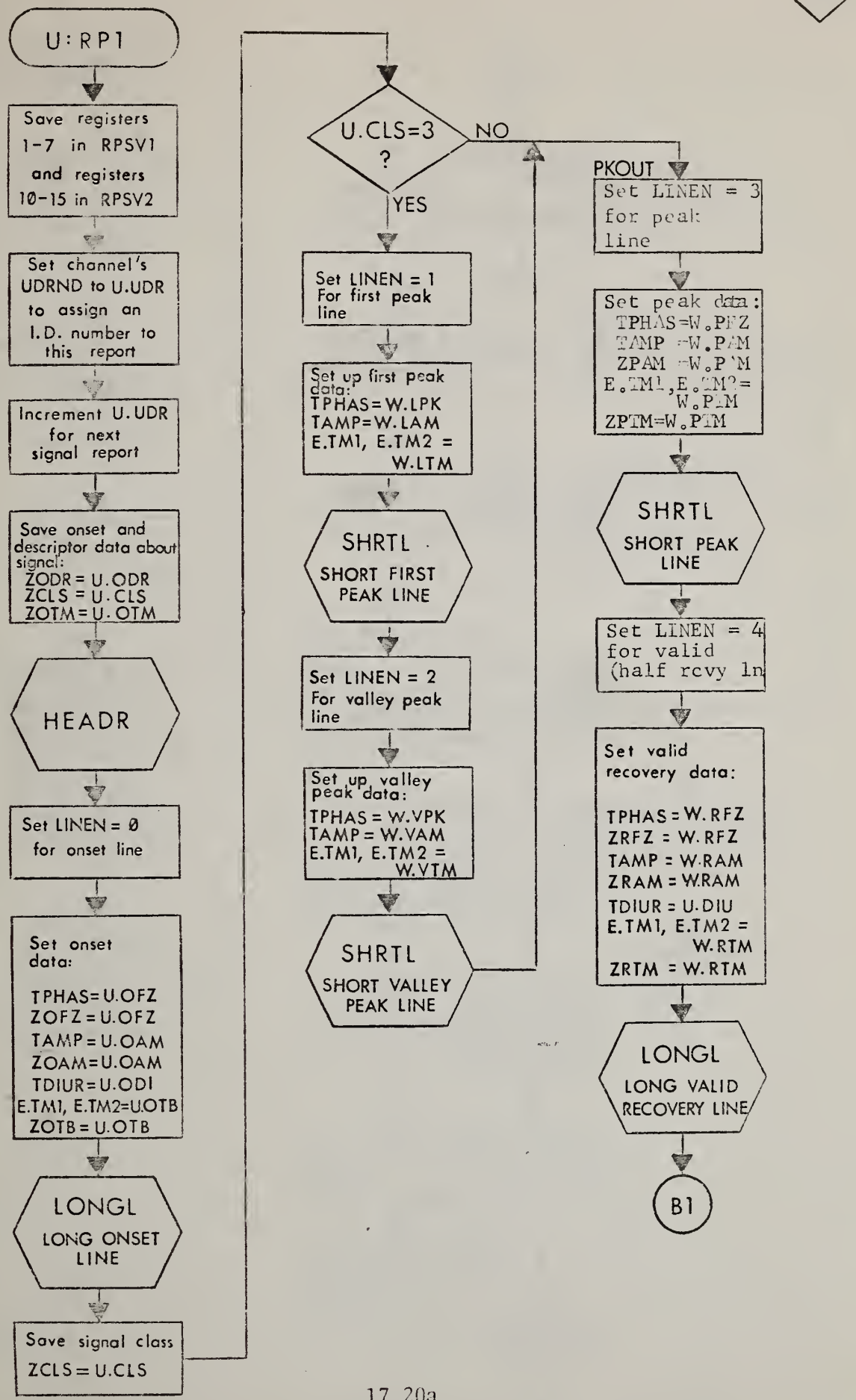
PARAMETER	SIZE	DESCRIPTION
TYPED	3	"DELTA" in ASCII characters.
TEMP	5	Working storage.
TPHAS	1	Parameter for internal subroutine; phase value.
TAMP	1	Parameter for internal subroutine; amplitude value.
TDIUR	1	Parameter for internal subroutine; diurnal slope estimate.
RPSV1	7	Register save area.
RPSV2	6	Register save area.
END1	6	"NORMALLY" in ASCII characters.
END2	6	"TIME LAPSE" in ASCII characters.
END3	6	"SIGNAL LOST" in ASCII characters.
END4	6	"NEW ONSET" in ASCII characters.
NOTBL	24	Pointers to ASCII characters of words in output messages.
NOØ	3	"ZERO" in ASCII characters.
NO1	3	"ONE" in ASCII characters.
NO2	3	"TWO" in ASCII characters.
NO3	4	"THREE" in ASCII characters.
NO4	3	"FOUR" in ASCII characters.
NO5	3	"FIVE" in ASCII characters.
NO6	3	"SIX" in ASCII characters.
NO7	4	"SEVEN" in ASCII characters.
NO8	4	"EIGHT" in ASCII characters.
NO9	4	"NINE" in ASCII characters.

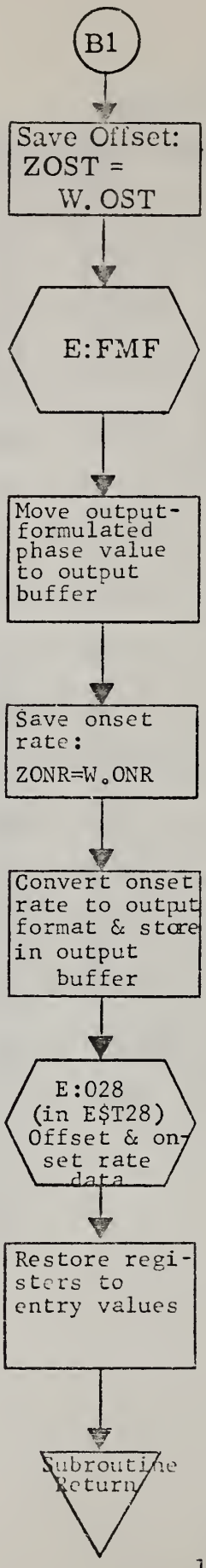
17.6 Internal Data Description (continued)

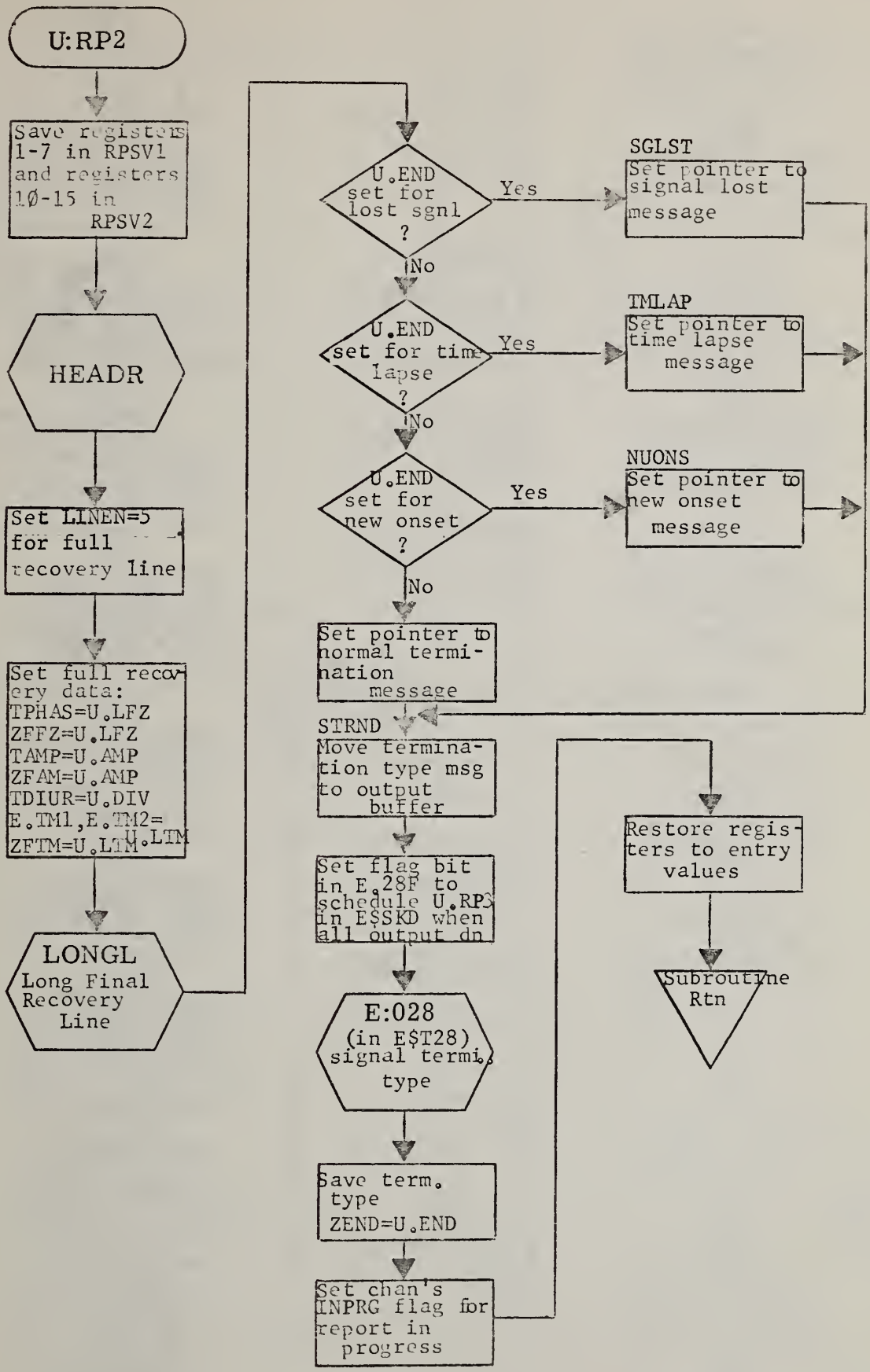
PARAMETER	SIZE	DESCRIPTION
NO1Ø	4	"FRONT" in ASCII characters.
NO11	3	"BACK" in ASCII characters.
NO12	3	"PEAK" in ASCII characters.
NO13	3	"HALF" in ASCII characters.
NO14	3	"FULL" in ASCII characters.
NO15	3	"HOUR" in ASCII characters.
NO16	3	"LOST" in ASCII characters.
NO17	7	"MICROSECONDS" in ASCII characters.
NO18	5	"ADVANCE" in ASCII characters.
NO19	4	"RETARD" in ASCII characters.
NO2Ø	3	"PLUS" in ASCII characters.
NO21	4	"MINUS" in ASCII characters.
NO22	2	"DB" in ASCII characters.
NO23	7	"SECOND ONSET" in ASCII characters.
ZCLS	14	Copy of U.CLS
ZTYPE	14	Pointer to TYPEA, TYPEB, TYPEC, or TYPED above.
ZFRQ	28	Copy of U.FRQ
CALLT	28	Computed call letters for sensor frequencies.
ZSTA	14	Copy of M.STA
ZOTM	28	Copy of U.OTM
ZOTB	28	Copy of U.OTB
ZOAM	14	Copy of U.OAM

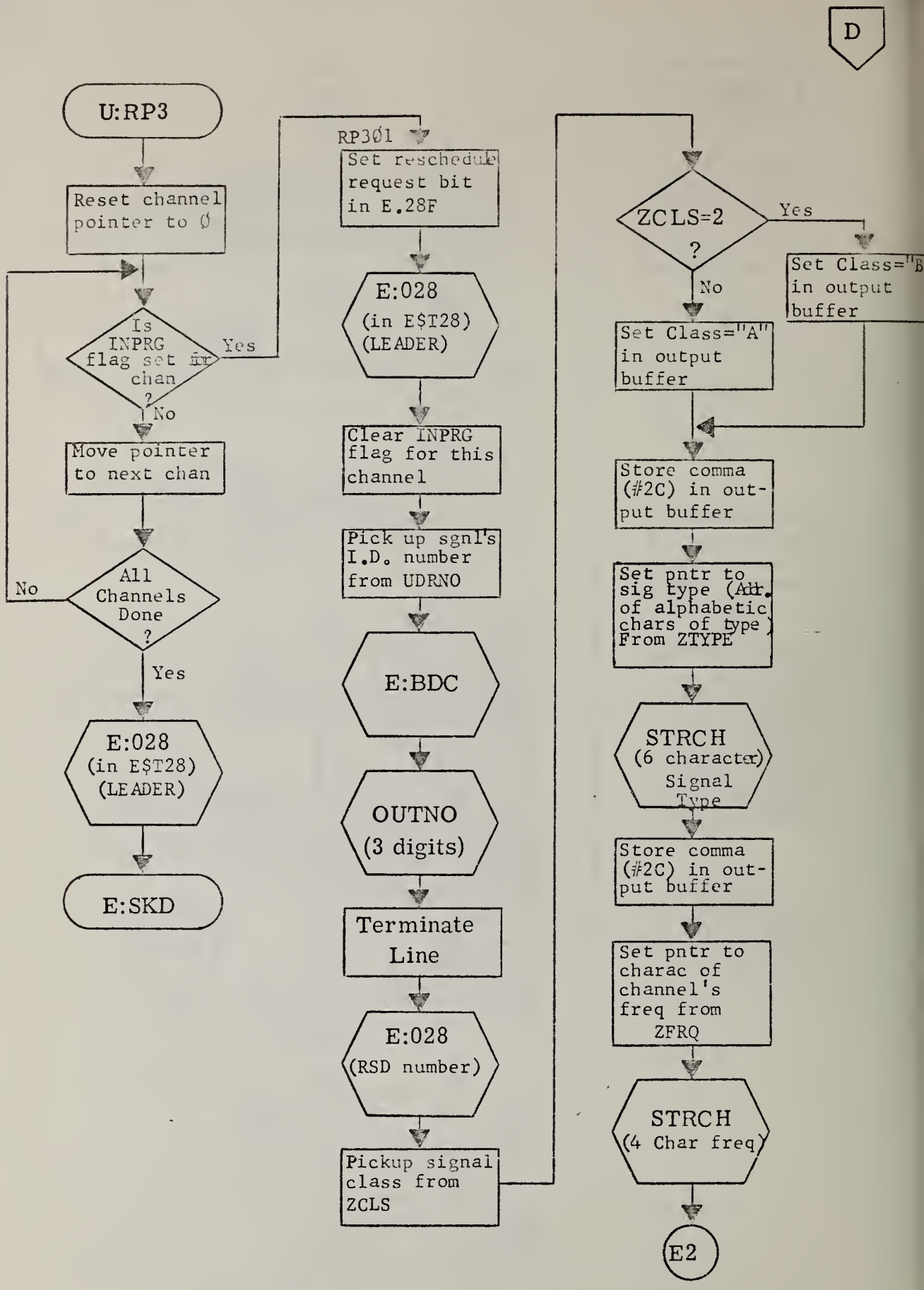
17.6 Internal Data Description (continued)

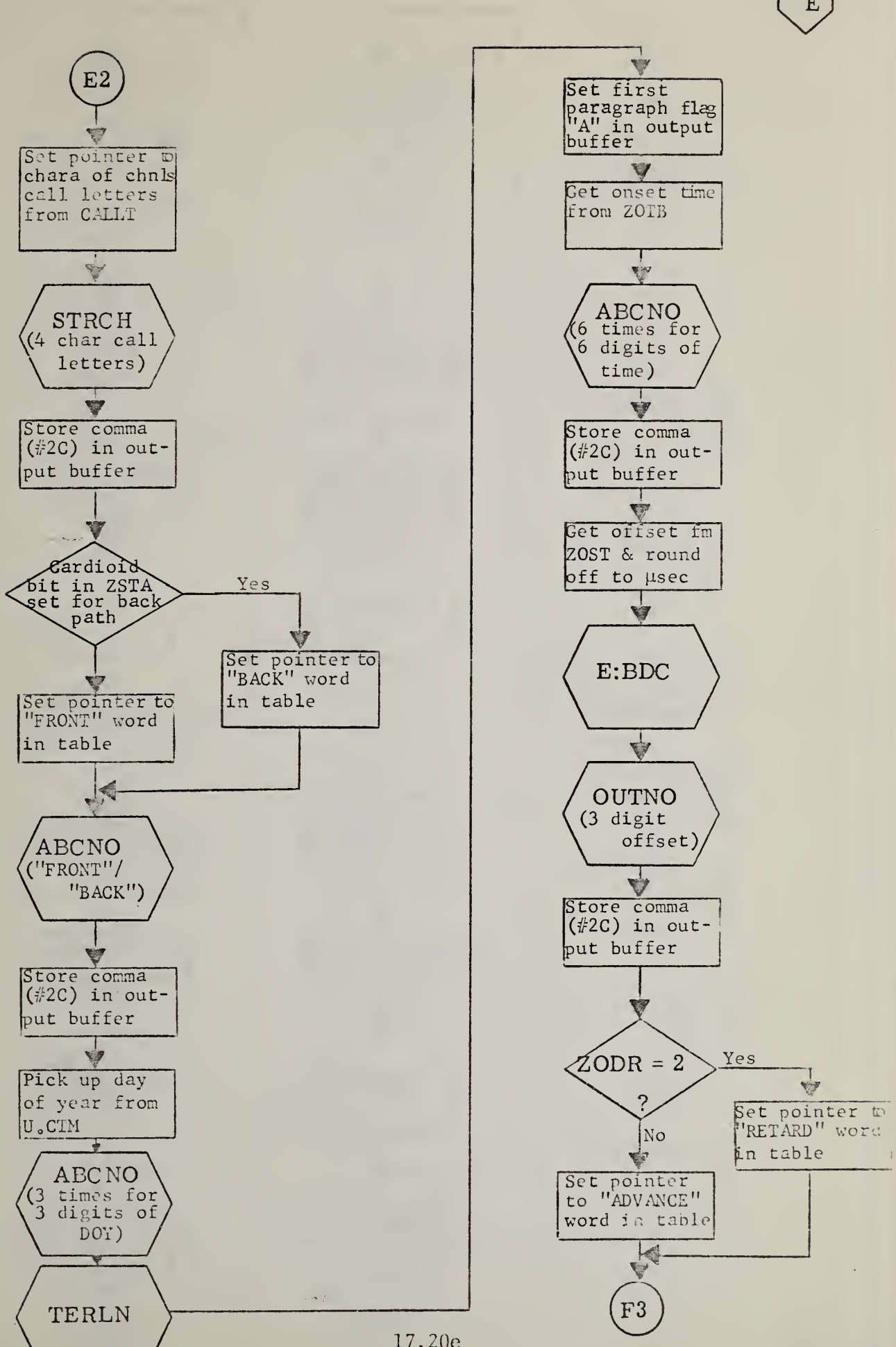
PARAMETER	SIZE	DESCRIPTION
ZOST	14	Copy of W.OST
ZODR	14	Copy of U.ODR
ZONR	14	Copy of W.ONR
ZPTM	28	Copy of W.PTM
ZPAM	14	Copy of W.PAM
ZRTM	28	Copy of W.RTM
ZRAM	14	Copy of W.RAM
ZRFZ	14	Copy of W.RFZ
ZTR	14	Copy of U.TRK
ZOSG	14	Copy of U.OSG
ZOFZ	14	Copy of U.OFZ
ZFAM	14	Copy of U.AMP
ZFFZ	14	Copy of U.LFZ
ZFTM	28	Copy of U.LTM
INPRG	14	Flag to indicate on which channels a report is in progress.
ZEND	14	Copy of U.END

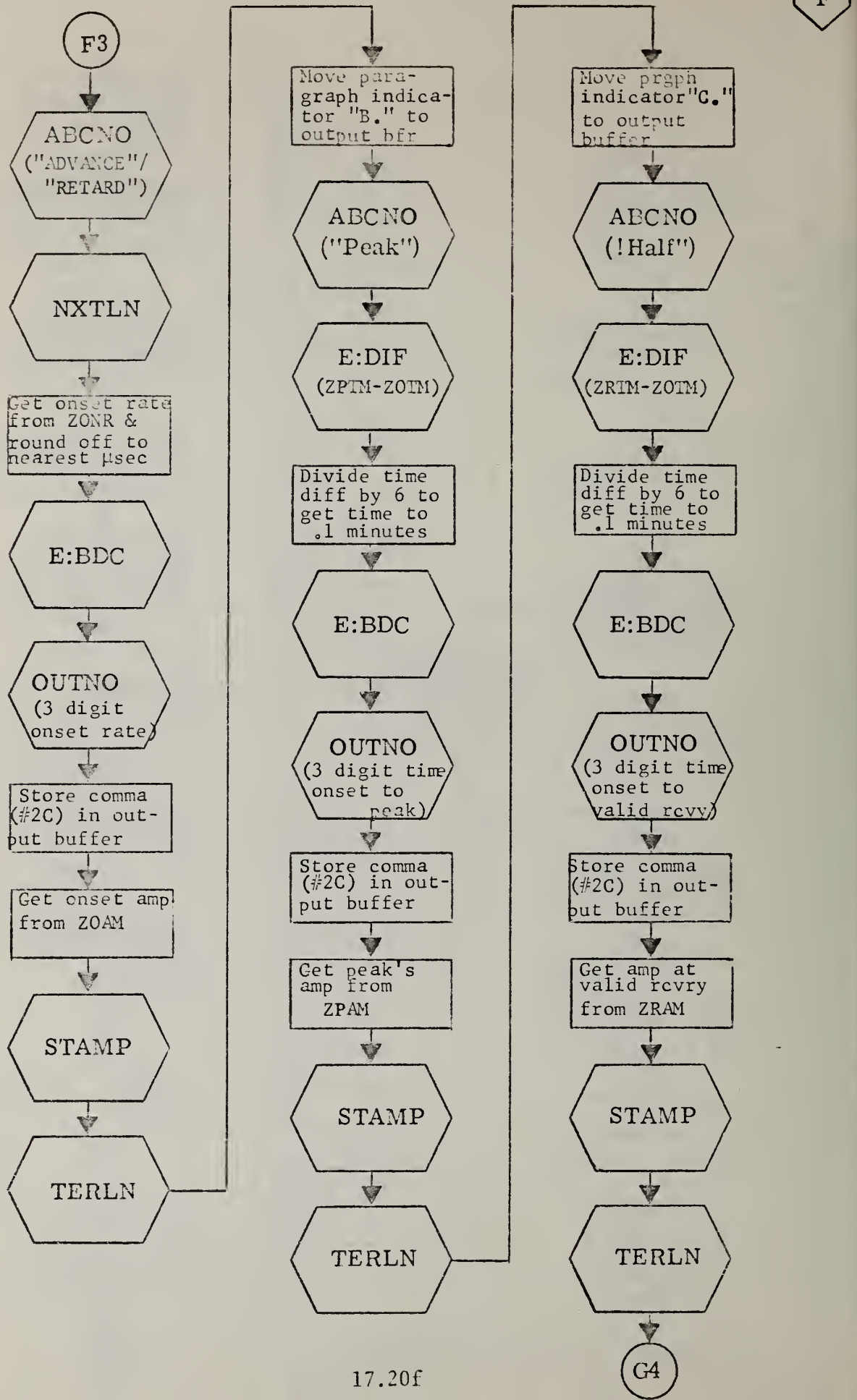

A
U:RP1
Save registers 1-7 in RPSV1 and registers 10-15 in RPSV2
Set channel's UDRND to U.UDR to assign an I.D. number to this report
Increment U.UDR for next signal report
Save onset and descriptor data about signal:
ZODR = U.ODR
ZCLS = U.CLS
ZOTM = U.OTM
HEADR
Set LINEN = 0 for onset line
Set onset data:
TPHAS = U.OFZ
ZOFZ = U.OFZ
TAMP = U.OAM
ZOAM = U.OAM
TDIUR = U.ODI
E.TM1, E.TM2 = U.OTB
ZOTB = U.OTB
LONGL
LONG ONSET LINE
Save signal class
ZCLS = U.CLS
U.CLS=3 ?
NO
YES
Set LINEN = 1 For first peak line
Set up first peak data:
TPHAS = W.LPK
TAMP = W.LAM
E.TM1, E.TM2 = W.LTM
SHRTL
SHORT FIRST PEAK LINE
Set LINEN = 2 For valley peak line
Set up valley peak data:
TPHAS = W.VPK
TAMP = W.VAM
E.TM1, E.TM2 = W.VTM
SHRTL
SHORT VALLEY PEAK LINE
PKOUT
Set LINEN = 3 for peak line
Set peak data:
TPHAS = W.PFZ
TAMP = W.PAM
ZPAM = W.PAM
E.TM1, E.TM2 = W.PTM
ZPTM = W.PTM
SHRTL
SHORT PEAK LINE
Set LINEN = 4 for valid (half rcvy ln
Set valid recovery data:
TPHAS = W.RFZ
ZRFZ = W.RFZ
TAMP = W.RAM
ZRAM = W.RAM
TDIUR = U.DIU
E.TM1, E.TM2 = W.RTM
ZRTM = W.RTM
LONGL
LONG VALID RECOVERY LINE
B1

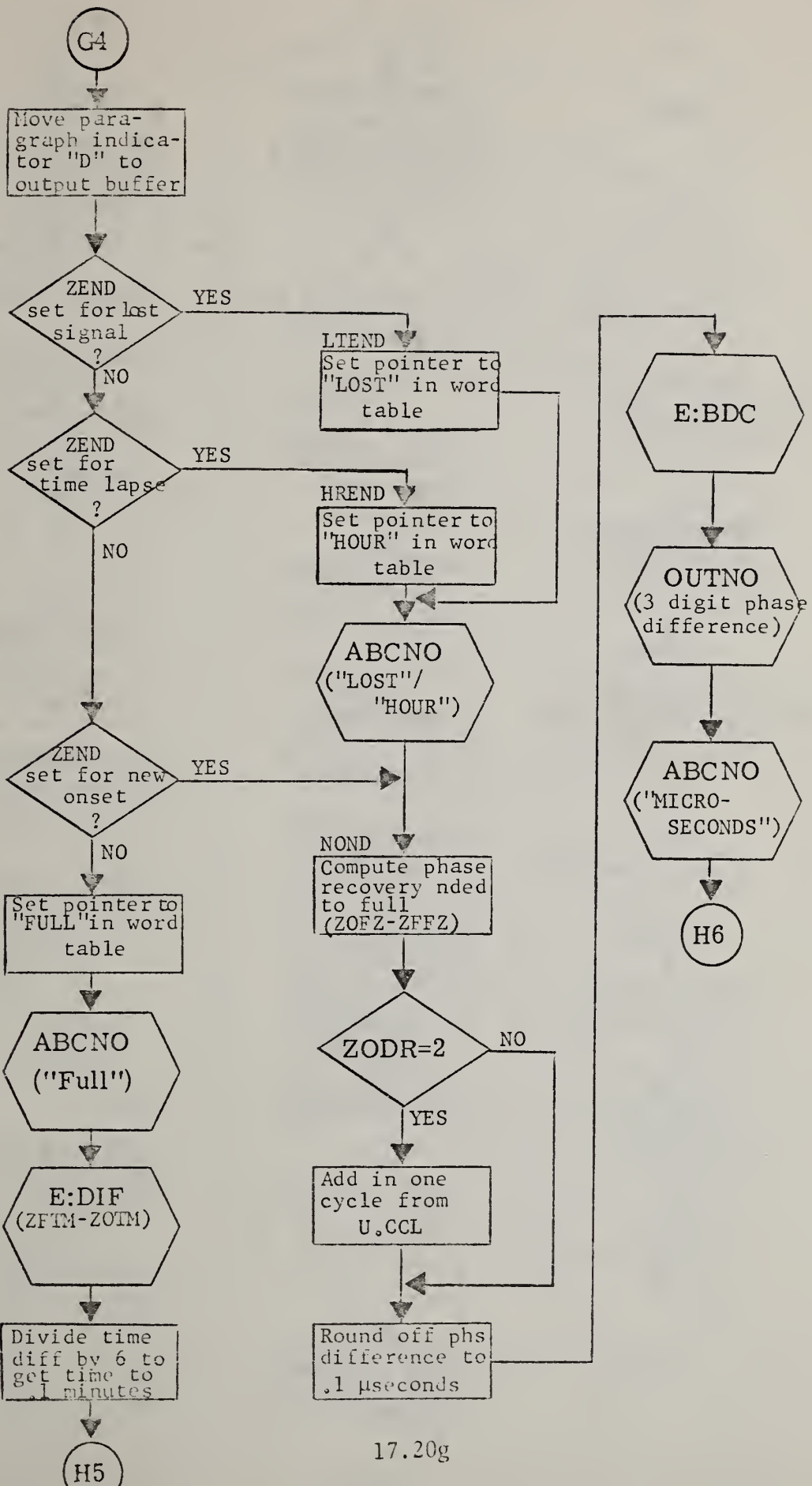

B1
Save Offset:
ZOST =
W. OST
E:FMF
Move output-formulated phase value to output buffer
Save onset rate:
ZONR=W.ONR
Convert onset rate to output format & store in output buffer
E:028
(in E$T28)
Offset & onset rate data
Restore registers to entry values
Subroutine Return

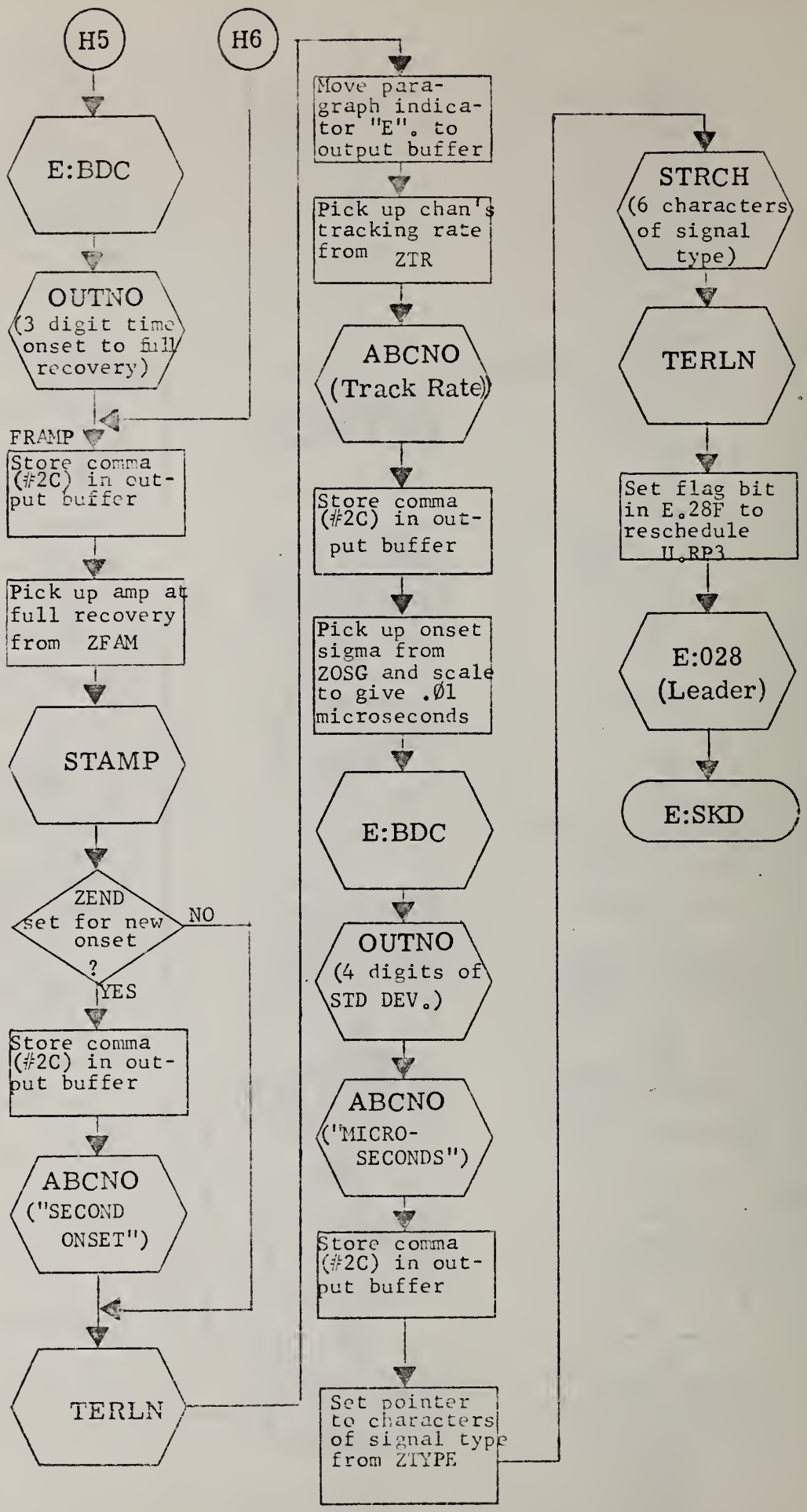

U:RP2
Save registers 1-7 in RPSV1 and registers 1Ø-15 in RPSV2
HEADR
Set LINEN=5 for full recovery line
Set full recovery data: TPHAS=U.LFZ ZFFZ=U.LFZ TAMP=U.AMP ZFAM=U.AMP TDIUR=U.DIV E.TM1,E.TM2=U.LIM ZFTM=U.LIM
LONGL Long Final Recovery Line
U.END set for lost sgnl ?
Yes
SGLST
Set pointer to signal lost message
No
U.END set for time lapse ?
Yes
TMLAP
Set pointer to time lapse message
No
U.END set for new onset ?
Yes
NUONS
Set pointer to new onset message
No
Set pointer to normal termination message
STRND
Move termination type msg to output buffer
Set flag bit in E.28F to schedule U.RPS in E$SKD when all output dn
E:028 (in E$T28) signal termi. type
Save term. type ZEND=U.END
Set chan's INPRG flag for report in progress
Restore registers to entry values
Subroutine Rtn

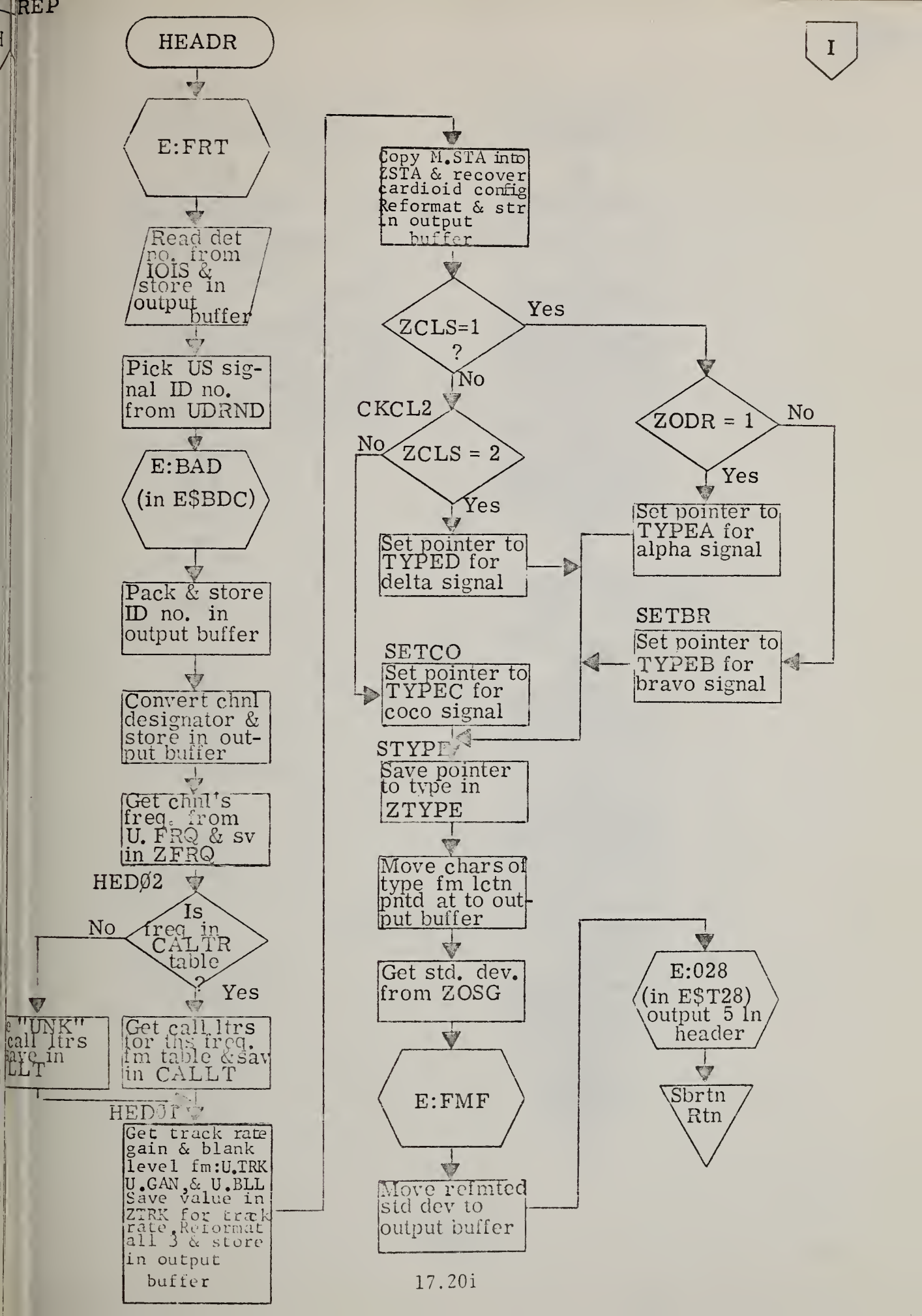

D
U:RP3
Reset channel pointer to Ø
Is INPRG flag set for chan ?
Yes
No
Move pointer to next chan
All Channels Done ?
No
Yes
E:028 (in E$T28) (LEADER)
E:SKD
RPØ1
Set reschedule request bit in E.28F
E:028 (in E$T28) (LEADER)
Clear INPRG flag for this channel
Pick up sgnl's I.D. number from UDRNO
E:BDC
OUTNO (3 digits)
Terminate Line
E:028 (RSD number)
Pickup signal class from ZCLS
ZCLS=2 ?
Yes
No
Set Class="B" in output buffer
Set Class="A" in output buffer
Store comma (#2C) in output buffer
Set pntr to sig type (Adr. of alphabetic chars of type) From ZTYPE
STRCH (6 character) Signal Type
Store comma (#2C) in output buffer
Set pntr to charac of channel's freq from ZFRQ
STRCH (4 Char freq)
E2

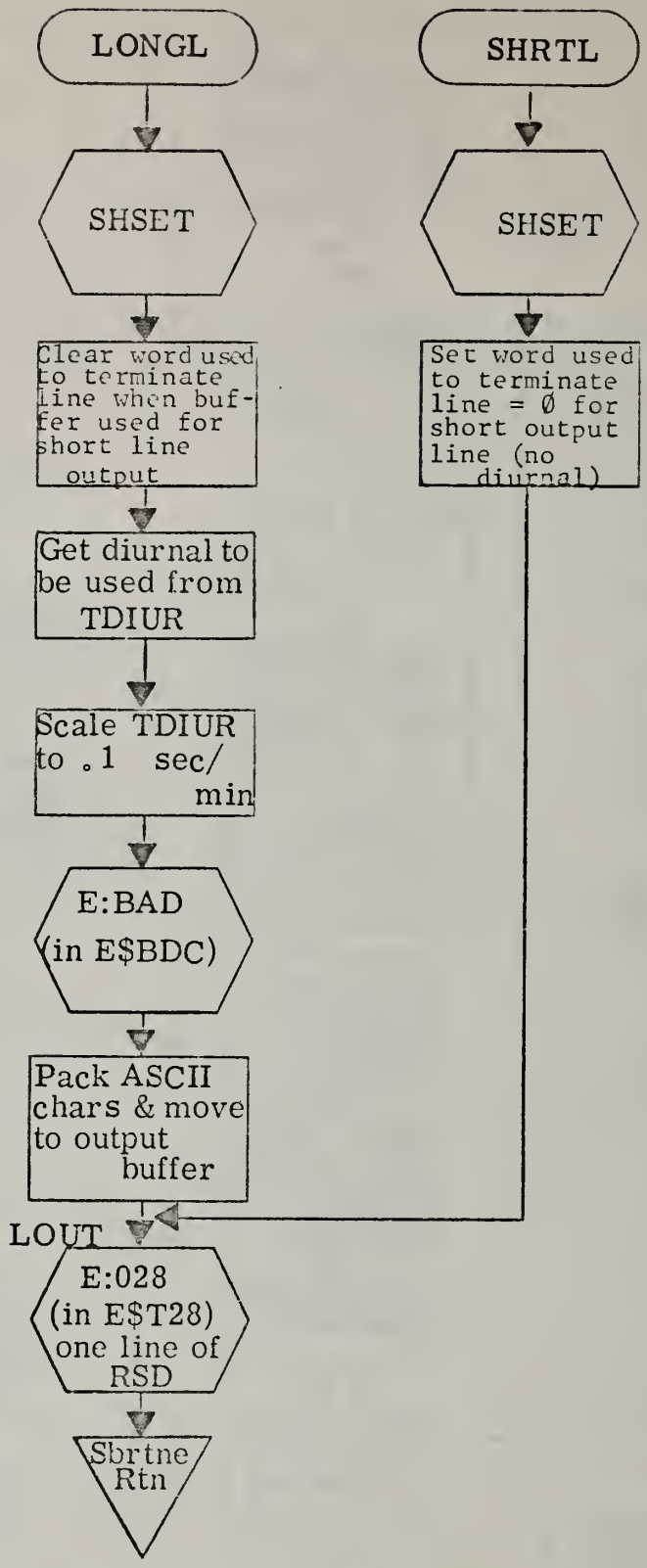

E
E2
Set pointer to chara of chnls call letters from CALLT
STRCH (4 char call letters)
Store comma (#2C) in output buffer
Cardioid bit in ZSTA set for back path
Yes
Set pointer to "BACK" word in table
Set pointer to "FRONT" word in table
ABCNO ("FRONT"/ "BACK")
Store comma (#2C) in output buffer
Pick up day of year from U.CTM
ABCNO (3 times for 3 digits of DOY)
TERLN
Set first paragraph flag "A" in output buffer
Get onset time from ZOTB
ABCNO (6 times for 6 digits of time)
Store comma (#2C) in output buffer
Get offset fm ZOST & round off to μsec
E:BDC
OUTNO (3 digit offset)
Store comma (#2C) in output buffer
ZODR = 2 ?
Yes
No
Set pointer to "RETARD" word in table
Set pointer to "ADVANCE" word in table
F3

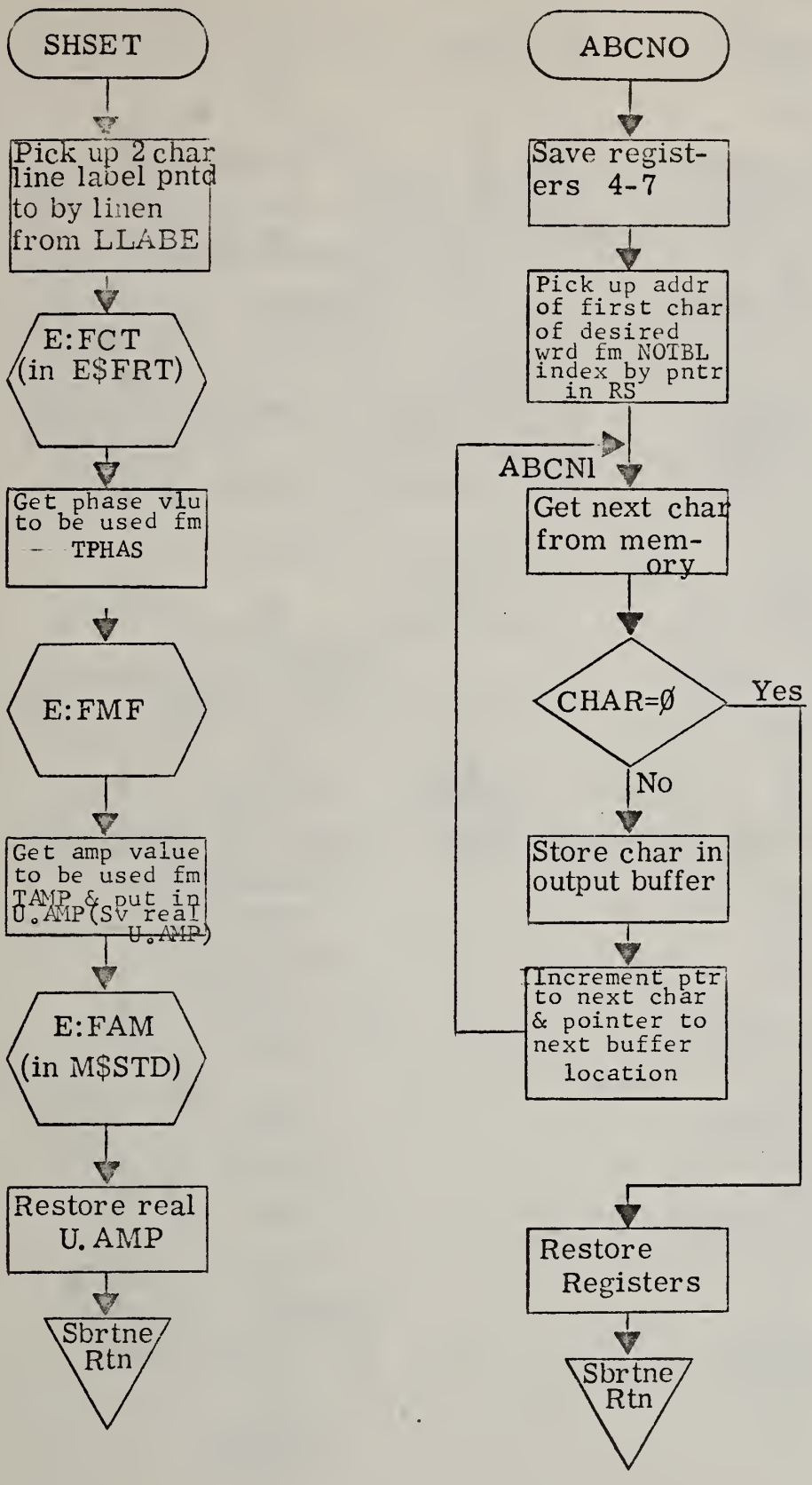

F3
ABCNO ("ADVANCE"/ "RETARD")
NXTLN
Get onset rate from ZONR & round off to nearest µsec
E:BDC
OUTNO (3 digit onset rate)
Store comma (#2C) in output buffer
Get onset amp from ZOAM
STAMP
TERLN
Move paragraph indicator "B." to output bfr
ABCNO ("Peak")
E:DIF (ZPTM-ZOTM)
Divide time diff by 6 to get time to .1 minutes
E:BDC
OUTNO (3 digit time onset to peak)
Store comma (#2C) in output buffer
Get peak's amp from ZPAM
STAMP
TERLN
Move prgph indicator "C." to output buffer
ABCNO (!Half")
E:DIF (ZRTM-ZOTM)
Divide time diff by 6 to get time to .1 minutes
E:BDC
OUTNO (3 digit time onset to valid rcvy)
Store comma (#2C) in output buffer
Get amp at valid rcvry from ZRAM
STAMP
TERLN
G4
F

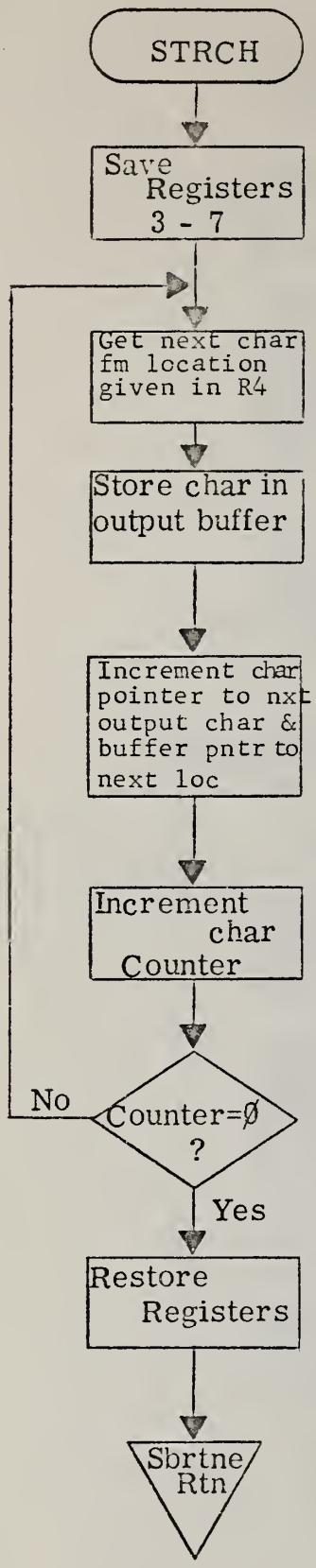

G4
Move paragraph indicator "D" to output buffer
ZEND set for lost signal ?
YES
NO
LTEND
Set pointer to "LOST" in word table
ZEND set for time lapse ?
YES
NO
HREND
Set pointer to "HOUR" in word table
ABCNO ("LOST"/ "HOUR")
ZEND set for new onset ?
YES
NO
NOND
Compute phase recovery nded to full (ZOFZ-ZFFZ)
Set pointer to "FULL" in word table
ABCNO ("Full")
ZODR=2
NO
YES
E:DIF (ZFTM-ZOTM)
Add in one cycle from U.CCL
Divide time diff by 6 to get time to .1 minutes
Round off phs difference to .1 μseconds
H5
E:BDC
OUTNO (3 digit phase difference)
ABCNO ("MICRO-SECONDS")
H6

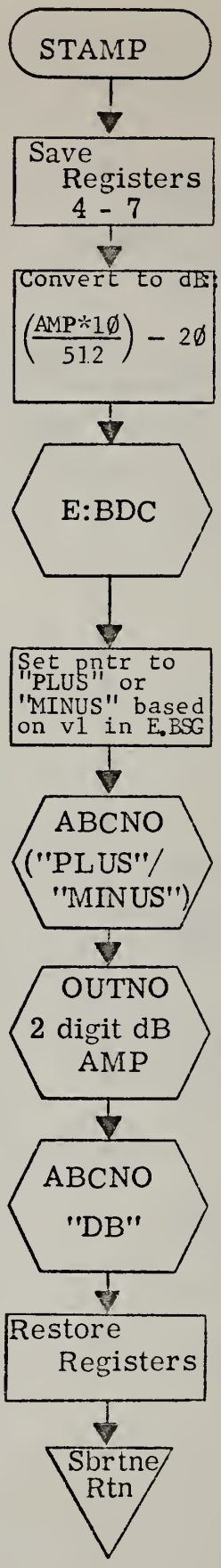

H5
H6
H
E:BDC
OUTNO
(3 digit time onset to full recovery)
FRAMP
Store comma (#2C) in output buffer
Pick up amp at full recovery from ZFAM
STAMP
ZEND set for new onset ?
NO
YES
Store comma (#2C) in output buffer
ABCNO ("SECOND ONSET")
TERLN
Move paragraph indicator "E". to output buffer
Pick up chan's tracking rate from ZTR
ABCNO (Track Rate)
Store comma (#2C) in output buffer
Pick up onset sigma from ZOSG and scale to give .Ø1 microseconds
E:BDC
OUTNO
(4 digits of STD DEV.)
ABCNO ("MICRO-SECONDS")
Store comma (#2C) in output buffer
Set pointer to characters of signal type from ZTYPE
STRCH
(6 characters of signal type)
TERLN
Set flag bit in E.28F to reschedule U.RP3
E:028
(Leader)
E:SKD


HEADR
I
E:FRT
Read det no. from IOIS & store in output buffer
Pick US signal ID no. from UDRND
E:BAD (in E$BDC)
Pack & store ID no. in output buffer
Convert chnl designator & store in output buffer
Get chnl's freq. from U.FRQ & sv in ZFRQ
HEDØ2
Is freq in CALTR table ?
No
Yes
"UNK" call ltrs save in LLT
Get call ltrs for this freq. fm table & sav in CALLT
HEDØ1
Get track rate gain & blank level fm:U.TRK U.GAN,& U.BLL Save value in ZTRK for track rate, Reformat all 3 & store in output buffer
Copy M.STA into ZSTA & recover cardioid config Reformat & str in output buffer
ZCLS=1 ?
Yes
No
CKCL2
ZCLS = 2
No
Yes
Set pointer to TYPED for delta signal
ZODR = 1
No
Yes
Set pointer to TYPEA for alpha signal
SETBR
Set pointer to TYPEB for bravo signal
SETCO
Set pointer to TYPEC for coco signal
STYPE
Save pointer to type in ZTYPE
Move chars of type fm lctn pntd at to output buffer
Get std. dev. from ZOSG
E:FMF
Move refmted std dev to output buffer
E:028 (in E$T28) output 5 ln header
Sbrtn Rtn

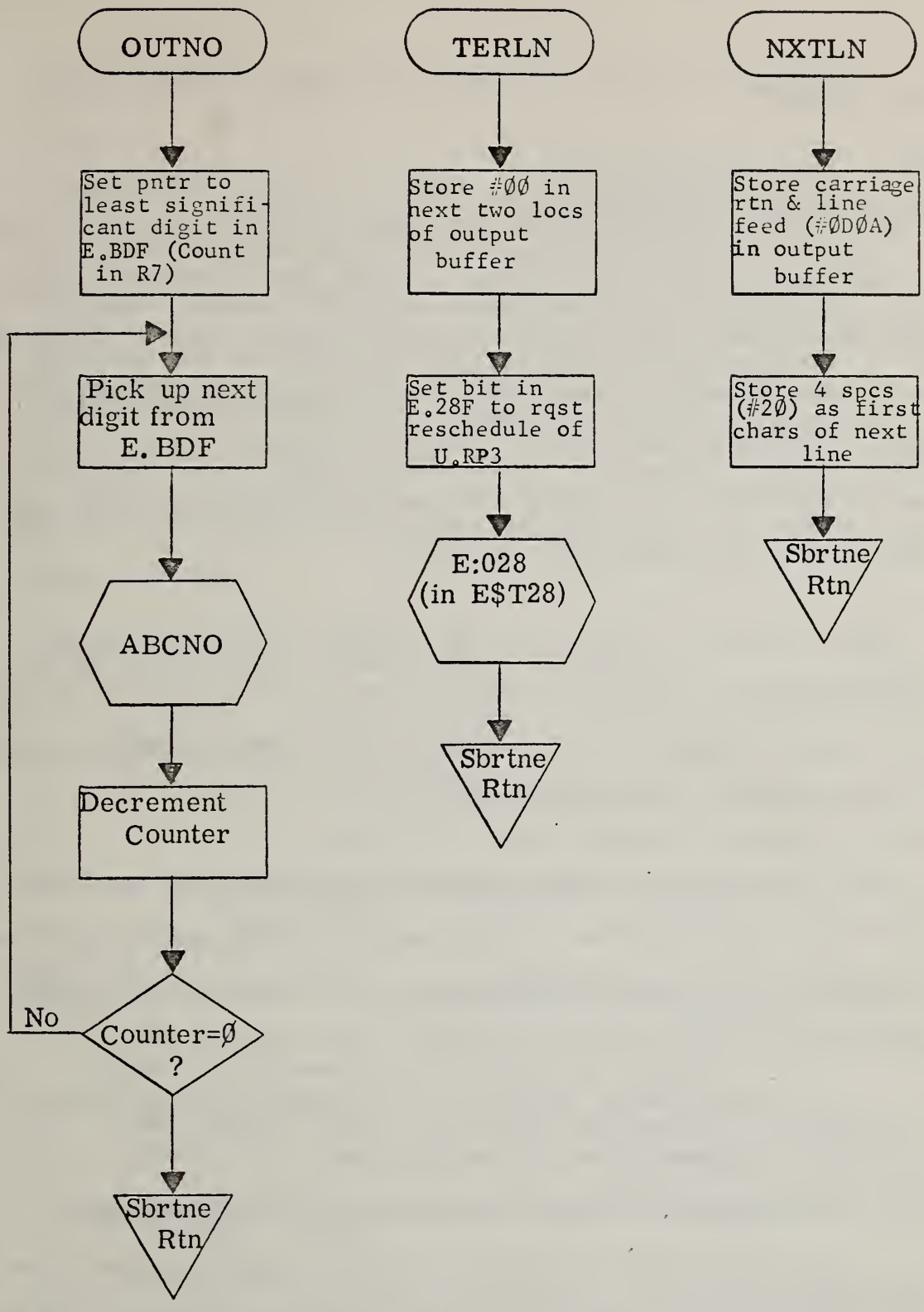

LONGL
SHRTL
SHSET
SHSET
Clear word used to terminate line when buffer used for short line output
Set word used to terminate line = Ø for short output line (no diurnal)
Get diurnal to be used from TDIUR
Scale TDIUR to .1 sec/min
E:BAD (in E$BDC)
Pack ASCII chars & move to output buffer
LOUT
E:028 (in E$T28) one line of RSD
Sbrtne Rtn


SHSET
Pick up 2 char line label pntd to by linen from LLABE
E:FCT (in E$FRT)
Get phase vlu to be used fm TPHAS
E:FMF
Get amp value to be used fm TAMP & put in U.AMP(SV real U.AMP)
E:FAM (in M$STD)
Restore real U.AMP
Sbrtne Rtn
ABCNO
Save registers 4-7
Pick up addr of first char of desired wrd fm NOTBL index by pntr in RS
ABCN1
Get next char from memory
CHAR=Ø
Yes
No
Store char in output buffer
Increment ptr to next char & pointer to next buffer location
Restore Registers
Sbrtne Rtn


STRCH
Save Registers 3 - 7
Get next char fm location given in R4
Store char in output buffer
Increment char pointer to nxt output char & buffer pntr to next loc
Increment char Counter
No
Counter=Ø ?
Yes
Restore Registers
Sbrtne Rtn


STAMP
Save Registers 4 - 7
Convert to dB: (AMP*1Ø/512) - 2Ø
E:BDC
Set pntr to "PLUS" or "MINUS" based on v1 in E.BSG
ABCNO ("PLUS"/ "MINUS")
OUTNO 2 digit dB AMP
ABCNO "DB"
Restore Registers
Sbrtne Rtn

M


OUTNO
Set pntr to least significant digit in E.BDF (Count in R7)
Pick up next digit from E.BDF
ABCNO
Decrement Counter
No
Counter=Ø ?
Sbrtne Rtn
TERLN
Store #ØØ in next two locs of output buffer
Set bit in E.28F to rqst reschedule of U.RP3
E:028 (in E$T28)
Sbrtne Rtn
NXTLN
Store carriage rtn & line feed (#ØDØA) in output buffer
Store 4 spcs (#2Ø) as first chars of next line
Sbrtne Rtn

18. U$RED

18.1 Functional Description

As NUSTAD is designed to run unattended for extended periods of time, and the system mission requires that reliable data be maintained on at least the highest priority channels, several sensor channels may be tuned to the same frequency to supply back-up coverage of the high priority paths. U$RED determines whether those sensor channels tuned to the same frequencies are arriving at the same processing results and logs those cases where channels fail to do so.

U$RED is entered at U:RED from the scheduler. This task may be scheduled either by E:MIN at a regular interval, or by E:OMI in response to an operator request (the CRC: input option). When completed, control is returned to the system scheduler at E:SKD.

U:RED first pairs all sensor channels which monitor the same paths. Where three channels monitor the same path, the three possible pairs are all detected. Two channels are considered to be monitoring the same path if:

a. Neither sensor channel has its processing inhibited; i.e., neither has a Maintenance or INE condition set.

b. Both sensor channels are tuned to the same frequency.

c. If both sensor channels are using a cardioid pattern, the FRONT/BACK directional selection is the same for both. If both are not

using a cardioid pattern, they will be considered to be in the same direction.

When a pair of sensor channels are encountered monitoring the same path, the processing results for those channels will be compared. If the results compare favorably, the channel pair will have passed the redundacy test successfully. If all pairs test successfully, a "T RS" (Total system Redundancy test Successful) message is entered into the station log. Where some pair fails, a message is generated indicating the sensor channels add the reason for the failure. The format for that message is:

DDD TTTTT RED FAILURE CHAND, C AND C ON LEVEL N

where: D is a digit of DOY

T is a digit of TOD

C is a character of sensor channel designation (A through N)

N is a digit indicating where the test failed, interpreted as follows:

LEVEL	REASON
1	The channel status, determined by the amplitude characteristics, is not the same for both channels. (U.CST)
2	The analysis status, indicating the progress in waveform processing, is not the same for both channels. (U.AST)
3	The short term noise characteristics are not the same on both channels. (U.TRK)
4	The long term trend characteristics are not the same on both channels. (U.DIU)

If no pair of channels monitoring the same path are encountered, no message is generated.

The tests conducted on the channel pairs include:

a. Channel Status. The pair passes this test only if both values of U.CST are the same.

b. Analysis Status. The pair passes this test only if both values of U.AST are the same.

c. Short Term Noise Characteristics. Since the tracking rate is adjusted on the basis of the signal standard deviation, the use of the tracking rate settings as a basis for this test is deemed reasonable. Since monir variations in the sensor itself can produce slight differences, identical settings will not be required. Therefore, the pair will pass this test if the tracking rates (U.TRK) for the two channels are within three settings of one another.

d. Long Term Trend Characteristics. Again, minor variations in the sensors will cause some differences in these estimates. The pair will pass this test if the diurnal slope estimates (U.DIU) are within .1Ø15625 microseconds/minute of one another.

18.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:SKD	E$SKD	System scheduler reentry point.
E:028	E$T28	Translates output message to BAUDOT code and stores in output buffer before transmission to ASR 28.
E:LOG	E$LOG	Generates coded log message for ASR 28.
E:FRT	E$FRT	Reformats BCD time from the WTC to ACCII for output.

18.3 Input Parameter Descriptions

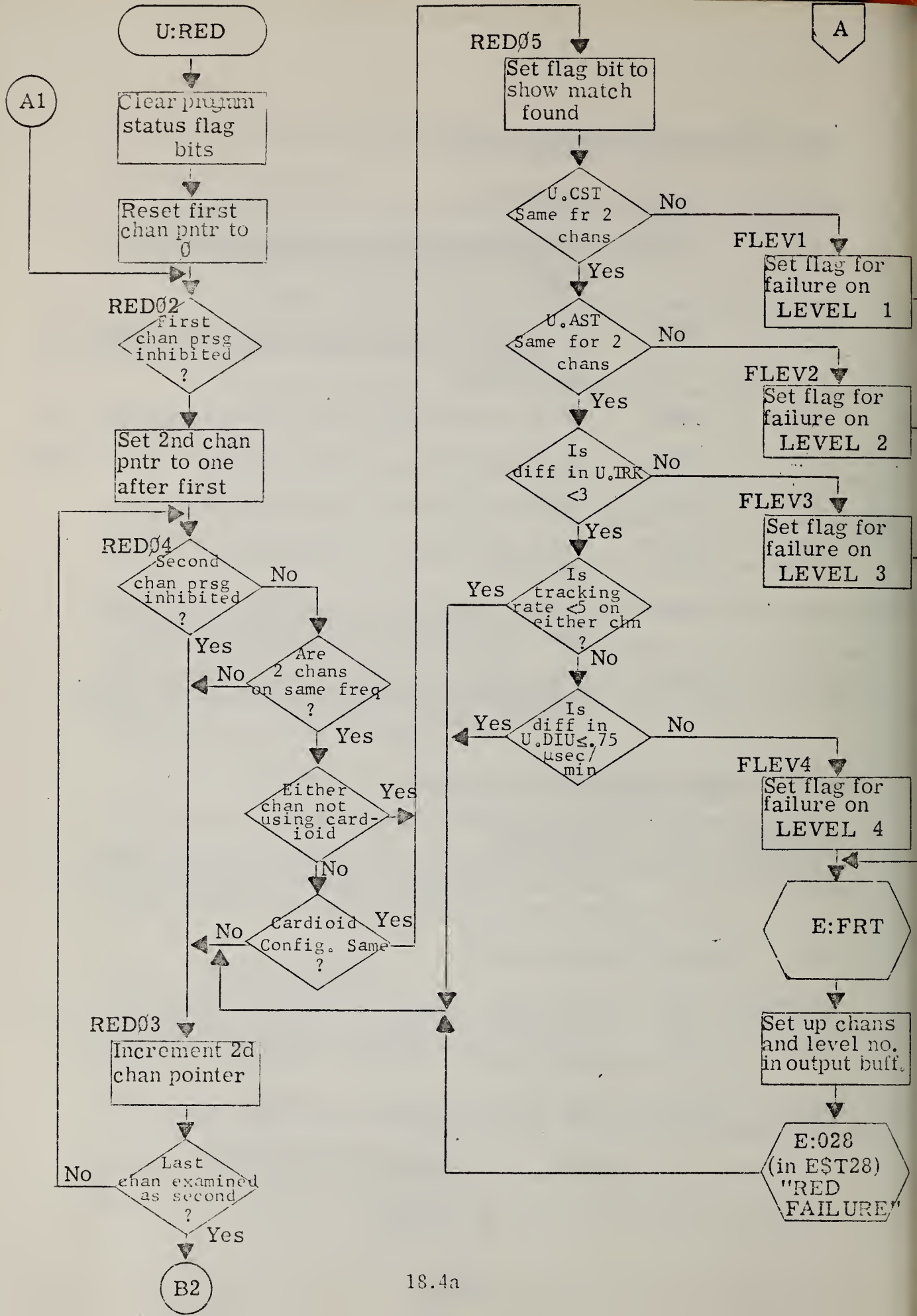
PARAMETER	PROGRAM	DESCRIPTION
U.CST	U$DAT	The channel's processing status, based on the results of the amplitude monitoring section of U:RTA.
U.AST	U$DAT	The channel's waveform analysis status, determined by the point in the signal to which processing has progressed.
U.TRK	U$DAT	Current settings for sensor channel tracking rates.
U.DIU	U$DAT	The diurnal slope, or long term data trend, estimate.
E.28F	E$T28	Parameter word used in calling E:028.
U.FRQ	E$LOG	The current settings of the sensor frequency switches.
U.IHB	U$DAT	Flag bit set to inhibit processing on a channel when a Maintenance or INE condition exists.
M.STA	M$ESC	IOIS digital input word with frequency, INE, Maintenance, Auto/Manual, and Cardioid settings for each channel.

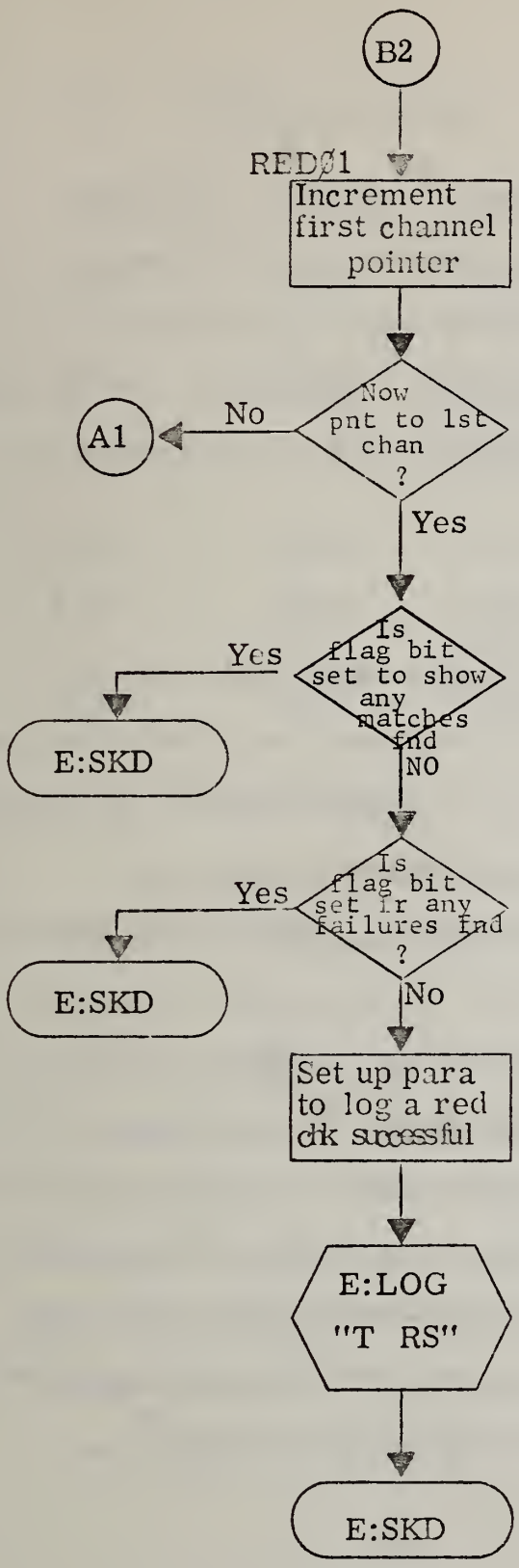
18.4 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
U:RED		Entry point for channel redundancy checking routine.

18.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
FMSG	27	"123 123456 RED FAILURE, CHANS A AND B ON LEVEL 1" message text.
FLAG	1	Flag word for status of U:RED processing: Bit Ø = 1 if failures have been found. Bit 1 = 1 if sensor channel pairs monitoring same path found.


U:RED
A1
Clear program status flag bits
Reset first chan pntr to 0
RED02
First chan prsg inhibited ?
Set 2nd chan pntr to one after first
RED04
Second chan prsg inhibited ?
No
Yes
Are 2 chans on same freq ?
No
Yes
Either chan not using cardioid
Yes
No
Cardioid Config. Same ?
No
Yes
RED03
Increment 2d chan pointer
Last chan examined as second ?
No
Yes
B2
RED05
Set flag bit to show match found
U.CST Same fr 2 chans
No
Yes
FLEV1
Set flag for failure on LEVEL 1
U.AST Same for 2 chans
No
Yes
FLEV2
Set flag for failure on LEVEL 2
Is diff in U.IRK <3
No
Yes
FLEV3
Set flag for failure on LEVEL 3
Is tracking rate <5 on either chn ?
Yes
No
Is diff in U.DIU≤.75 µsec/min
Yes
No
FLEV4
Set flag for failure on LEVEL 4
E:FRT
Set up chans and level no. in output buff.
E:028 (in E$T28) "RED FAILURE"
A


B2
RED01
Increment first channel pointer
Now pnt to 1st chan ?
No
A1
Yes
Is flag bit set to show any matches fnd
Yes
E:SKD
NO
Is flag bit set fr any failures fnd ?
Yes
E:SKD
No
Set up para to log a red clk successful
E:LOG "T RS"
E:SKD

19. U$PST

19.1 Functional Description

This program allows the operator to make changes to the sensor tracking rate, gain, and blanking level by typing the desired value with a keyword identifier and sensor channel information on the ASR 35 teletype. NUSTAD responds by either carrying out the desired task or explaining why it couldn't.

19.1.1 U:PST

U:PST is entered from the system scheduler when E:OMI identifies an operator keyword designation of OPC: and serves two primary functions:

a. A link between NUSTAD and the operator used to pass parameter values to the sensor channels.

b. Text editing to prevent improper parameter values from being transmitted.

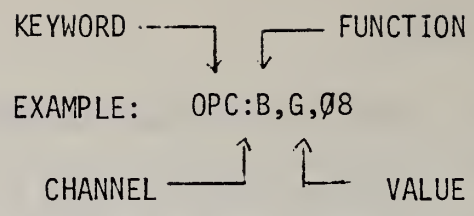
Parameter change messages are fixed format as explained in Section 19.3 and are passed via the ASR 35 and NUSTAD to the sensor channels. Prior to any change being made, a check (MAYI) is made on the affected channel to determine if a signal is in progress. If a signal is in progress, a message is output explaining that no change can be made at that time. Once a change is made, control is returned to NUSTAD and the operator must reinitiate the calling sequence to make additional changes.

19.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:035	E$T35	Transfer output message to buffer before transmission to the ASR 35.
U:CNI	U$RTA	Entry point for routine to determine whether a signal is in progress for granting permission to make sensor parameter setting adjustments (see Section 12.1.2).
E:SKD	E$SKD	System scheduler entry point.
E:MIT	E$UIN	Transmits GAIN, TRACKING RATE, and BLANKING LEVEL values to sensor channel given in R3.
E:LOG	E$LOG	Generate coded log message for ASR 28.

19.3 Data Formats

The operator calling sequence used in this program includes the keyword OPC: followed by the channel designation, function code, and parameter values desired. The channel designations are the letters A, B, C, through N, and correspond to the fourteen sensor channels. A single letter is used to denote the function desired, B for BLANKING LEVEL change, G for GAIN chainge, and T for TRACKING RATE change. Each of these functions have an upper and a lower limit to the value that can be requested; BLANKING level ranges from ØØ through 63, GAIN from ØØ through 24, and TRACKING RATE from ØØ through Ø9. The request should take the form of the following example:



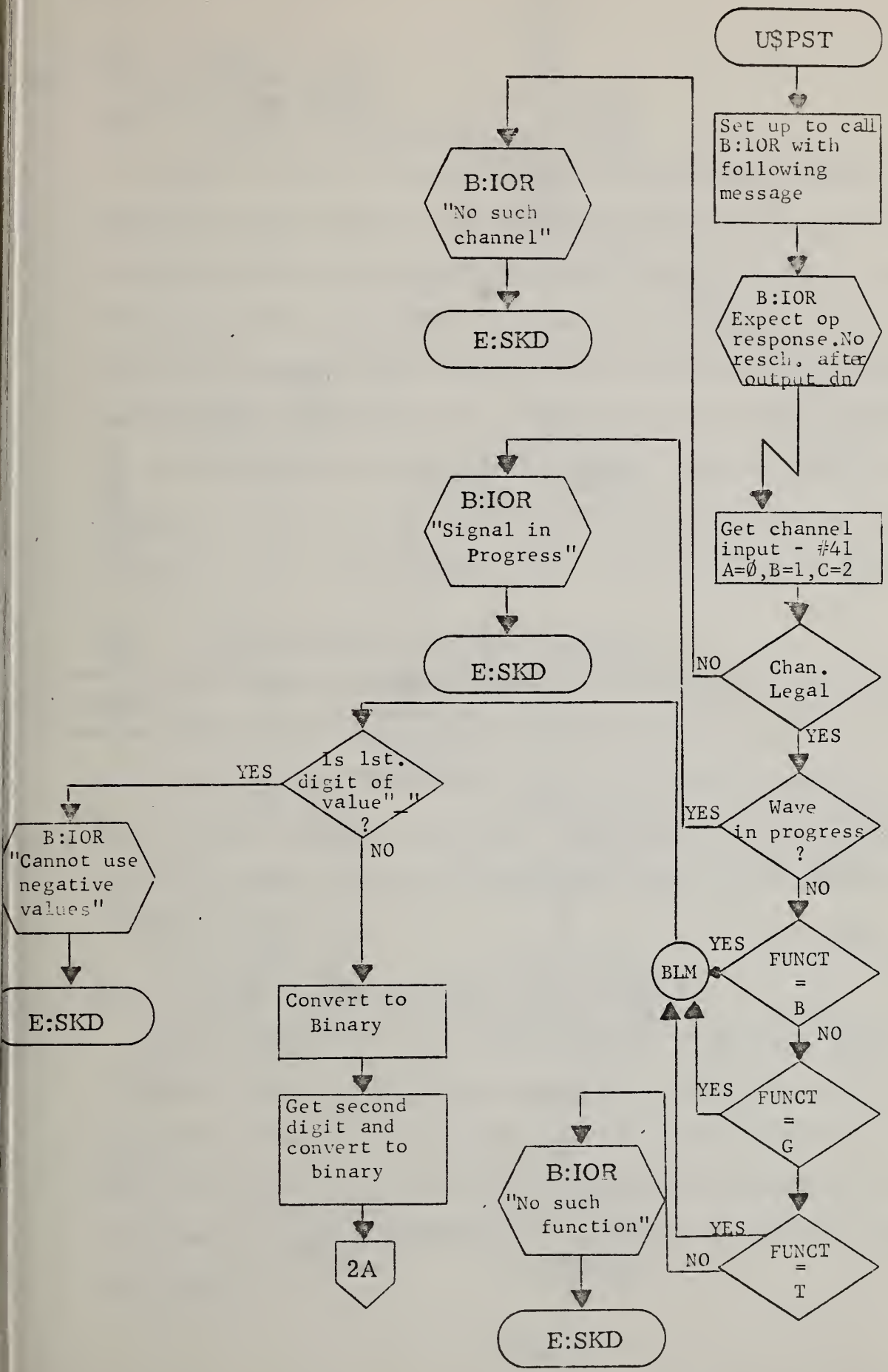
The request should be followed by a carriage return.

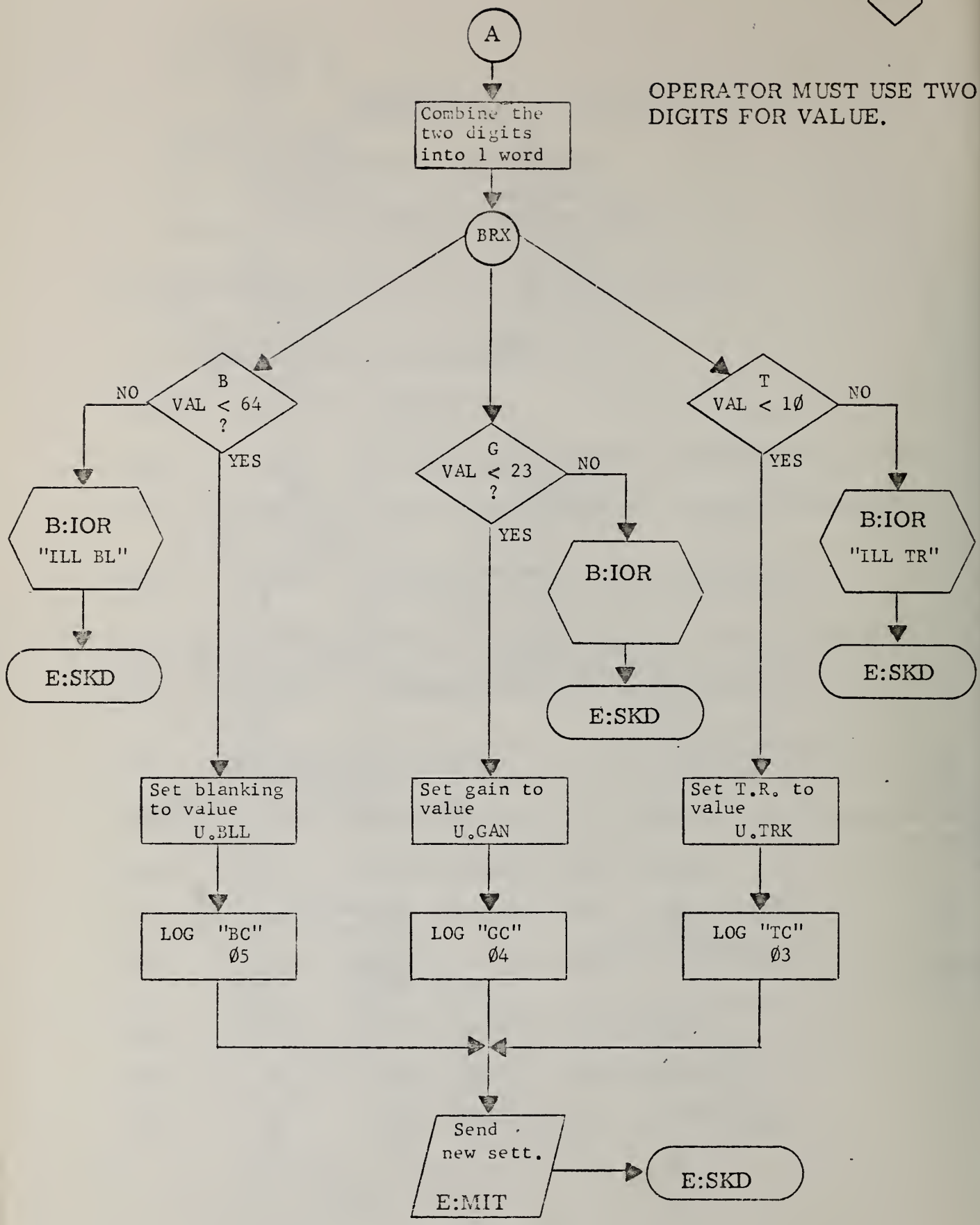
19.4 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
U.GAN	U$DAT	Current sensor RF GAIN setting (see Chapter 16).
U.TRK	U$DAT	Current sensor TRACK RATE setting (see Chapter 16).
U.BLL	U$DAT	Current sensor BLANKING LEVEL setting (see Chapter 16).
E.35I	E$T35	Address of first character of input from ASR 35.
E.IOF	E$T35	Parameter word used in calling E$T35.

19.5 Internal Data Description

PARAMETER	SIZE	DESCRIPTION
ILLCH	11	"INVALID CHANNEL" output message.
ILLVL	15	"VALUE NOT WITHIN LIMITS" output message.
NOPAR	23	"NO PARM. CHANGE PERMITTED, SIG. IN PROG." output message.
ILFUN	11	"INVALID FUNCTION" output message.
INFMT	1Ø	"INVALID FORMAT" output message.
ILVAL	14	"CANNOT USE NEG. VALUES" output message.


U$PST
Set up to call B:IOR with following message
B:IOR Expect op response.No resch. after output dn
Get channel input - #41 A=Ø,B=1,C=2
Chan. Legal
NO
YES
Wave in progress ?
YES
NO
FUNCT = B
YES
NO
FUNCT = G
YES
NO
FUNCT = T
YES
BLM
B:IOR "No such channel"
E:SKD
B:IOR "Signal in Progress"
E:SKD
Is lst. digit of value " _ " ?
YES
NO
B:IOR "Cannot use negative values"
E:SKD
Convert to Binary
Get second digit and convert to binary
2A
B:IOR "No such function"
E:SKD



OPERATOR MUST USE TWO DIGITS FOR VALUE.

2Ø. M$ESC

2Ø.1 Functional Description

NUSTAD monitors the hardware status of the sensor and ADACS interface through digital information transmitted from these devices to the processor via the IOIS digital input. Specifically, the sensor frequency setting, the cardioid configuration, the position of the maintenance and auto/manual switches, and the status of the INE check are made available to the system through fourteen words, one per sensor channel, of the digital input portion of the IOIS. When any of these values change, the level three user defined external interrupt of the IOIS, referred to as the INE interrupt, vectors control to M:INT of M$ESC.

2Ø.1.1 M:INT (INE Interrupt Service Routine)

An INE interrupt vectors control to M:INT when any of the information in the digital status words in the first fourteen channels of the digital IOIS changes. M:INT then sets a five second delay timer (M.TM1) in E:SEC when the timer reaches zero, E:SEC flags M:ESC in the system scheduler. After starting the delay timer, M:INT returns control to the interrupted program.

2Ø.1.2 M:ESC (Equipment Status Change Monitor).

M:ESC is entered from the system scheduler to determine the cause of the INE interrupt and to react accordingly. The previous values for the digital status words are stored in M.STA (known internally as SVWRD). Channel by channel, the current values are read and compared with the old values. The following actions are taken when the various parameters have changed:

a. Auto/Manual bit changed. An "AU" message is generated for the station log if the change is to the Automatic position, or a "MN" message if the change is to the Manual position.

b. Maintenance bit changed. A "MS" or "MR" message is generated for the station log to indicate whether the maintenance switch had been set or reset, respectively. If the sensor channel has been put into maintenance, the inhibit bit (U.IHB) is set to cease processing on that sensor channel, and the channel is put DOWN. If the channel has been brought out of maintenance, and the INE condition is not set, the inhibit bit is cleared and the processing parameters for that channel are reinitialized to permit the channel to restart.

c. INE bit changed. An "IS" or "IR" message is generated for the station log to indicate whether the maintenance switch had been set or reset, respectively. If the sensor channel is going into the INE condition, the inhibit bit (U.IHB) is set to terminate processing on that sensor channel, and the channel is put DOWN. The INE condition refers to a state of Invalid data, Equipment sensed; i.e., detection circuits in the sensor and ADACS interface indicate a hardware condition which invalidates the data. When coming out of the INE condition, and the maintenance switch is not set, the inhibit bit is cleared and the processing parameters for that channel are reinitialized to permit the channel to restart.

d. Cardioid configuration changed. The one digit code for the new configuration is logged in a "CC" message on the ASR 28.

e. Frequency changed. The new frequency setting is logged on the ASR 28 with a "FC" message. The sensor channel is put DOWN, and the processing parameters are reinitialized to permit the channel to come up on the frequency.

When all channels have been checked and all changes logged, control is returned to the system scheduler at E:SKD.

20.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:SKD	E$SKD	System scheduler reentry point.
E:LOG	E$LOG	Generates coded log messages for the ASR 28.

20.3 Data Formats

20.3.1 Digital Input From IOIS

The first fourteen words of digital input from the IOIS supply the status data on the equipment condition. The format for these inputs, one word per sensor channel, is:

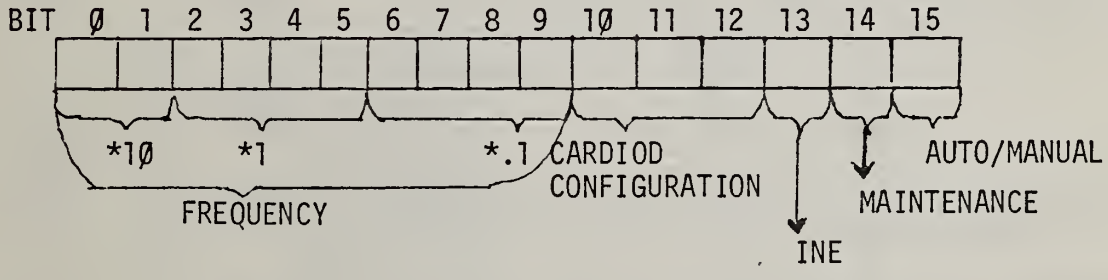


Figure 20.1 Digital IOIS Input Data Format

The frequency readings are input in 9's complement. The individual digits may be interpreted as follows:

TENS DIGIT		UNITS AND TENTHS DIGITS	
INPUT VALUE	ACTUAL VALUE	INPUT VALUE	ACTUAL VALUE
Ø 1	Ø	1 Ø Ø 1	Ø
Ø Ø	1	1 Ø Ø Ø	1
1 1	2	Ø 1 1 1	2
1 Ø	3	Ø 1 1 Ø	3
		Ø 1 Ø 1	4
		Ø 1 Ø Ø	5
		Ø Ø 1 1	6
		Ø Ø 1 Ø	7
		Ø Ø Ø 1	8
		Ø Ø Ø Ø	9

Table 2Ø.1 Frequency Value Interpretation

The value which is actually read into the processor is the ones complement of all bits except bits 14 and 15. M:ESC first complements bits Ø through 13. The cardioid configuration is interpreted as follows:

VALUE	CONFIGURATION
Ø	LOOP/WHIP NORMAL
1	LOOP NORMAL
2	WHIP NORMAL
4	LOOP/WHIP REVERSE
5	LOOP REVERSE
6	WHIP REVERSE
7	NO CARDIOID USED

Table 2Ø.2 Cardioid Configuration Interpretation

Bits 13, 14, and 15 are interpreted as follows:

Bit 13 = Ø INE condition is RESET
= 1 INE condition is SET, processing is inhibited.

Bit 14 = Ø Maintenance condition is RESET.
= 1 Maintenance condition is SET, processing is inhibited.

Bit 15 = Ø Sensor channel is operating in AUTO mode.
= 1 Sensor channel is operating in MANUAL mode.

2Ø.4 Input Parameter Descriptions

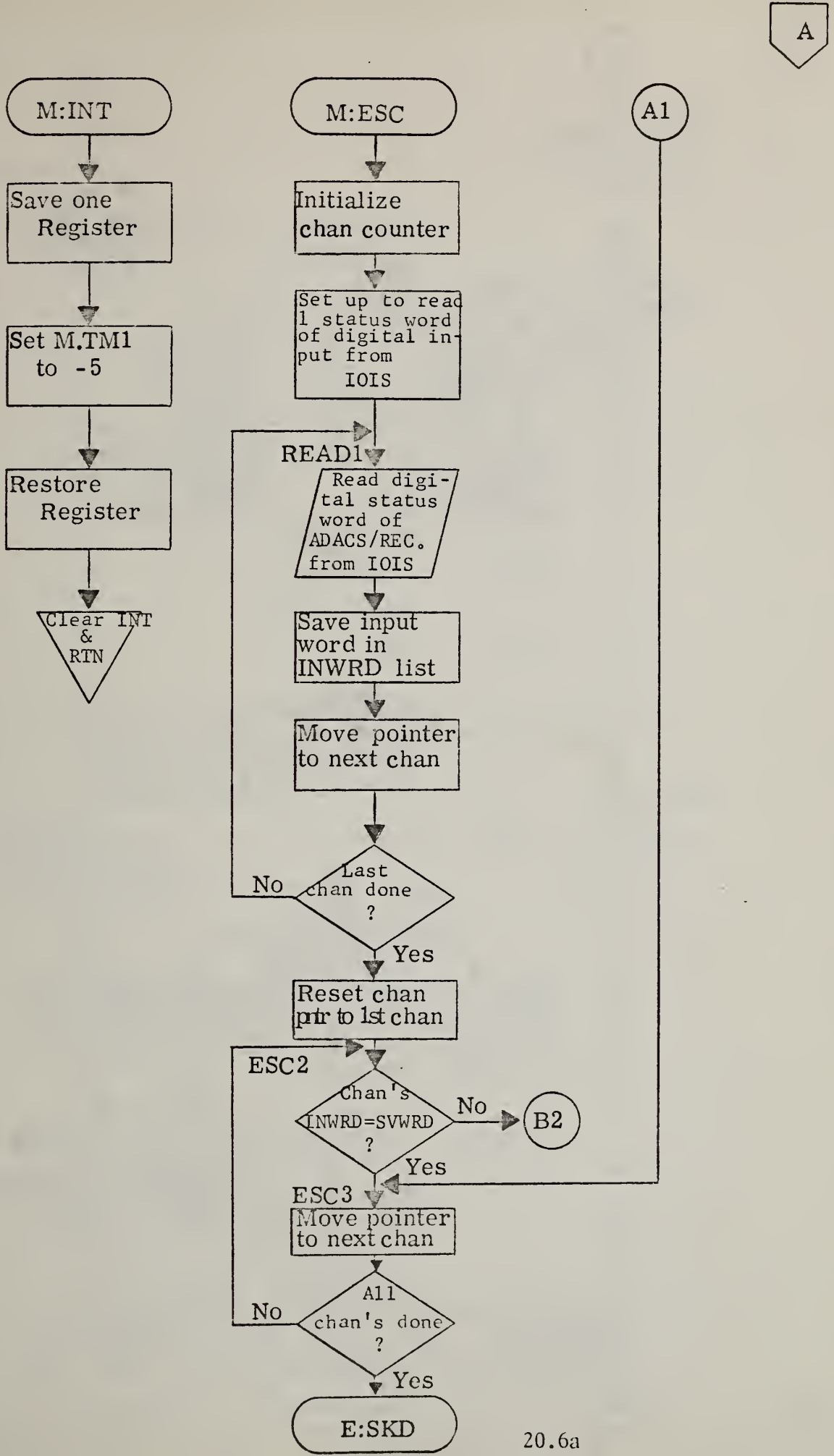
PARAMETER	PROGRAM	DESCRIPTION
U.IHB	U$DAT	Flag bit set to inhibit processing on a sensor channel if the INE or Maintenance bits are set.
U.CST	U$DAT	The channel's processing status, based on the results of the amplitude monitoring section of U:RTA.
U.RTY	U$DAT	Counter for consecutive ten-second intervals of "good" data required to bring a channel to the UP state.
U.END	U$DAT	Flag to indicate how processing terminated on signal just completed.
U.CLS	U$DAT	The class of the waveform being processed, based on the set of criteria met.
U.TRF	U$TGR	Flag to indicate the status of the trigger detection program based on the progress of the triggering sequence.
U.OTM	U$DAT	Signal onset time, binary format.
U.CCN	U$DAT	Accumulated sum of U.CYC to indicate the total effect of cycle shifts induced by NUSTAD.
U.TRL	U$TGR	The count of compressed data points required to trigger waveform analysis.

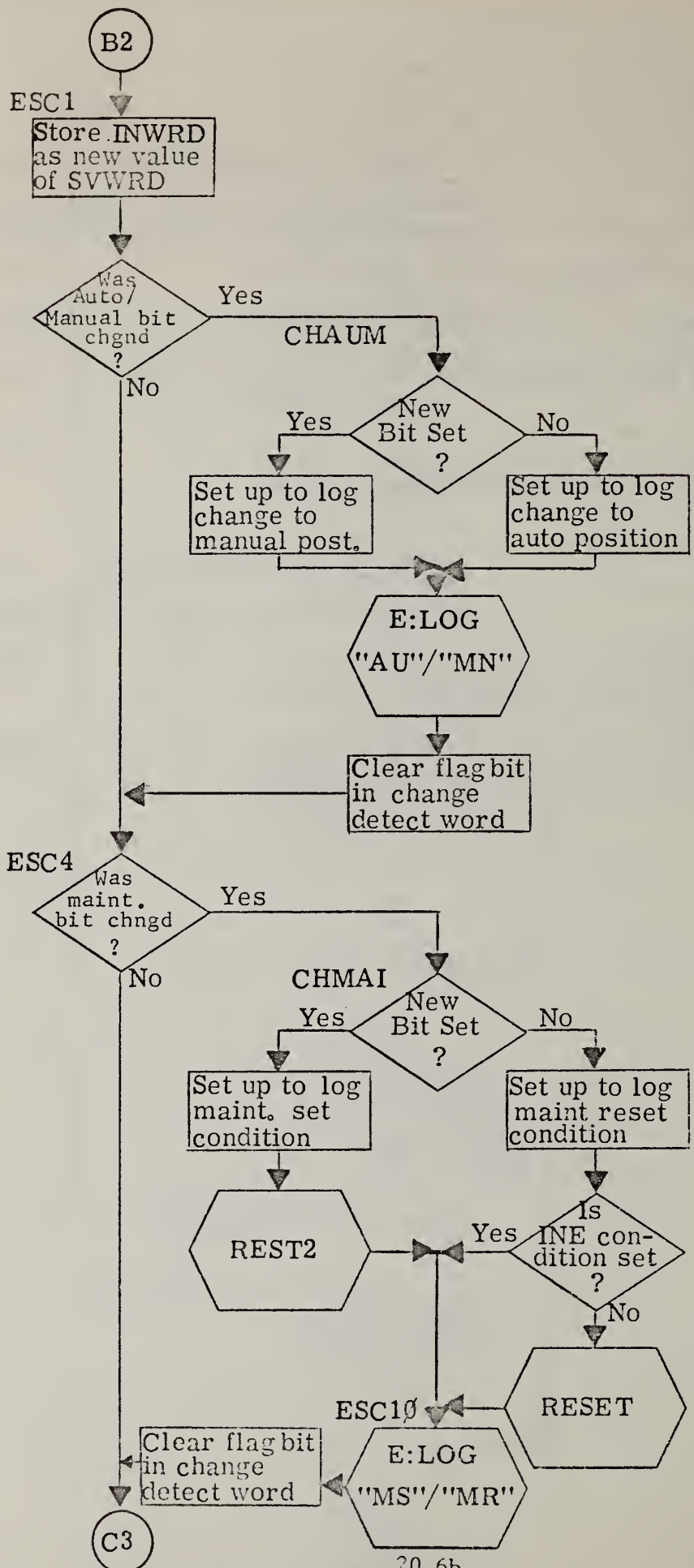
2Ø.5 Output Parameter Descriptions

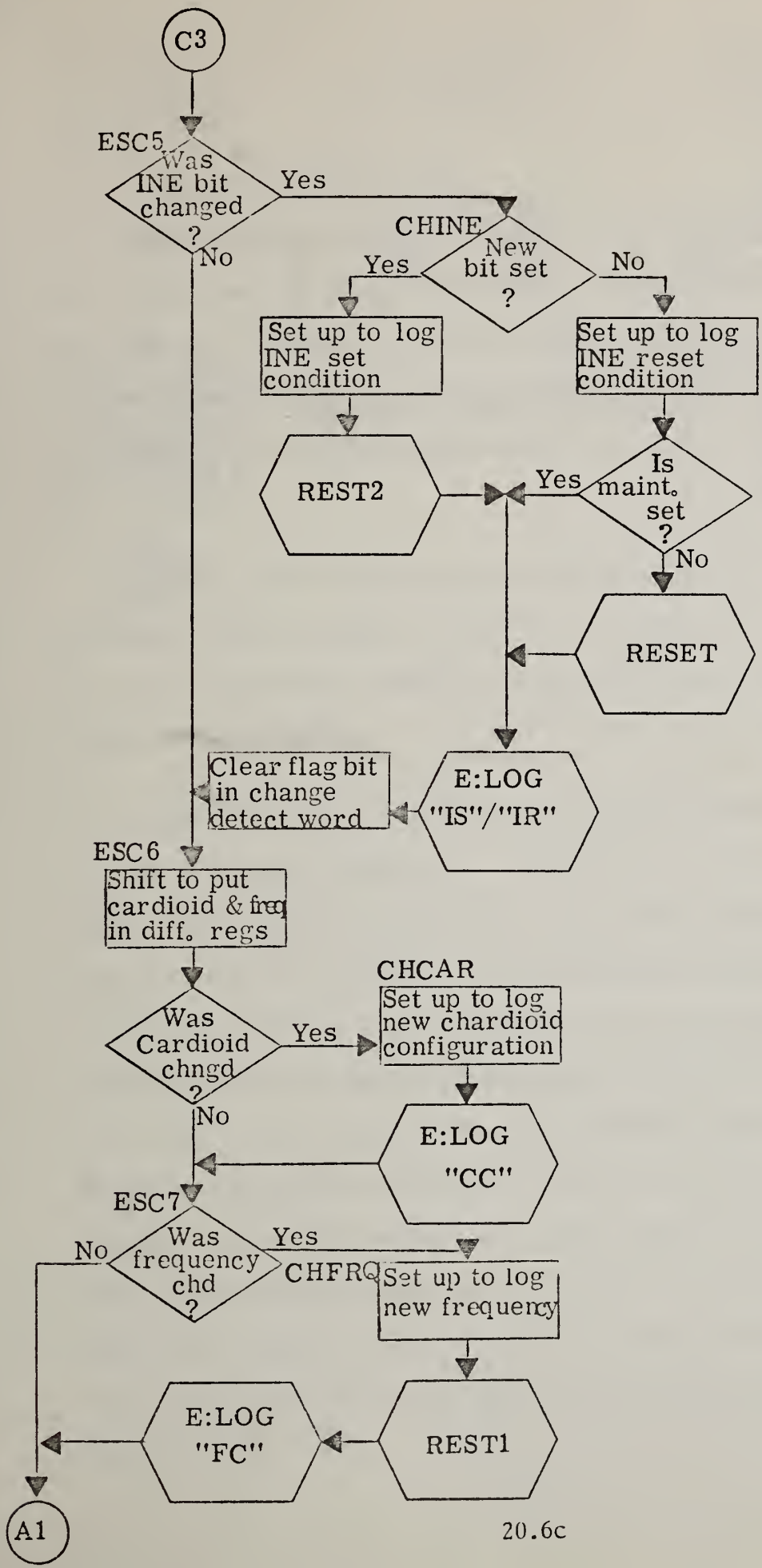
PARAMETER	SIZE	DESCRIPTION
M:INT		Entry point for INE interrupt service routine.
M.TM1	1	Five second delay timer for scheduling M:ESC.
M:ESC		Entry point for Equipment Status Change monitoring program.
M.STA	14	Current values for input digital status words, after all changes are logged.

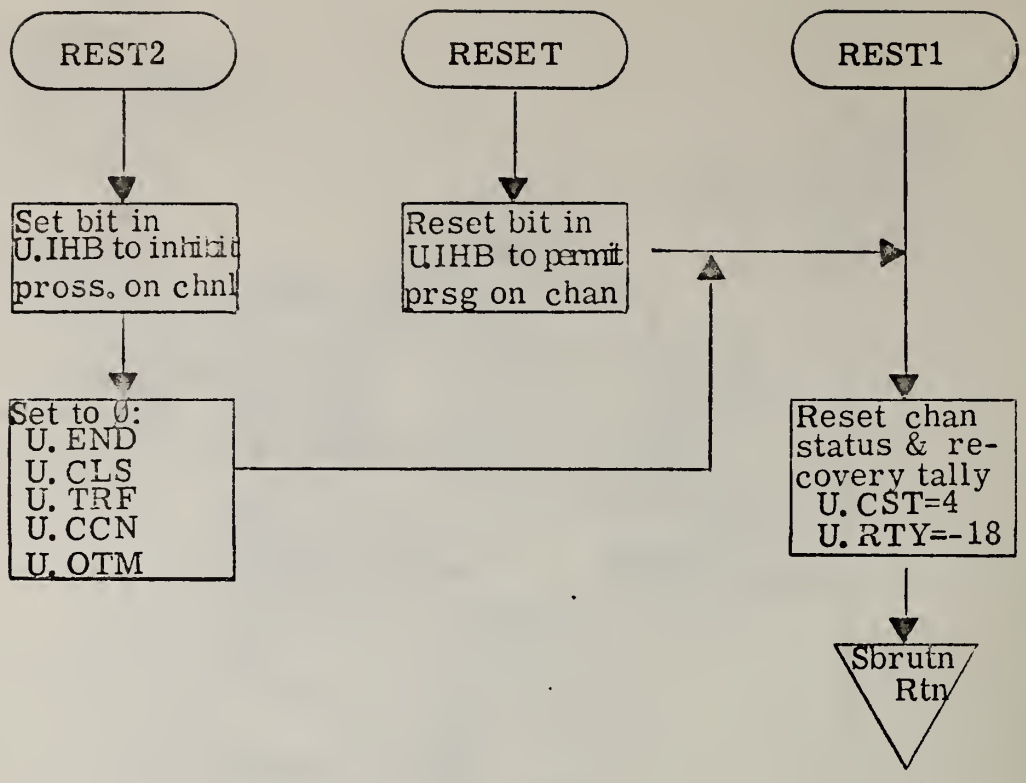
2Ø.6 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
SVWRD	14	Value of digital input status words from last call to M:ESC. Also called M.STA by external programs.
INWRD	14	Buffer of input values read in from first fourteen words of digital input of IOIS during this call to M:ESC.


A
M:INT
Save one Register
Set M.TM1 to -5
Restore Register
Clear INT & RTN
M:ESC
Initialize chan counter
Set up to read 1 status word of digital input from IOIS
READ1
Read digital status word of ADACS/REC. from IOIS
Save input word in INWRD list
Move pointer to next chan
Last chan done ?
No
Yes
Reset chan ptr to 1st chan
ESC2
Chan's INWRD=SVWRD ?
No
B2
Yes
A1
ESC3
Move pointer to next chan
All chan's done ?
No
Yes
E:SKD


B2
ESC1
Store INWRD as new value of SVWRD
Was Auto/ Manual bit chgnd ?
Yes
No
CHAUM
New Bit Set ?
Yes
No
Set up to log change to manual post.
Set up to log change to auto position
E:LOG "AU"/"MN"
Clear flag bit in change detect word
ESC4
Was maint. bit chngd ?
Yes
No
CHMAI
New Bit Set ?
Yes
No
Set up to log maint. set condition
Set up to log maint reset condition
REST2
Is INE condition set ?
Yes
No
RESET
ESC1Ø
E:LOG "MS"/"MR"
Clear flag bit in change detect word
C3


C3
ESC5
Was INE bit changed ?
Yes
No
CHINE
New bit set ?
Yes
No
Set up to log INE set condition
Set up to log INE reset condition
REST2
Yes
Is maint. set ?
No
RESET
Clear flag bit in change detect word
E:LOG "IS"/"IR"
ESC6
Shift to put cardioid & freq in diff. regs
CHCAR
Was Cardioid chngd ?
Yes
Set up to log new chardioid configuration
No
E:LOG "CC"
ESC7
Was frequency chd ?
No
Yes
CHFRQ
Set up to log new frequency
E:LOG "FC"
REST1
A1


REST2
RESET
REST1
Set bit in U.IHB to inhibit pross. on chnl
Reset bit in U.IHB to permit prsg on chan
Set to 0:
U. END
U. CLS
U. TRF
U. CCN
U. OTM
Reset chan status & recovery tally
U. CST=4
U. RTY=-18
Sbrutn Rtn

21. M$LEV

21.1 Functional Description

M$LEV generates a table indicating historical information about each sensor channel which can be used in determining the sensor channel reliability. The table, called the PARAMETER HISTORY, indicates the percentage of time which each channel was in an UP state, and the percentage of up time that each channel was at each tracking rate or gain setting.

M:LEV is entered from the system scheduler when the current time matches an entry in LEVTB of E:MIN (see Section 5.3). E:MIN identifies the need to generate a PARAMETER HISTORY table, and flags M:LEV in the scheduler's task table.

Figure 21.1 shows an example of the output generated by M:LEV on the ASR 28 logging teleprinter. The DOY/TOD group and detachment number are supplied in the healing. The columns correspond to the sensor channels, labeled A through N. The row marked UP gives the percentage of time since the last system startup or the last execution of M:LEV, whichever is more recent, that each sensor channel was in the UP state (i.e. U.CST = 1). Under the heading TRACK RATE, each of the possible tracking rate settings corresponds to one row, and the percentage of up time that each sensor channel was at that setting is given in that row. Since there are 25 gain settings, the settings are grouped as shown in Table 21.1. The percentage of channel up time that each sensor channel was in each of the gain groupings is given in the section under the heading of GAIN.

```
024 083040  PARAMETER HISTORY, DET 215

CHAN  A    B    C    D    E    F    G    H    I    J    K    L    M    N

JP   99  100  100   99  100  100  100    0    0    0    0    0   99   73

TRACK RATE
 0    0    0    0   12    7    0    1    0    0    0    0    0    0    0
 1    0    0    0    9    8    0    1    0    0    0    0    0    0    0
 2    0    0    0   19   41    0    1    0    0    0    0    0    0    0
 3    0    0    0   16   25    0    1    0    0    0    0    0    0    0
 4    0    0    0    6   18    0    0    0    0    0    0    0    0    0
 5    0    0    0    8    1    0    1    0    0    0    0    0    0    0
 6    0    0    0    6    0    0    0    0    0    0    0    0    1    0
 7    0    0    0   14    0    2    1    0    0    0    0    0    1    1
 8    4    0    0   11    0    5    3    0    0    0    0    0    0    4
 9   95  100  100    0    0   93   91    0    0    0    0    0   98   95

GAIN
 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 1    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 2    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 3   56    0    0    0   58   98    0    0    0    0    0    0    0    0
 4   44  100  100    0   30    2   49    0    0    0    0    0    0    0
 5    0    0    0    0   12    0   24    0    0    0    0    0   73    0
 6    0    0    0   88    0    0   27    0    0    0    0    0   27    0
 7    0    0    0   12    0    0    0    0    0    0    0    0    0  100
```

Figure 21.1 Example of PARAMETER HISTORY Table Generated by M:LEV

When the table is completed, the counters are all reset and control is returned to the system scheduler at E:SKD.

GAIN GROUP	GAIN SETTINGS
Ø	Ø, 1, 2
1	3, 4, 5
2	6, 7, 8
3	9, 1Ø, 11
4	12, 13, 14
5	15, 16, 17
6	18, 19, 2Ø
7	21, 22, 23, 24

Table 21.1 Organization of Gain Groupings

21.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:FRT	E$FRT	Reformats BCD time from the WTC to ASCII for output.
E:028	E$T28	Translates output message to BAUDOT code and transfers message to output buffer before transmission to the ASR 28.
E:BAD	E$BCD	Converts binary values to ASCII decimal characters for output.
E:SKD	E$SKD	Reentry point for system scheduler.

21.3 Input Parameter Descriptions

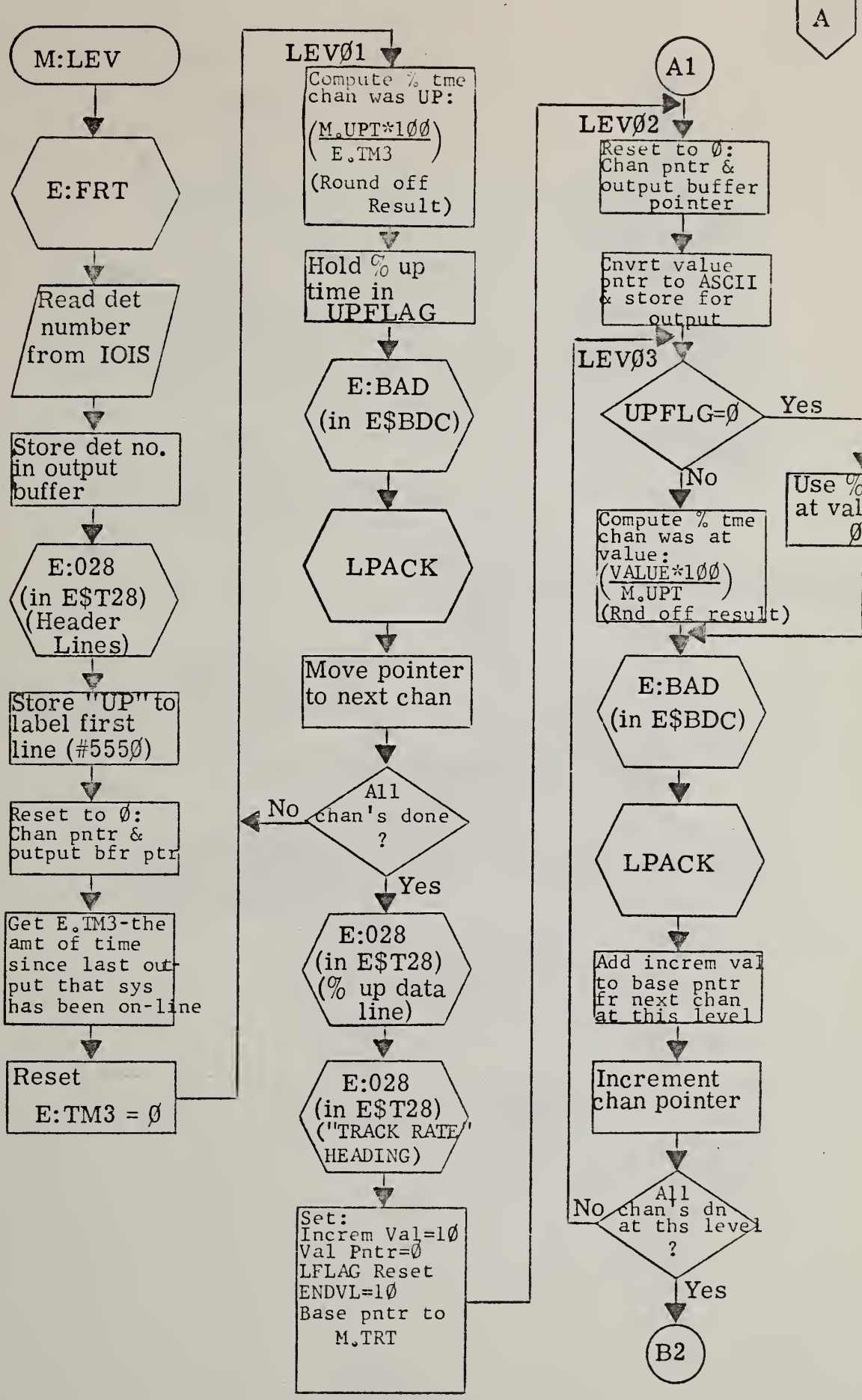
PARAMETER	PROGRAM	DESCRIPTION
E.TM3	E$CLK	Counter for minutes of system up time.
M.UPT	E$CLK	Counters for minutes of sensor channel up times.
M.TRT	E$CLK	Counters for minutes of channel up time at various tracking rate settings.
M.GNT	E$CLK	Counters for minutes of channel up time at various gain group settings.
E.BDF	E$BDC	Buffer of ASCII decimal characters generated by E:BAD.
E.28F	E$T28	Parameter word used in calling E$T28

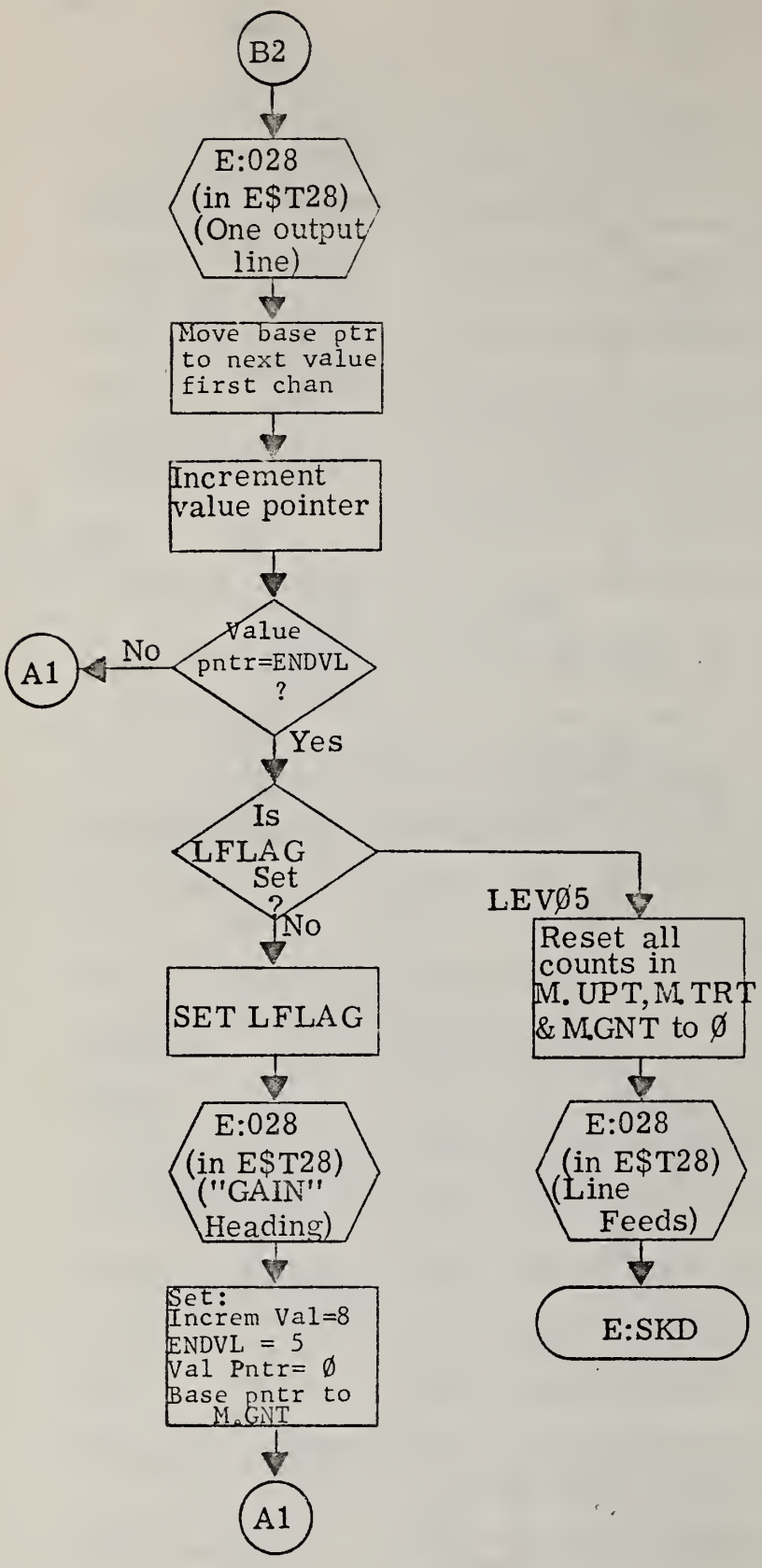
21.4 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
M:LEV		Entry point for PARAMETER HISTORY table generator.

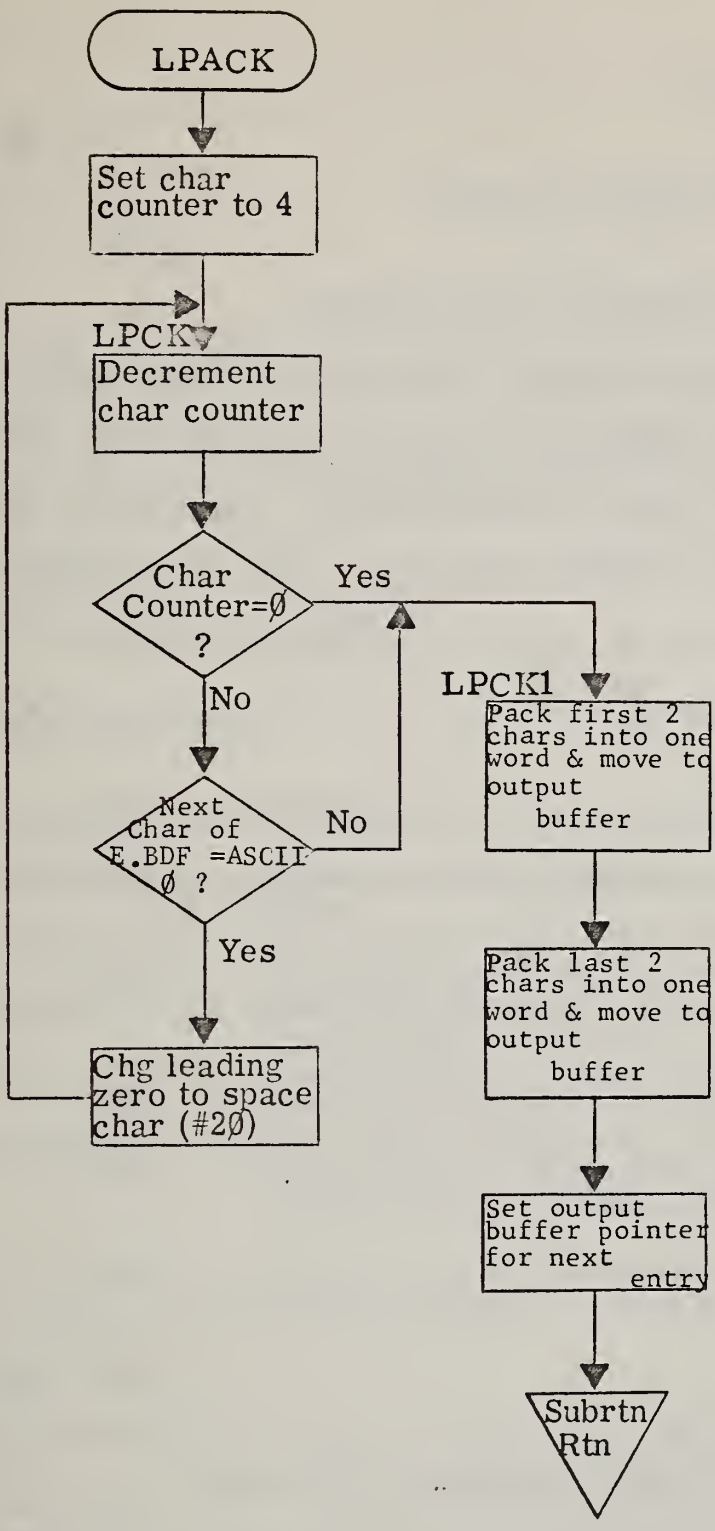
21.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
LINEØ LINE1	55	Output buffer for first two lines of output, through column headings.
LINE2	8	"TRACK RATE" section heading message.
LINE3	5	"GAIN" section heading message.
TERMN	4	Five line feed characters used to terminate output.
BUFFR	31	Output buffer for data lines.
UPFLG	14	Set to percentage up time, therefore = Ø for channels for which TRACK RATE and GAIN section values are all = Ø.
LFLAG	1	Bit Ø = Ø during TRACK RATE section; = 1 during GAIN section.
ENDVL	1	Set to highest setting value possible for TRACK RATE and GAIN sections to control number of rows of output in each section.


M:LEV
E:FRT
Read det number from IOIS
Store det no. in output buffer
E:028 (in E$T28) (Header Lines)
Store "UP" to label first line (#555Ø)
Reset to Ø: Chan pntr & output bfr ptr
Get E.TM3-the amt of time since last output that sys has been on-line
Reset E:TM3 = Ø
LEVØ1
Compute % tme chan was UP: (M.UPT*1ØØ / E.TM3) (Round off Result)
Hold % up time in UPFLAG
E:BAD (in E$BDC)
LPACK
Move pointer to next chan
All chan's done ?
No
Yes
E:028 (in E$T28) (% up data line)
E:028 (in E$T28) ("TRACK RATE" HEADING)
Set: Increm Val=1Ø Val Pntr=Ø LFLAG Reset ENDVL=1Ø Base pntr to M.TRT
A
A1
LEVØ2
Reset to Ø: Chan pntr & output buffer pointer
Cnvrt value pntr to ASCII & store for output
LEVØ3
UPFLG=Ø
Yes
No
Use % time at value as Ø
Compute % tme chan was at value: (VALUE*1ØØ / M.UPT) (Rnd off result)
E:BAD (in E$BDC)
LPACK
Add increm val to base pntr fr next chan at this level
Increment chan pointer
All chan's dn at ths level ?
No
Yes
B2


B
B2
E:028
(in E$T28)
(One output
line)
Move base ptr
to next value
first chan
Increment
value pointer
Value
pntr=ENDVL
?
No
A1
Yes
Is
LFLAG
Set
?
No
LEVØ5
SET LFLAG
Reset all
counts in
M.UPT, M.TRT
& M.GNT to Ø
E:028
(in E$T28)
("GAIN"
Heading)
E:028
(in E$T28)
(Line
Feeds)
Set:
Increm Val=8
ENDVL = 5
Val Pntr= Ø
Base pntr to
M.GNT
E:SKD
A1

C


LPACK
Set char counter to 4
LPCK
Decrement char counter
Char Counter=Ø ?
Yes
No
Next Char of E.BDF =ASCII Ø ?
No
Yes
Chg leading zero to space char (#2Ø)
LPCK1
Pack first 2 chars into one word & move to output buffer
Pack last 2 chars into one word & move to output buffer
Set output buffer pointer for next entry
Subrtn Rtn

22. M$STD

22.1 Functional Description

22.1.1 M:STD (Status Display Routine)

NUSTAD logs pertinent information about the sensor parameter settings and processing status on the ASR 28 in the form of a table entitled the CURRENT RECEIVER STATUS. This table is generated by M:STD either at predetermined times listed in the STDTB of E:MIN (see Section 5.3) or in response to an operator request via E:OMI (the STD: input option).

If the current time, read from the WTC, corresponds to an entry in STDTB of the one minute interrupt service routine (E:MIN) E:MIN sets the flag for M:STD in the scheduler's task table. If the operator enters STD: as the keyword request on the ASR 35 teletypewriter, E:OMI will flag the scheduler task table entry for M:STD. In either way, the scheduler will transfer control to M:STD to generate the CURRENT RECEIVER STATUS table.

After the table is generated, M:STD returns control to the scheduler at E:SKD.

22.1.2 E:FAM (Amplitude Reformat Subroutine)

E:FAM is an executive support subroutine which converts amplitude values from internal binary representation to ASCII decimal characters representing the signal amplitude in dB.

Calling Sequence:

```
BLM,14      E:FAM
DFC         STORE
```

where the value of U.AMP for the channel specified in R6 is converted to ASCII decimal characters and stored in three computer words starting at the location passed in the second statement of the calling sequence (at the location called STORE in the above example). The format of the subroutine output is: ±ØØØØ

22.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:FRT	E$FRT	Reformats BCD time from the WTC to ASCII for output.
E:028	E$T28	Translates output message to BAUDOT code and transfers message to output buffer before transmission to the ASR 28.
E:BAD	E$BDC	Binary to ASCII decimal conversion routine.
E:FMF	E$FMF	Reformats phase values from internal representation to ASCII decimal for output.
E:SKD	E$SKD	Reentry point for the system scheduler.

22.3 Data Formats

Figure 22.1 shows two examples of the CURRENT RECEIVER STATUS tables generated by M:STD. Line 1 includes the DOY/TOD group and the detachment number with the table identification. Each row of the table itself supplies the following information for one sensor channel.

a. Channel designation, A through N.

b. Frequency, as read from the sensor through the digital input portion of the IOIS.

c. Cardioid configuration, a single digit, interpreted by Table 21.1.

d. INE condition, = Ø if INE condition reset; = 1 if INE condition set.

e. Maintenance condition, = Ø if channel not in maintenance; = 1 if channel is in maintenance.

f. Auto/Manual selection, = A if channel is in Automatic mode; = M if channel is in Manual mode.

If either the INE or the Maintenance conditions are set, the line is terminated after the Auto/Manual indication. Otherwise, the line continues:

g. Gain setting, the current sensor RF gain setting.

h. Tracking Rate setting, the current sensor tracking rate setting.

i. Blanking Level setting, the current sensor blanking level setting.

j. Diurnal slope estimate, the current long term phase trend estimation, given in microseconds/minute. Positive value corresponds to the retard direction, negative to the advance direction.

```
024 060040  CURRENT RECEIVER STATUS, DET 215

 CHAN FREQ C I M AM GAIN TR BLL DIURNAL SIGMA AMPLITUDE
   A  17.8 5 0 0  A  09   8  00  -000.8 00.62 -09.60   UP
   B  21.0 5 0 0  A  12   9  02  -000.1 00.62 -06.76   UP
   C  21.0 1 0 0  A  12   9  04  -000.1 00.62 -03.16   UP
   D  16.0 5 0 0  A  20   2  00  -000.1 00.25 -05.04   UP
   E  22.3 1 0 0  A  09   2  01  &001.7 06.63 &00.68   UP
   F  18.6 5 0 0  A  11   9  00  -000.1 00.00 -00.08   UP
   G  24.0 5 0 0  A  20   3  00  -000.7 01.37 -01.24   UP
   H ZERO INPUT...
   I  17.8 7 0 0  A  11   8  00  -008.9 00.00 -19.96  DOWN
   J ZERO INPUT...
   K ZERO INPUT...
   L ZERO INPUT...
   M  24.0 7 0 0  A  19   9  00  &023.3 10.81 -06.48  C,R
   N  17.8 7 0 0  A  24   6  00  -000.4 11.00 -18.80  C,R


024 090153  CURRENT RECEIVER STATUS, DET 215

 CHAN FREQ C I M AM GAIN TR BLL DIURNAL SIGMA AMPLITUDE
   A  17.8 5 0 0  A  12   9  00  -000.1 00.18 -03.04   UP
   B  21.0 5 0 0  A  16   1  16  &000.6 03.00 -05.36   UP
   C  21.0 1 0 0  A  14   1  17  &000.7 03.00 -06.96   UP
   D  16.0 5 0 0  A  22   2  00  &000.0 00.81 -01.76   UP
   E  22.3 1 0 0  A  11   1  01  &001.5 00.25 -00.68   UP
   F  18.6 5 0 0  A  11   9  00  -000.2 00.06 &00.76   UP
   G  24.0 5 0 0  A  18   9  00  -000.1 00.25 &04.52   UP
   H ZERO INPUT...
   I  17.8 7 1 1  M
   J ZERO INPUT...
   K ZERO INPUT...
   L ZERO INPUT...
   M  24.0 7 0 0  A  20   9  00  -000.1 00.06 &03.48   UP
   N  17.8 7 0 0  A  24   9  00  -000.1 11.93 -19.44  DOWN
```

Figure 22.1 Two Examples of CURRENT RECEIVER STATUS Tables Generated by M:STD

k. Standard Deviation estimate, the current standard deviation value for the incoming phase signal, given in microseconds.

l. Amplitude value, the current signal amplitude in dB.

m. Channel processing status, the channel processing status based on the amplitude evaluation; UP if the channel is up; C,NR if the channel is coasting, no report; C,R, if the channel is coasting, and the reason has been reported in the station log; and DOWN if the channel is down.

Additionally, if the channel's digitial IOIS data word is zero, the INE and MAINTENANCE conditions are set by default. This state is entered as a

ZERO INPUT...

entry in the table.

22.4 Input Parameter Description

PARAMETER	PROGRAM	DESCRIPTION
E.28F	E$T28	Parameter word used in calling E:028
E.BSG	E$BDC	The ASCII representation for the sign of the output of E:BAD.
E.BDF	E$BDC	The buffer of ASCII decimal characters resulting from E:BAD.
U.GAN	U$DAT	The current sensor channel RF gain settings.
U.TRK	U$DAT	The current sensor channel tracking rate settings.
U.BLL	U$DAT	The current sensor channel blanking level settings.
U.SIG	U$DAT	The computed standard deviation of the incoming phase signals.

22.4 Input Parameter Description (continued)

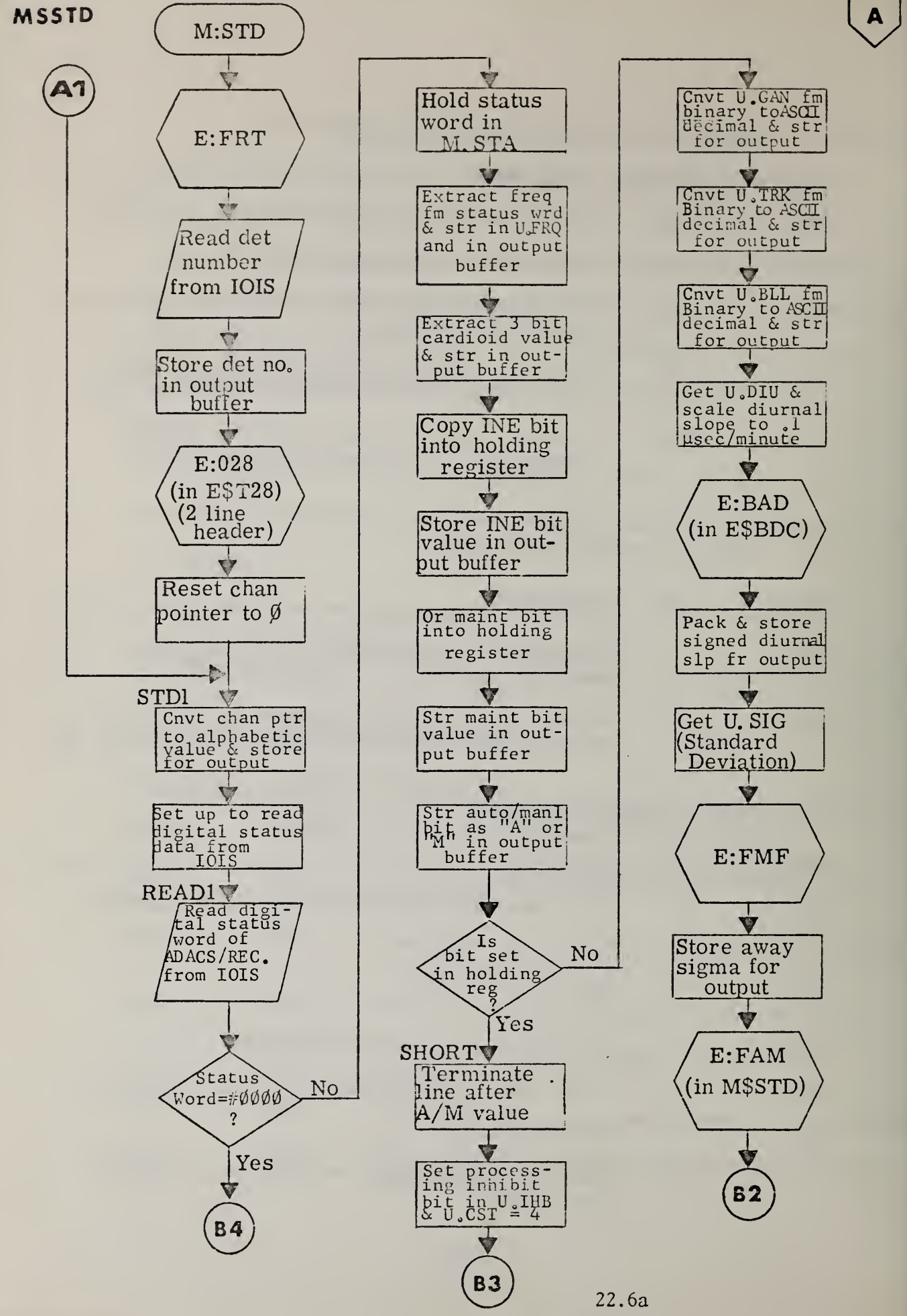
PARAMETER	PROGRAM	DESCRIPTION
U.FREQ	E$LOG	The current sensor channel frequency settings.
U.AMP	U$DAT	The current signal amplitude estimates.
M.STA	M$LEV	The current digital IOIS status from the sensors and ADACS interfaces.
U.IHB	U$DAT	Flag bit used to inhibit processing on channels with either INE or Maintenance conditions set.
U.CST	U$DAT	Channel processing status based on amplitude evaluation by amplitude monitoring section of U:RTA

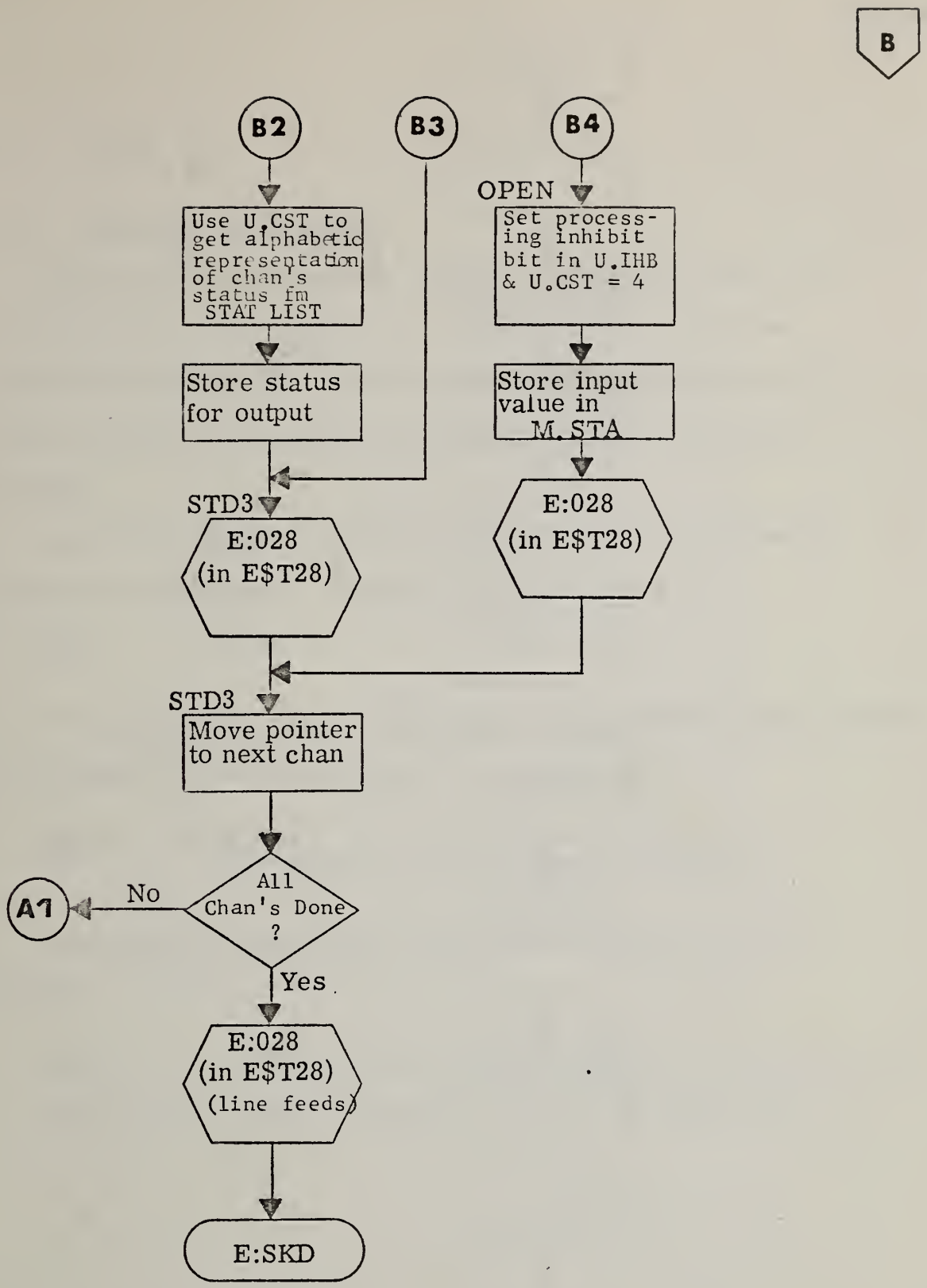
22.5 Output Parameter Descriptions

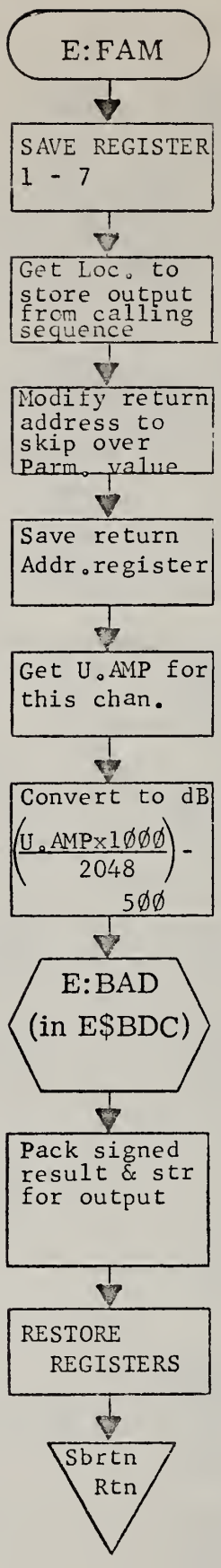
PARAMETER	SIZE	DESCRIPTION
M:STD		Entry point to CURRENT RECEIVER STATUS table generation program.
E:FAM		Entry point to executive support subroutine to reformat amplitude values to ASCII characters of dB.

22.6 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
LINEØ LINE	54	First two lines of table, through column headings.
LINE2 L2A1	31	Data line for table
LINE3	11	"ZERO INPUT..." line for table
TERMN	3	Three line feed characters to terminate output.
TEMP	5	Working storage.
STAT	8	Table to convert U.CST from numeric to characters for output.


A
M:STD
A1
E:FRT
Read det number from IOIS
Store det no. in output buffer
E:028 (in E$T28) (2 line header)
Reset chan pointer to Ø
STD1
Cnvt chan ptr to alphabetic value & store for output
Set up to read digital status data from IOIS
READ1
Read digital status word of ADACS/REC. from IOIS
Status Word=#ØØØØ ?
No
Yes
B4
Hold status word in M.STA
Extract freq fm status wrd & str in U.FRQ and in output buffer
Extract 3 bit cardioid value & str in output buffer
Copy INE bit into holding register
Store INE bit value in output buffer
Or maint bit into holding register
Str maint bit value in output buffer
Str auto/manl bit as "A" or "M" in output buffer
Is bit set in holding reg ?
No
Yes
SHORT
Terminate line after A/M value
Set processing innibit bit in U.IHB & U.CST = 4
B3
Cnvt U.GAN fm binary to ASCII decimal & str for output
Cnvt U.TRK fm Binary to ASCII decimal & str for output
Cnvt U.BLL fm Binary to ASCII decimal & str for output
Get U.DIU & scale diurnal slope to .1 μsec/minute
E:BAD (in E$BDC)
Pack & store signed diurnal slp fr output
Get U. SIG (Standard Deviation)
E:FMF
Store away sigma for output
E:FAM (in M$STD)
B2


B
B2
B3
B4
OPEN
Use U.CST to get alphabetic representation of chan's status fm STAT LIST
Set processing inhibit bit in U.IHB & U.CST = 4
Store status for output
Store input value in M.STA
STD3
E:028 (in E$T28)
E:028 (in E$T28)
STD3
Move pointer to next chan
A1
No
All Chan's Done ?
Yes
E:028 (in E$T28) (line feeds)
E:SKD


E:FAM
SAVE REGISTER 1 - 7
Get Loc. to store output from calling sequence
Modify return address to skip over Parm. value
Save return Addr.register
Get U.AMP for this chan.
Convert to dB
(U.AMPx1ØØØ / 2048) - 5ØØ
E:BAD
(in E$BDC)
Pack signed result & str for output
RESTORE REGISTERS
Sbrtn Rtn

23. E$LOG

23.1 Functional Description

Routine messages concerning changes to parameter settings, etc. are entered into the station log on the ASR 28 in a coded form. Systems and applications programs generate these messages by calling E:LOG, the executive support subroutine to generate routine log messages.

The calling sequence depends on whether or not a new value is appended to the message. The basic calling sequence is:

```
BLM,4          E:LOG
```

If further information is required, as in a parameter change message, it is passed in a second word, as:

```
BLM,4          E:LOG
DFC            (New value or other additional information)
```

The message text and sensor channel are identified in R5 as follows:

Bits Ø - 7.....Channel designation, Ø for chan A, 1 for chan B, etc.

Bits 8 - 15.....Message designation number, see Table 23.1

MESSAGE NO.	MESSAGE GENERATED	ADDITIONAL INFORMATION
ØØ	"U" Channel UP	Frequency, Track Rate, Gain, Blank Lv
Ø1	"FC" Frequency change	New frequency setting
Ø2	"CC" Cardioid change	New cardioid pattern code
Ø3	"TC" Tracking rate change	New tracking rate
Ø4	"GC" Gain change	New gain setting
Ø5	"BC" Blanking Level change	New blanking level setting
Ø6	"RS" Redundancy check successful	None
Ø7	"SD" System Dead in scheduler	None
Ø8	"MN" Auto/Manual set to Manual	None
Ø9	"AU" Auto/Manual set to Auto	None
1Ø	"MS" Maintenance switch set	None
11	"MR" Maintenance switch reset	None
12	"IS" INE condition set	None
13	"IR" INE condition reset	None
14	"CF" Channel coasting, failure	None
15	"CN" Channel coasting, noise	None
16	"CS" Channel coasting, saturation	None
17	"D" Channel Down	None
18	"AF" Analog subsystem failure	None
19	"PF" Power failure	None
2Ø	"PR" Power restored	None
21	"MP" Memory parity error	Memory location of error

Table 23.1 Message Number Designation and Interpretation

After the message is generated and transferred to the ASR 28 output buffer via E:028, control is returned to the calling program.

23.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:028	E$T28	Translates output message to BAUDOT code and transfers message to output buffer before transmission to the ASR 28.
E:FRT	E$FRT	Reformats BCD time from the WTC to ASCII for output.
E:BAD	E$BDC	Binary to ASCII decimal conversion subroutine

```
023 220149  G TC03
023 220149  I TC08
023 220149  M TC08
023 220149  N TC03
023 220302 L: NOSTAD GOING UNATTENDED.....JRE.....
023 220319  A TC09
023 220319  B TC03
023 220319  E TC09
023 220319  F TC09
023 220319  G TC09
```

Figure 23.1 Example of Routine Log Messages

23.3 Data Formats

The routine log message, as illustrated in Figure 23.1, assumes the following format:

DDD TTTTTT C MMAA

where: D indicates a digit of DOY

T indicates a digit of TOD

C indicates an alphabetic designation for sensor channel

M indicates one of two characters giving the message text, see table 23.1 for interpretation of the legal messages.

A indicates a character of additional information which may be associated with the message text.

NOTE: Line 5 of Figure 23.1 illustrates an example of the output generated by the operator LOG: option (see Section 8.1).

23.4 Input Parameter Descriptions

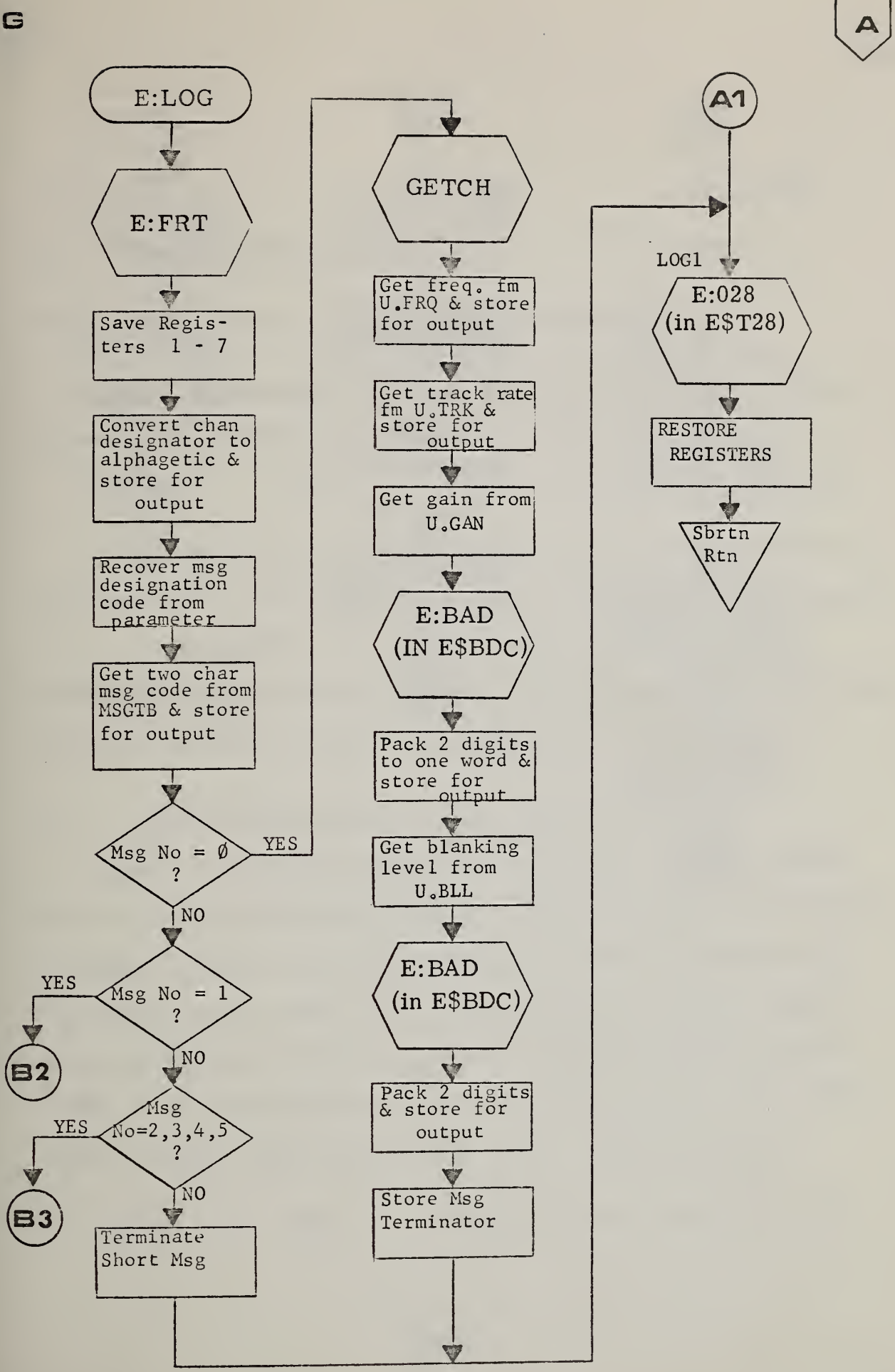
PARAMETER	PROGRAM	DESCRIPTION
U.TRK	U$DAT	Current sensor channel tracking rate settings.
U.GAN	U$DAT	Current sensor channel RF gain settings.
U.BLL	U$DAT	Current sensor channel blanking level settings.
E.BDF	E$BDC	Buffer of ASCII decimal characters from call to E:BAD
E.28F	E$T28	Parameter word used in calling E:028

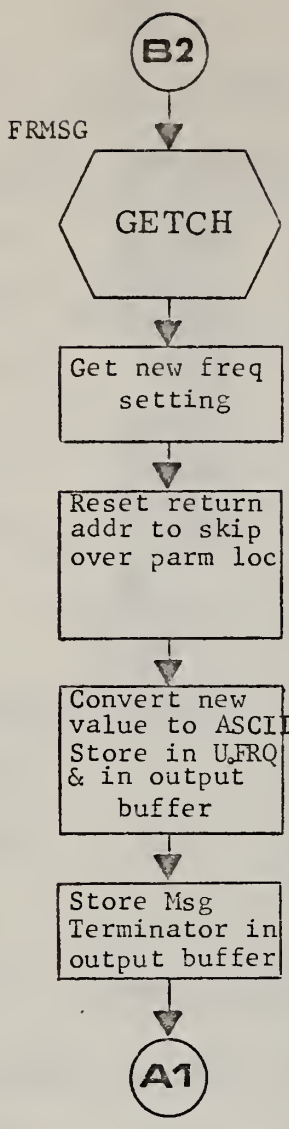
23.5 Output Parameter Descriptions

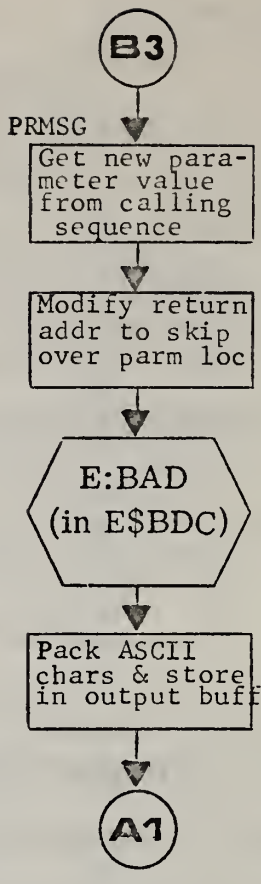
PARAMETER	SIZE	DESCRIPTION
E:LOG		Entry point to routine log message generator.
U.FRQ	28	ASCII characters for current sensor frequency settings.

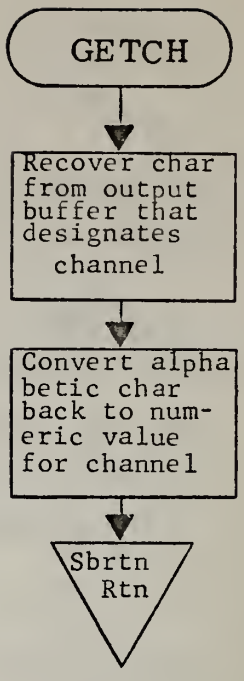
23.6 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
MSGTB	22	Table of the character message texts for the routine log messages.
OBUFF OBUF1	17	Message output buffer.
SAVRS	7	Register storage area.


A
E:LOG
E:FRT
Save Regis-ters 1 - 7
Convert chan designator to alphagetic & store for output
Recover msg designation code from parameter
Get two char msg code from MSGTB & store for output
Msg No = Ø ?
YES
NO
Msg No = 1 ?
YES
B2
NO
Msg No=2,3,4,5 ?
YES
B3
NO
Terminate Short Msg
GETCH
Get freq. fm U.FRQ & store for output
Get track rate fm U.TRK & store for output
Get gain from U.GAN
E:BAD (IN E$BDC)
Pack 2 digits to one word & store for output
Get blanking level from U.BLL
E:BAD (in E$BDC)
Pack 2 digits & store for output
Store Msg Terminator
A1
LOG1
E:028 (in E$T28)
RESTORE REGISTERS
Sbrtn Rtn


B2
FRMSG
GETCH
Get new freq setting
Reset return addr to skip over parm loc
Convert new value to ASCII Store in U.FRQ & in output buffer
Store Msg Terminator in output buffer
A1


B3
PRMSG
Get new parameter value from calling sequence
Modify return addr to skip over parm loc
E:BAD (in E$BDC)
Pack ASCII chars & store in output buff
A1


GETCH
Recover char from output buffer that designates channel
Convert alphabetic char back to numeric value for channel
Sbrtn Rtn

24. E$BDC

24.1 Functional Description

24.1.1 E:BDC (Binary to Decimal Conversion Subroutine)

E:BDC is an executive support subroutine designed to convert binary values to BCD (decimal) equivalents. The calling sequence is:

```
BLM,14          E:BDC          Binary value to be converted in R12
```

The sign of the value is stored in E.BSG as either $2Ø2B_{16}$ (the ASCII characters for " + ") for positive values or $2Ø2D_{16}$ (the ASCII characters for " - ") for negative. The least significant five digits of the resulting BCD value are stored in E.BDF, the least significant digit first. After the conversion, control is returned to the calling program.

24.1.2 E:BAD (Binary to ASCII Decimal Conversion Subroutine)

Normally a binary to decimal conversion is made to generate output data in a form usable by the operator. E:BAD performs the same conversion as E:BDC, but also converts the BCD digits to ASCII characters during the process to have them in the form compatible with standard output devices. The sign is stored in E.BSG and the least significant five digits of the resulting value are stored in E.BDF as with E:BDC. These values are ASCII rather than BCD characters. Calling sequence is:

```
BLM, 14         E:BAD          Binary value to be converted in R12
```

24.2 Computational Methods

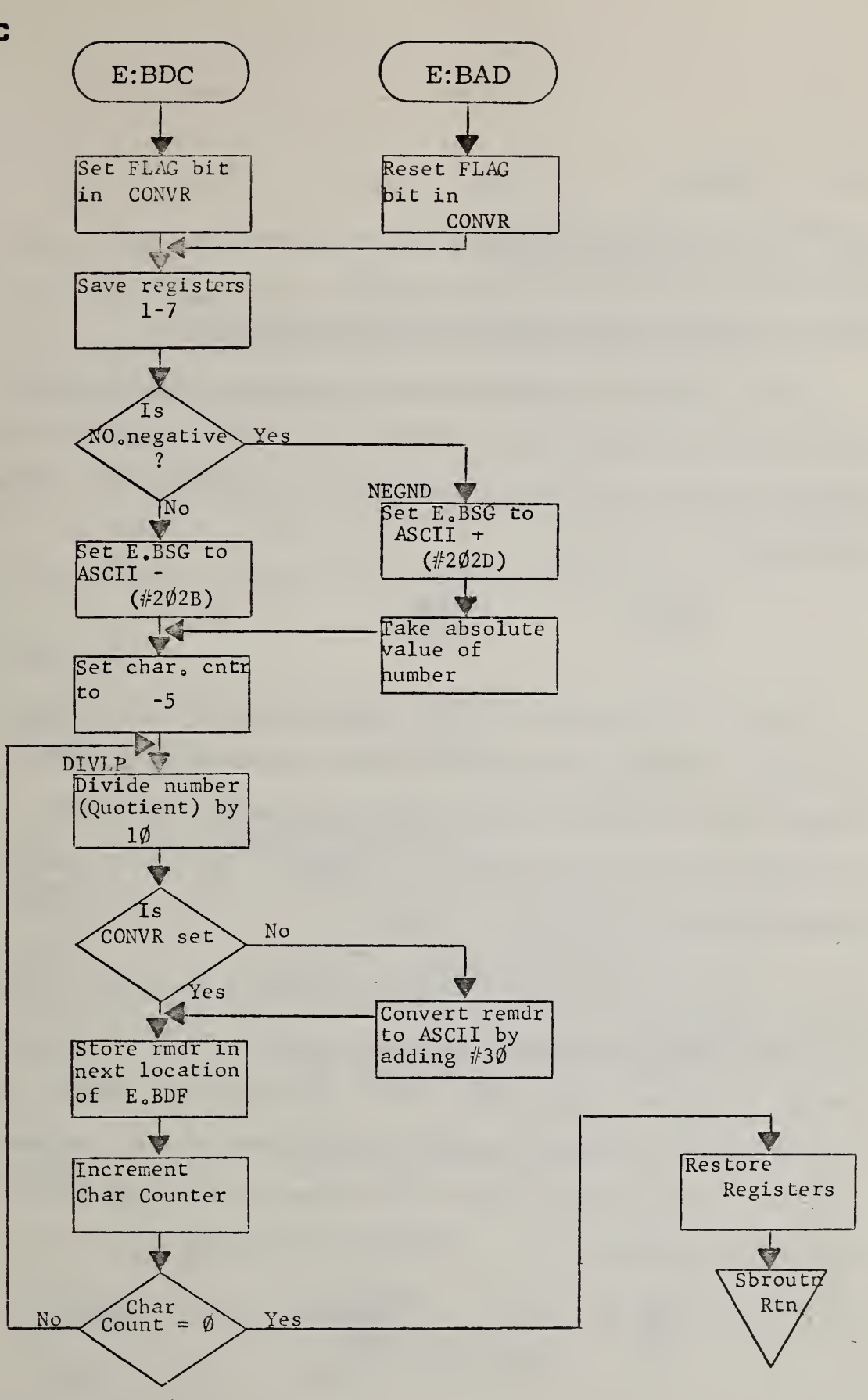
The binary to BCD ccnversion is made by successive divisions by ten. The conversion from BCD to ASCII is made by adding 30_{16} to each digit.

24.3 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
E:BDC		Entry point for binary to decimal conversion routine.
E:BAD		Entry point for binary to ASCII decimal conversion routine.
E:BDF	5	Output character buffer for BDC or ASCII digits, arranged with least significant digit first, etc.
E:BSG	1	$=202B_{16}$ (ASCII " + ") if value is positive; $-202D_{16}$ (ASCII " - ") if value is negative.

24.4 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
CONVR	1	Bit 0 = 0 for BCD output, = 1 for ASCII decimal output.
SAVRS	7	Register storage area.


A
E:BDC
E:BAD
Set FLAG bit in CONVR
Reset FLAG bit in CONVR
Save registers 1-7
Is NO. negative ?
Yes
No
NEGND
Set E.BSG to ASCII + (#2Ø2D)
Set E.BSG to ASCII - (#2Ø2B)
Take absolute value of number
Set char. cntr to -5
DIVLP
Divide number (Quotient) by 1Ø
Is CONVR set
No
Yes
Convert remdr to ASCII by adding #3Ø
Store rmdr in next location of E.BDF
Increment Char Counter
Char Count = Ø
No
Yes
Restore Registers
Sbroutn Rtn

25. E$FRT

25.1 Functional Description

25.1.1 E:FRT (Reformat Real Time for Output Subroutine)

NUSTAD generally includes the time of message generation in most of the messages entered into the station log. Those message generating programs normally call E:FRT to accomplish this function. The calling sequence is:

```
BLM,14          E:FRT
DFC             STORE
```

E:FRT reads the current BCD time from the WTC, rearranges the characters, converts them to ASCII values, and stores them in five computer words starting at the location specified by the second instruction of the calling sequence. Control is returned to the calling program when the conversion is complete.

25.1.2 E:FCT (Reformat BCD Time Value From Memory for Output Subroutine)

Several NUSTAD programs store a time value in the BCD format for a period of time before that value needs to be output in a message. E:FCT is a variation on E:FRT which takes the BCD formatted time from memory locations E.TM1 and E.TM2 rather than reading the time from the WTC. The calling sequence is:

```
BLM, 14         E:FCT
DFC             STORE
```

E:FCT goes directly to E.TM1 & T.TM2 to get the BCD time. It shares coding with E:FRT to reformat this value to ASCII characters and to store them in five computer words starting at the location specified by the second instruction of the calling sequence. Control is returned to the calling program when the conversion is complete.

25.2 Data Formats

The output of either E:FRT or E:FCT is stored in five memory locations with two ASCII characters per location, in the following form:

DDD TTTTTT

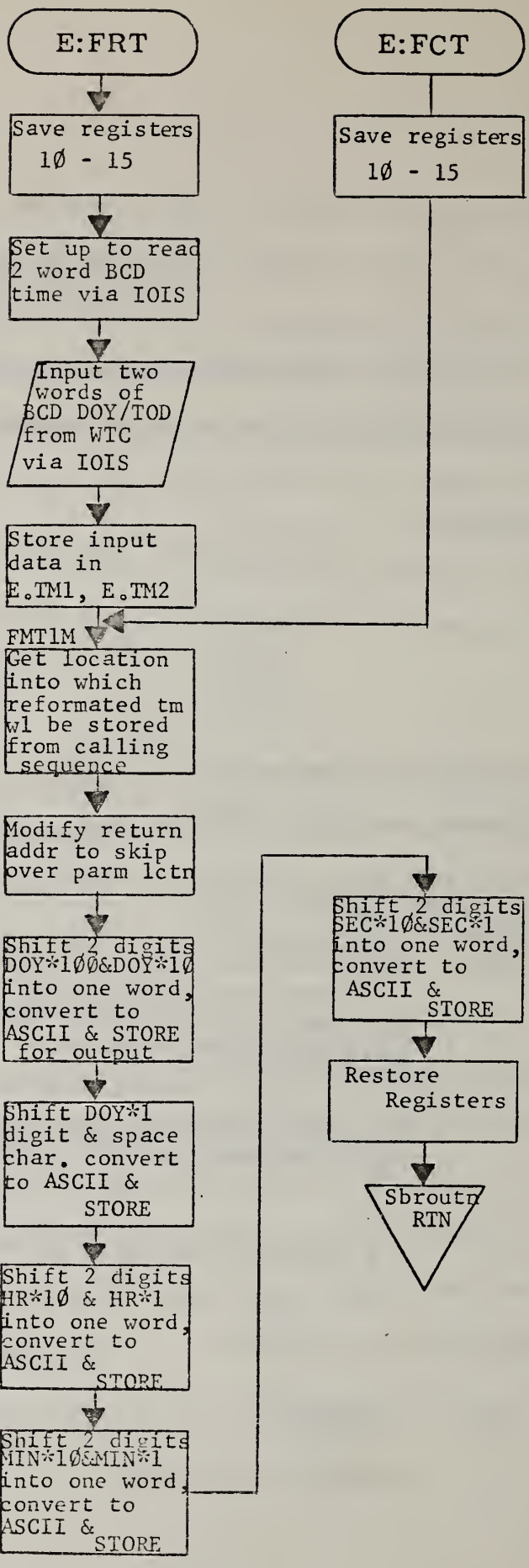
WHERE: D indicates a digit of DOY
T indicates a digit of TOD

25.3 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
E:FRT		Entry point for subroutine to convert real time to ASCII characters for output.
E:FCT		Entry point for subroutine to convert BCD formatted time from memory to ASCII characters for output.
E.TM1 E.TM2	2	BCD formatted time value converted by E:FCT.

25.4 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
SAVER	6	Register storage area.


E:FRT
E:FCT
A
Save registers 1Ø - 15
Save registers 1Ø - 15
Set up to read 2 word BCD time via IOIS
Input two words of BCD DOY/TOD from WTC via IOIS
Store input data in E.TM1, E.TM2
FMT1M
Get location into which reformated tm wl be stored from calling sequence
Modify return addr to skip over parm lctn
Shift 2 digits DOY*1ØØ&DOY*1Ø into one word, convert to ASCII & STORE for output
Shift DOY*1 digit & space char. convert to ASCII & STORE
Shift 2 digits HR*1Ø & HR*1 into one word, convert to ASCII & STORE
Shift 2 digits MIN*1Ø&MIN*1 into one word, convert to ASCII & STORE
Shift 2 digits SEC*1Ø&SEC*1 into one word, convert to ASCII & STORE
Restore Registers
Sbroutn RTN

26. E$DIF

26.1 Functional Description

NUSTAD stores most values for time in the BCD format. This is the format under which time is read from the WTC, and conversion from this format to ASCII characters for output is very straightforward. However, the processor cannot perform computations with the time value in a packed BCD format, so the following executive support subroutines are included in NUSTAD to permit conversion between the BCD and binary time formats and to perform the most common computation using the time values.

26.1.1

The waveform analysis programs have frequent need to know how much time has elapsed since the signal onset. When onset was discovered, both the BCD time (in U.OTB) and the binary time (in U.OTM) were saved. Any program which requires the time difference between onset time and a BCD formatted time value calls E:DIF where the time difference in seconds is computed and returned to the calling program. E:DIF also indicates the absence of a signal in progress by adjusting the return address. The calling sequence is:

```
BLM,14          E:DIF       Sensor channel designated in R6
DFC             ADDRS       Address of BCD value
BRU             NO SIG      Return if no signal in progress
...             ......      Return with time difference in R12,R13
```

Upon entry, E:DIF checks the onset time (U.OTM) for the sensor channel specified in R6. If it is zero, there is no signal in progress, and E:DIF returns control to the calling program. If the onset time is nonzero, E:DIF recovers the BCD formatted value from the location specified by the calling sequence and converts that value to its binary equivalent. The difference between the onset time and converted value is computed and adjusted if the time span overlaps the 2400 hour. The return address is adjusted and control is returned to the calling program with the time difference (in seconds) in R12, R13.

If a program requires the time difference between a binary value and a BCD time when the binary value is not a signal onset time, E:DIF can be used to store the binary time value in the two memory locations immediatedly following the U.OTM storage area. This two-word time buffer is called U.DTM. Setting the channel designation in R6 to 14_{10} will cause E:DIF to compute the time difference as if a fifteenth sensor channel existed and the time elapsed since onset on that channel were required.

26.1.2 E:COT (BCD Formatted Time to Binary Equivalent Conversion Subroutine

When an applications program needs to convert a BCD time value to its binary equivalent, as to supply U.DTM with a binary value prior to calling E:DIF, E:COT can be called to perform the conversion. The calling sequence is:

```
BLM,14          E:COT
DFC             ADDRS       Address of BCD value to be converted
```

E:COT retrieves the BCD value from the location specified, converts the value to its binary equivalent and returns control to the calling program with the result in R12, R13.

26.2 Computational Methods

The BCD time value is formatted as illustrated in Figure 16.4. The conversion from this format to the binary equivalent, the format of which is illustrated in Figure 16.5, is made by the following computation:

$$T_{bin} = (((((D_{\emptyset} \times 10 + D_1) \times 6 + D_2) \times 10 + D_3) \times 6 + D_4) \times 10 + D_5)$$

where: $D_{\emptyset}$ is the hours x 10 digit

D_1 is the hours x 1 digit

D_2 is the minutes x 10 digit

D_3 is the minutes x 1 digit

D_4 is the seconds x 10 digit

D_5 is the seconds x 1 digit

26.3 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
U.OTM	U$DAT	Signal onset time in binary format.

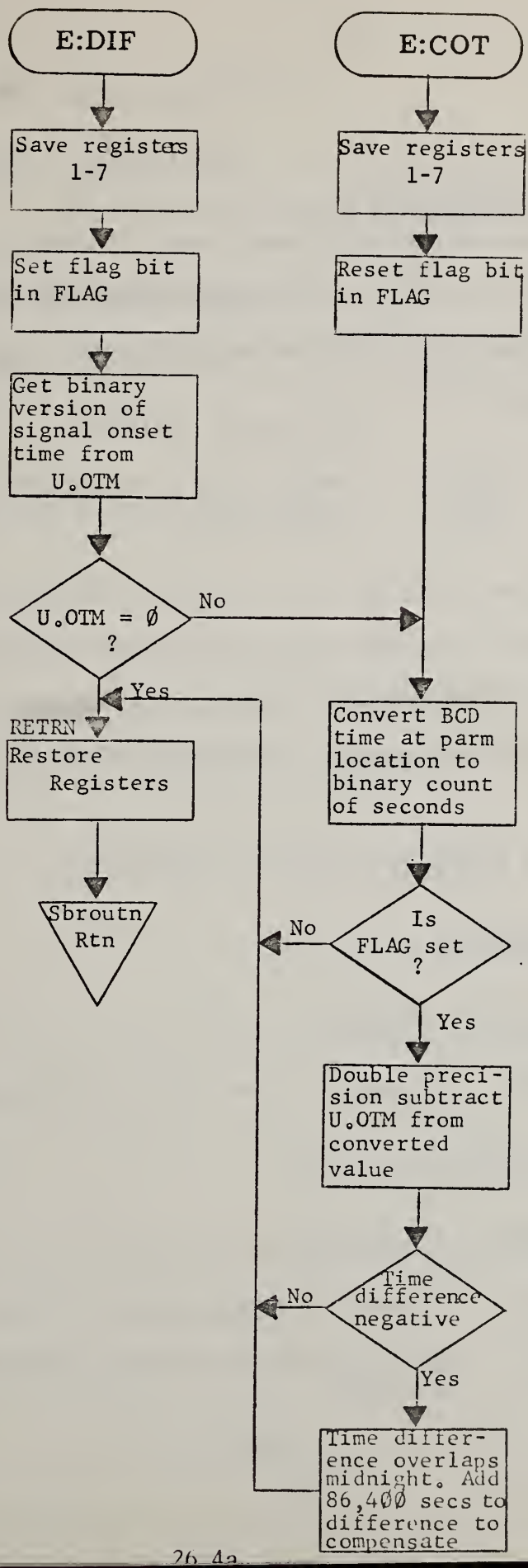
26.4 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
E:DIF		Entry point for time difference computation subroutine.
E:COT		Entry point for time format conversion subroutine.

26.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
SAVER	7	Register storage area.
FLAG	1	=1 if entry made through E:COT; = Ø if through E:DIF

A


E:DIF
E:COT
Save registers 1-7
Save registers 1-7
Set flag bit in FLAG
Reset flag bit in FLAG
Get binary version of signal onset time from U.OTM
U.OTM = Ø ?
No
Yes
RETRN
Restore Registers
Sbroutn Rtn
Convert BCD time at parm location to binary count of seconds
Is FLAG set ?
No
Yes
Double precision subtract U.OTM from converted value
Time difference negative
No
Yes
Time difference overlaps midnight. Add 86,400 secs to difference to compensate

27. E$FMF

27.1 Functional Description

When NUSTAD needs to output a phase value, the executive support subroutine E:FMF is called to reformat that value from its internal storage format (Figure 16.3) to a decimal form indicating microseconds. The calling sequence is:

```
BLM,15      E:FMF     Phase value to be converted in R12
DFC         STORE     Address where result to be store
```

E:FMF assumes the value in R12 is a phase formatted value, converts that binary number to a decimal value, and stores the corresponding ASCII characters in five computer words starting at the location specified in the calling sequence. The format of the resulting output is: ±ØØØØ.ØØ
which represents a signed phase value in microseconds.

27.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:BAD	E$BDC	Converts binary value to ASCII decimal for output

27.3 Input Parameter Descriptions

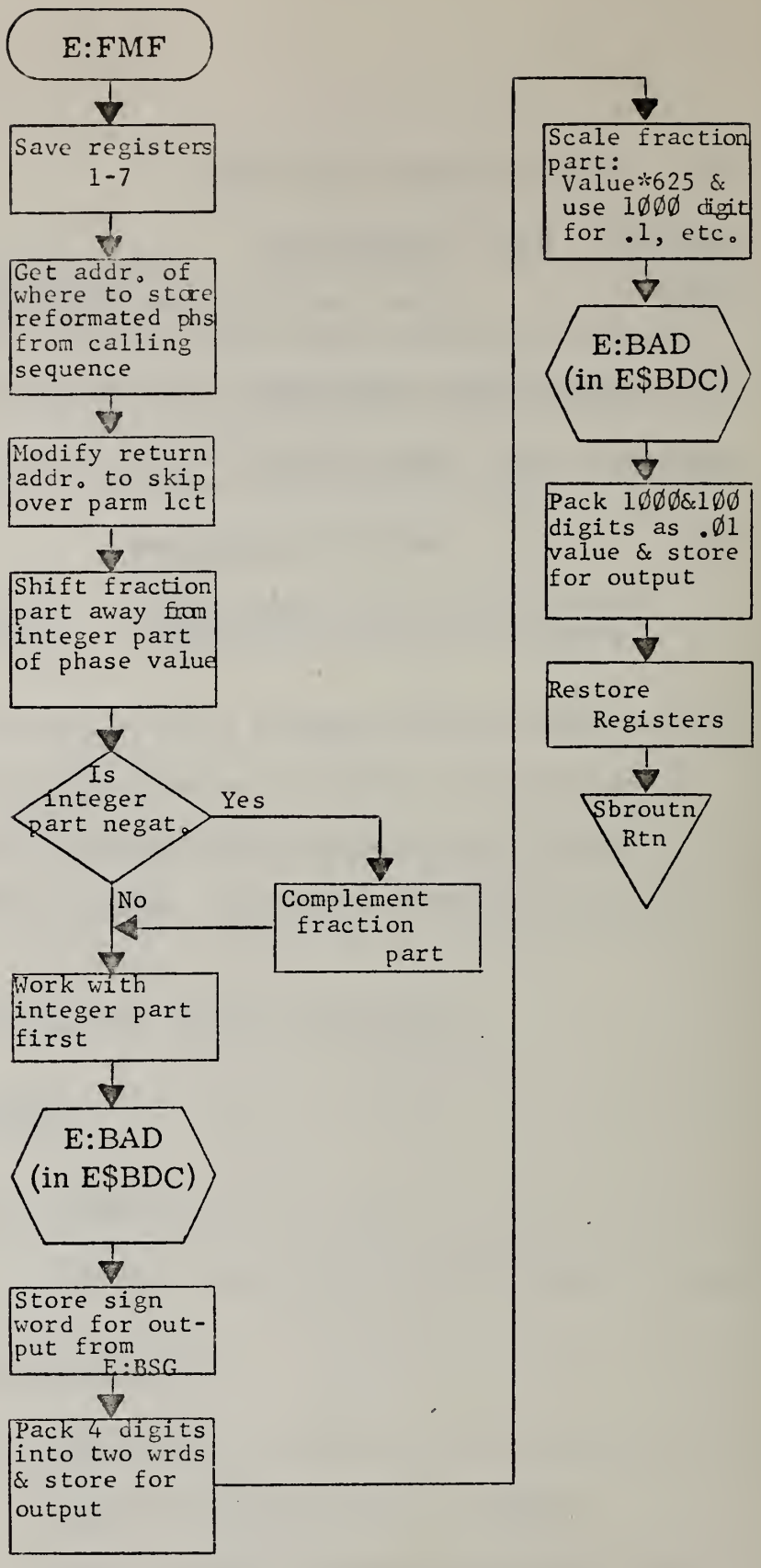
PARAMETER	PROGRAM	DESCRIPTION
E.BSG	E$BDC	Sign of the output to call to E:BAD
E.BDG	E$BDC	Buffer for ASCII characters generated by call to E:BAD

27.4 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
E:FMF		Entry point to phase reformatting subroutine.

27.5 Internal Data Descriptions

PARAMETER	SIZE	DESCRIPTION
SAVER	7	Register storage area.


E:FMF
Save registers 1-7
Get addr. of where to store reformated phs from calling sequence
Modify return addr. to skip over parm lct
Shift fraction part away from integer part of phase value
Is integer part negat.
Yes
No
Complement fraction part
Work with integer part first
E:BAD (in E$BDC)
Store sign word for output from E:BSG
Pack 4 digits into two wrds & store for output
Scale fraction part: Value*625 & use 1000 digit for .1, etc.
E:BAD (in E$BDC)
Pack 1000&100 digits as .01 value & store for output
Restore Registers
Sbroutn Rtn

28. E$SRT

28.1 Functional Description

E:SRT is an executive support subroutine to compute the positive square root of a double precision binary value. The double precision value is entered in R12, R13 and the subroutine is called by the following sequence:

```
BLM,14        E:SRT                D.P. value in R12,R13
```

The positive (single precision) square root is returned in R13.

28.2 Computational Methods

The square root is computed using Newton's method of tangents. The process is iterative and uses the following scheme:

$$x_{n+1} + \frac{(A / x_n) + x_n}{2}$$

where: x_n is the current estimate of the square root

x_{n+1} is the next estimate of the square root

A is the argument of of the function

To aid in convergence of the successive estimates, the initial value $x_\emptyset$ is chosen to be close to the final value. That initial estimate is made thusly:

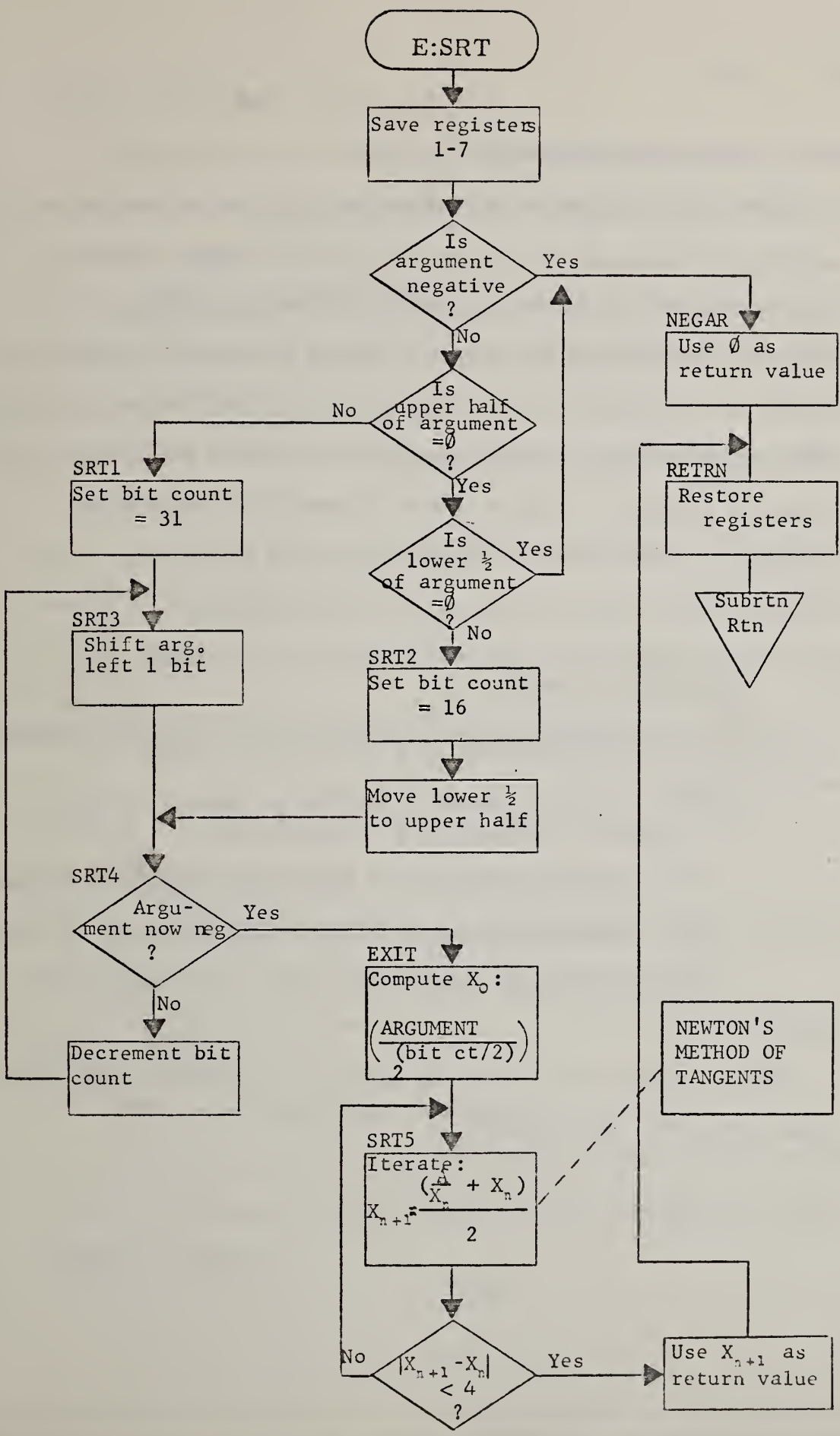
$$x_{\emptyset} = (A / 2^{(n/2)})$$

Where: n is the number of significant bits required to represent A in binary.

(Note: n/2 is truncated to give an integer)

28.3 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
SAVER	7	Register storage area.


E:SRT
Save registers 1-7
Is argument negative ?
Yes
No
NEGAR
Use Ø as return value
Is upper half of argument =Ø ?
No
Yes
SRT1
Set bit count = 31
Is lower ½ of argument =Ø ?
Yes
No
RETRN
Restore registers
Subrtn Rtn
SRT3
Shift arg. left 1 bit
SRT2
Set bit count = 16
Move lower ½ to upper half
SRT4
Argument now neg ?
Yes
No
EXIT
Compute X_0:
$\left(\frac{\text{ARGUMENT}}{(\text{bit ct}/2)}\right)^2$
Decrement bit count
NEWTON'S METHOD OF TANGENTS
SRT5
Iterate:
$X_{n+1} = \frac{(\frac{A}{X_n} + X_n)}{2}$
No
$|X_{n+1} - X_n| < 4$?
Yes
Use X_{n+1} as return value

29. F$FMT

29.1 Functional Description

F$FMT checks the DRFUD tape data for invalid bit configuration by checking for known zero bit locations in the DRFUD data stream. If a bit is found to be set at one of these locations, the tape track containing the improper bit state is labeled and output to the ASR-35 teletype for the operator's information. By working in conjunction with F$DMP, the entire data scan containing the bit error is displayed on the ASR-35 teletype to further aid the operator in locating the discrepancy. This routine is used to check the reliability of the DRFUD data and is therefore run in the background mode.

29.1.1 F:FMT (DRFUD format)

F:FMT is the operator entry point to F$FMT from E:BSK and performs two basic tasks:

a. Interprets the operator's intentions by

(1) Checking status of bit Ø of switch register. (Figure 29.1)

(2) Requesting number of blocks of DRFUD data to be checked.

b. Sets a counter to control the number of blocks of data checked.

F:FMT is entered only after the operator requests a format check action using DFC: as a keyword.

29.1.2 F:CHK (DRFUD Checking Routine)

F:CHK performs the checking function and enters an error locating routine if an error is detected. The sequence is executed using the following steps.

a. Compares the DRFUD data, one word at a time, to a known fixed format. If any ones compare, an error is present and a branch is made to an error locating routine.

b. Goes through a word mask and a bit shifting sequence to locate the bit in error.

c. Outputs a message telling the operator which tape track contains the error.

d. Executes a branch to F:DDD and displays the scan containing the error.

e. Checks bit position Ø of switch register to determine if operator intends to continue checking same block of data.

29.1.3 F:TRD (Tape Read)

F:TRD sets required parameters and initiates a mag tape read via B:IOR. Data is stored in MTBUF (Mag Tape Buffer).

29.1.4 F:USE

F:USE serves two primary functions:

a. Responds to a need for a mag tape read by calling F:TRD.

b. Transfers 55 byte blocks of data from MTBUF to FUDBF (DRFUD Data Buffer).

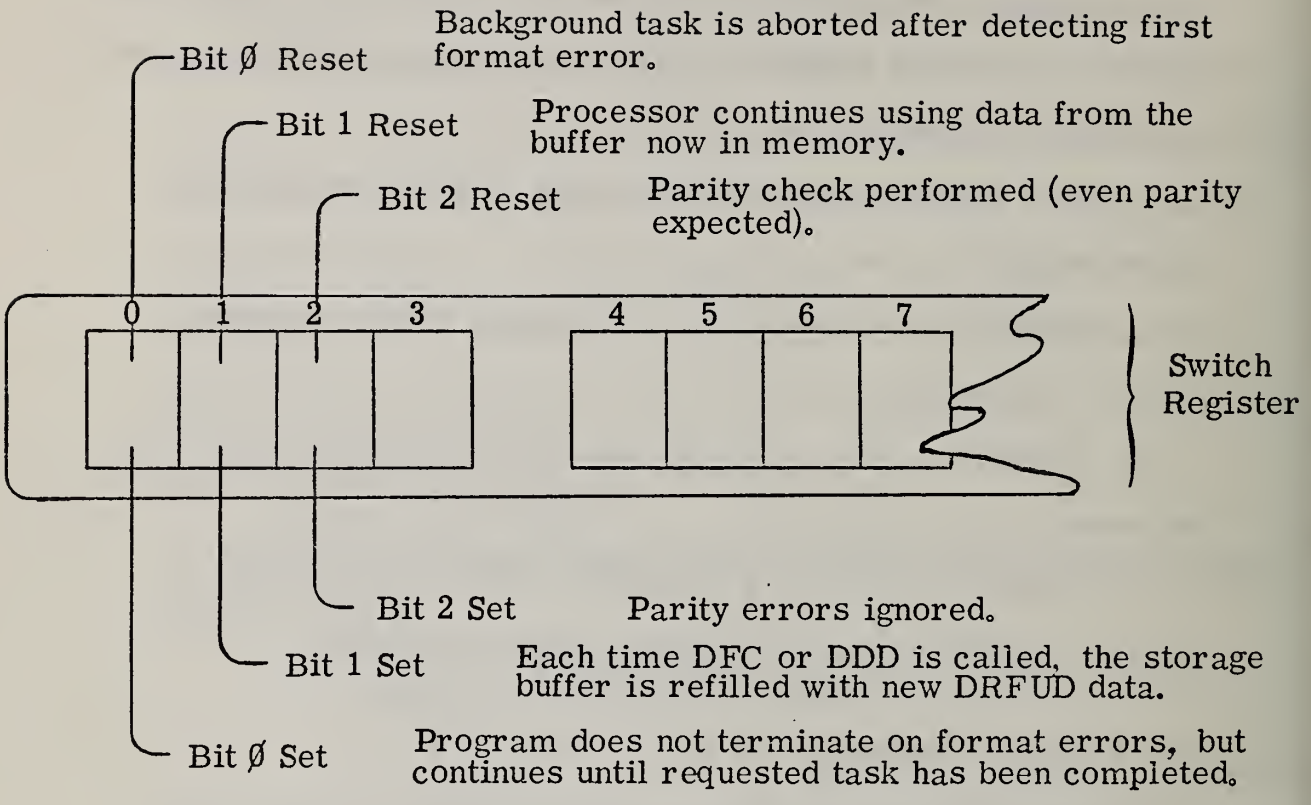


Figure 29.1 Switch Register Options

29.1.5 F:CVT

F:CVT is a general purpose routine that performs text analysis on and converts operator responses to ASCII.

29.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
E:SKD	E$SKD	Scheduler reentry point.
B:IOR	B$TSI	Background program I.O. request routine.
F:DDD	F$DMP	DRFUD data display routine.

29.3 Computational Methods

29.3.1 Error Detection Scheme

Error detection is accomplished by checking the DRFUD data for bits set in known zero locations. Once an error has been detected, the word is examined by extracting the data and checking for the set bit position through a series of shifts. Once the set bit position has been located, the tape track containing it is labeled and output to the ASR-35 teletype.

29.4 Data Formats

29.4.1 DRFUD Tape Format

Input requests by the operator in response to "NO. OF BLOCKS TO BE CHECKED" should be a positive integer less than 32,767 and are entered as explained in Appendix III.

DRFUD data is read from magnetic tape in the format shown in Figure 29.3. It is repacked, two bytes to a word, and is stored in MTBUF. The same format is kept when the data is transferred to FUDBF. Zeros are inserted in the last byte position of FUDBF to insure that any error detected is not the result of this byte containing previously set values.

29.5 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
B.STT	E$SKD	Background status flag, set to Ø for no task in progress.
E.35I	E$T35	Address of first character of input from ASR-35.

29.6 Output Parameter Descriptions

PARAMETER	SIZE	DESCRIPTION
F:FMT		Entry point for DRFUD format check routine (see Section 29.1.1).
F:CHK		Entry point to the format checking sequence (see Section 29.1.2).
F:TRD		Entry point to the tape read initiator (see Section 29.1.3).
F:USE		Entry point for operator response conversion routine (see Section 29.1.5).
F.DBF	1	External reference name for the DRFUD data buffer (FUDBF).
F.MTP	1	Location pointer for MTBUF.

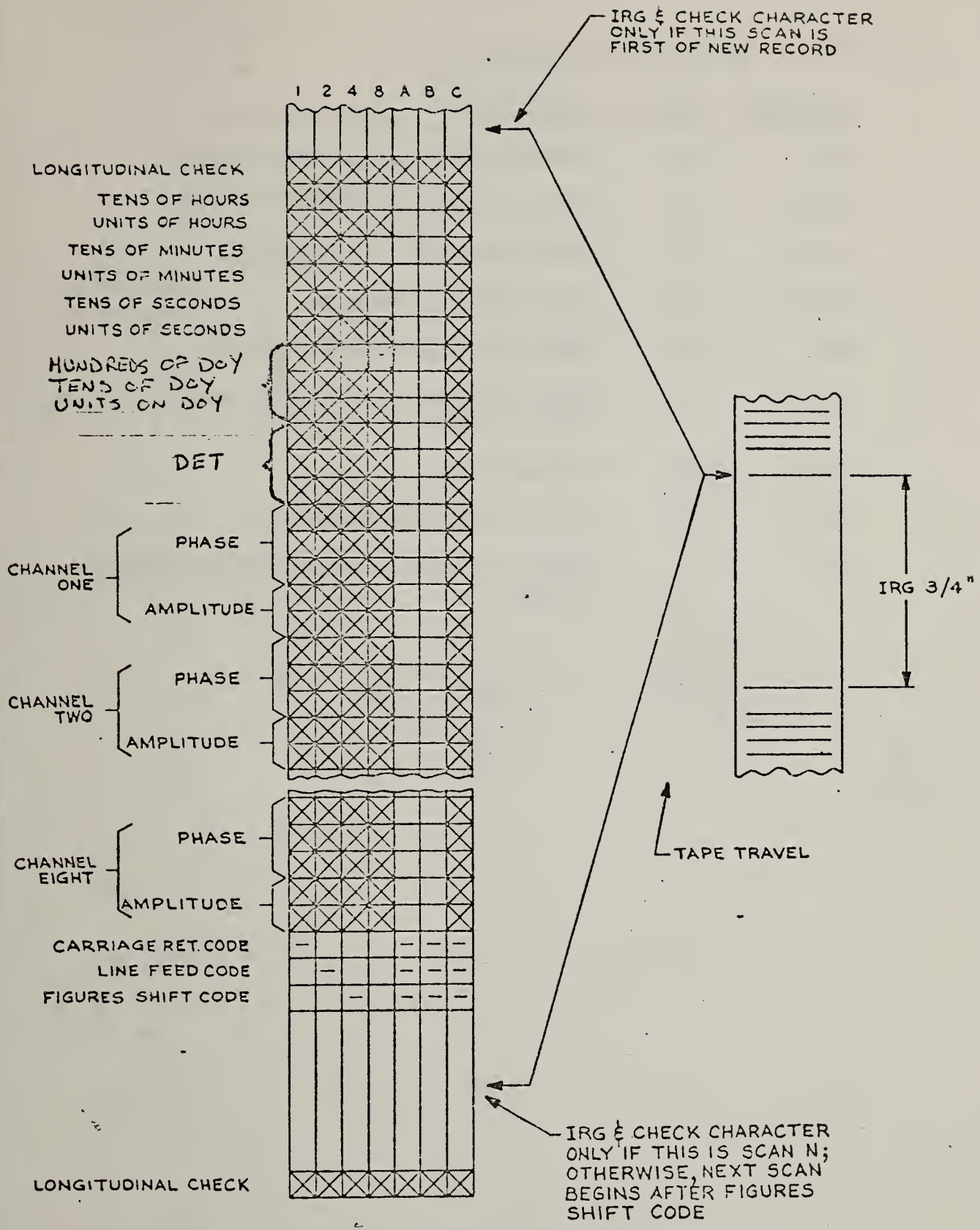
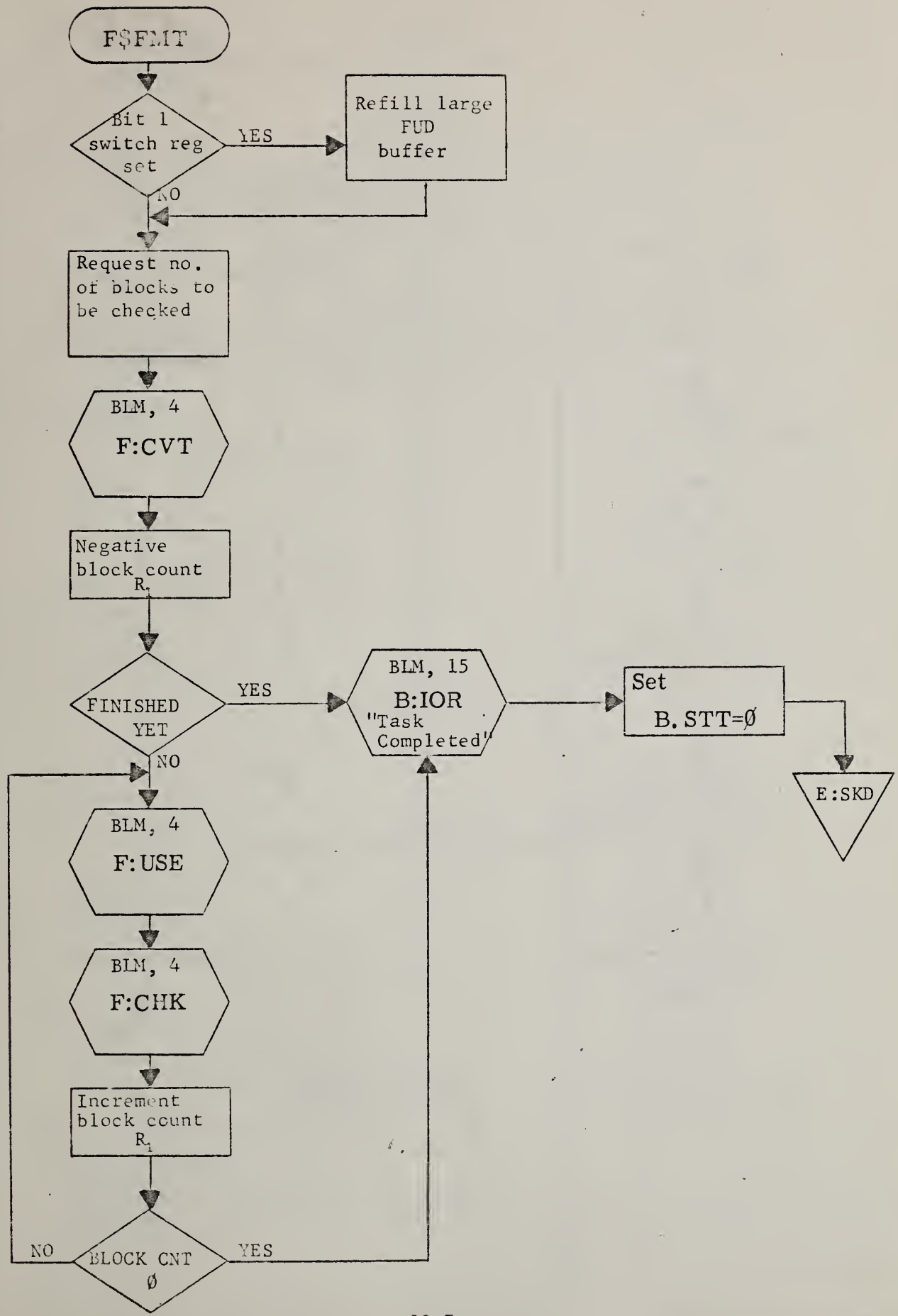
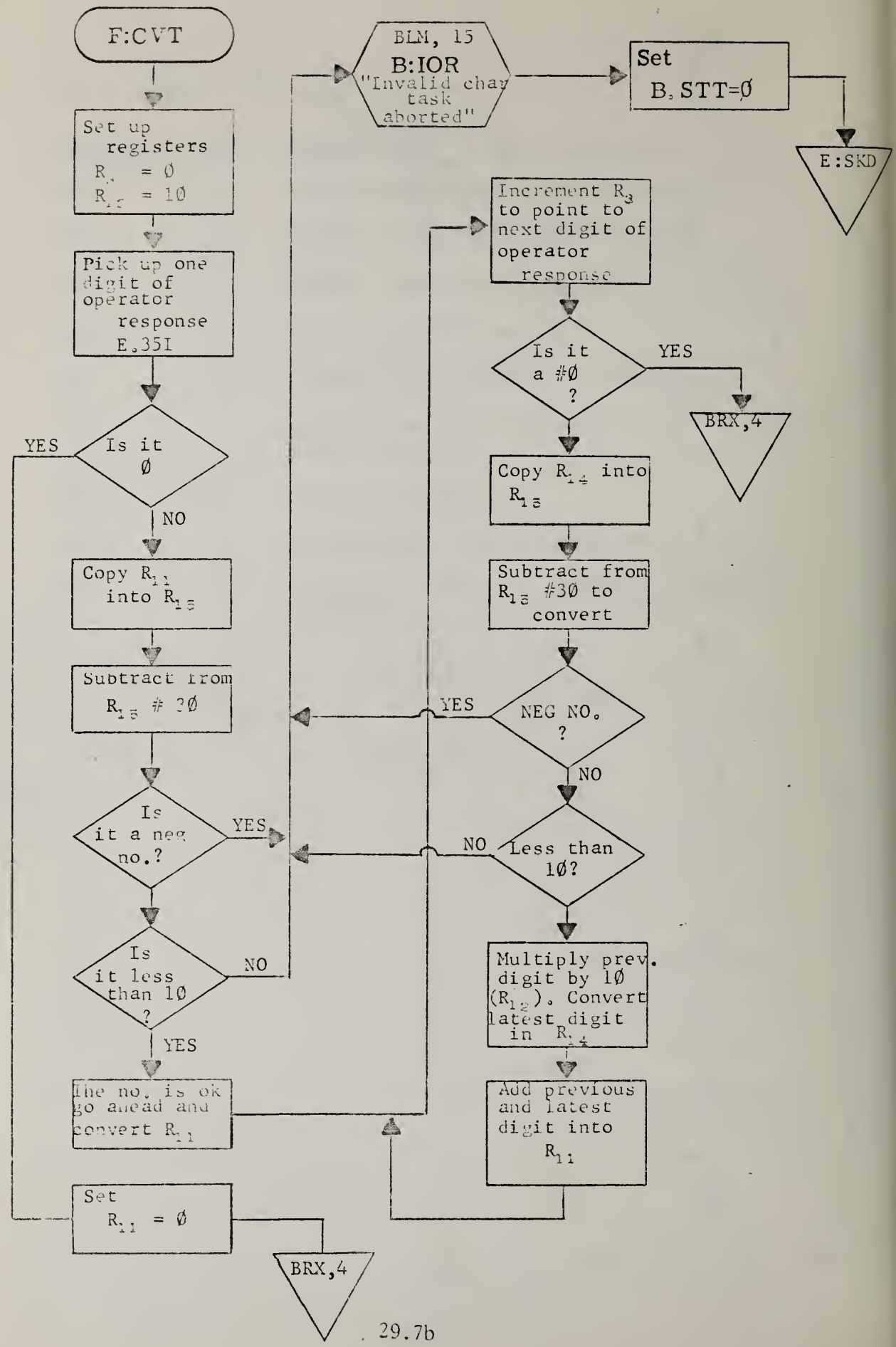


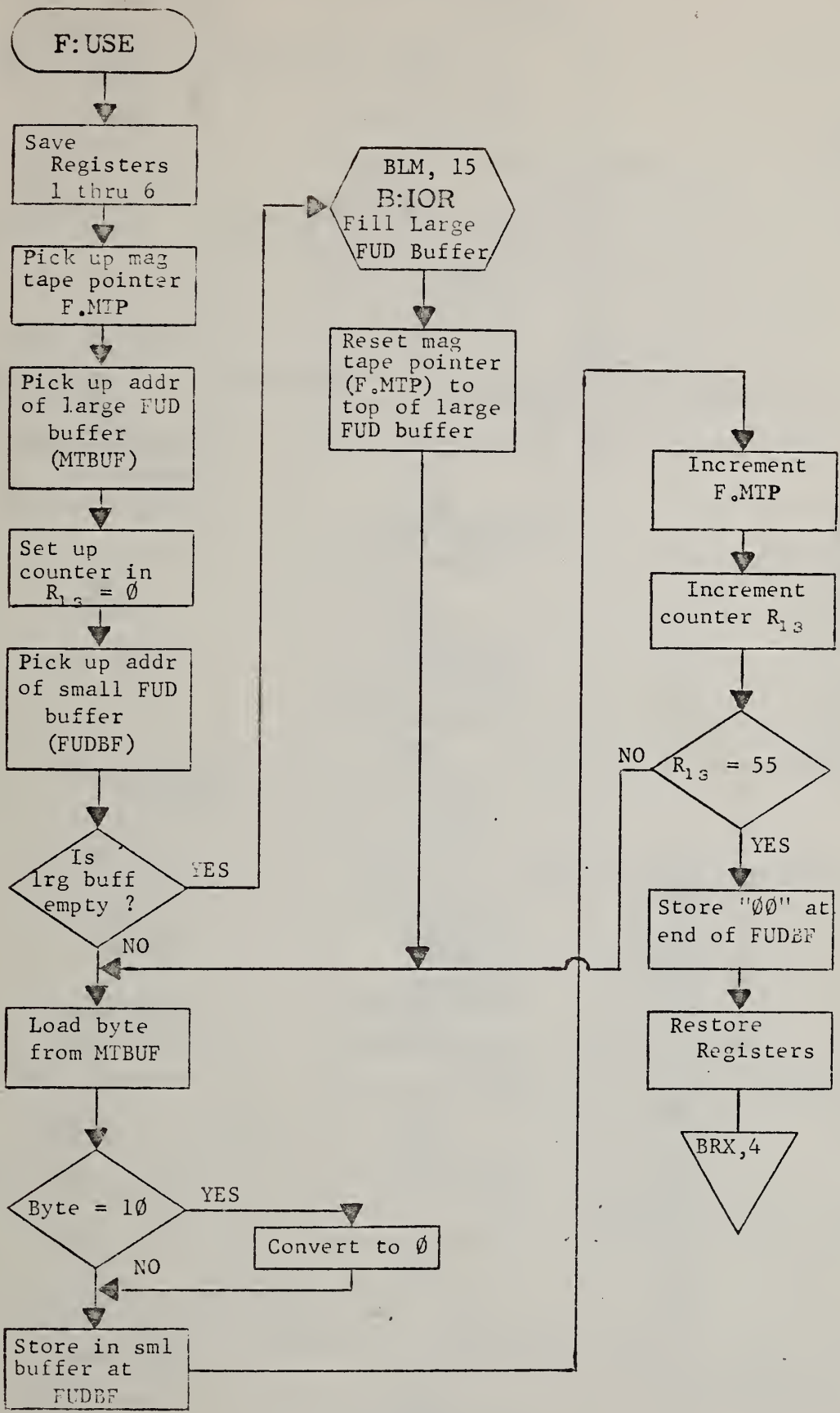
Figure 29.3 DRFUD TAPE FORMAT (NEW U SYSTEM)

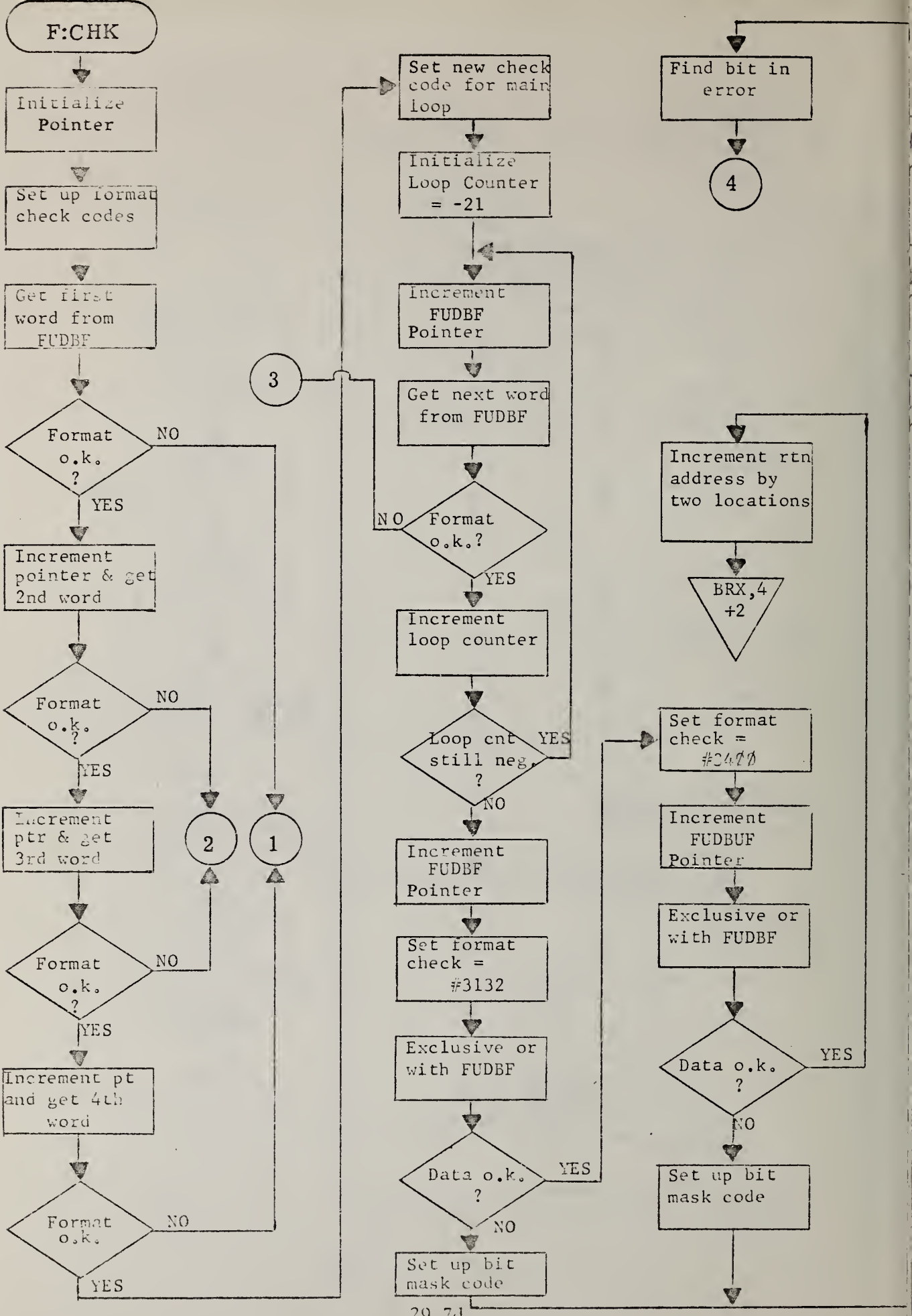
29.8 Internal Data Descriptions

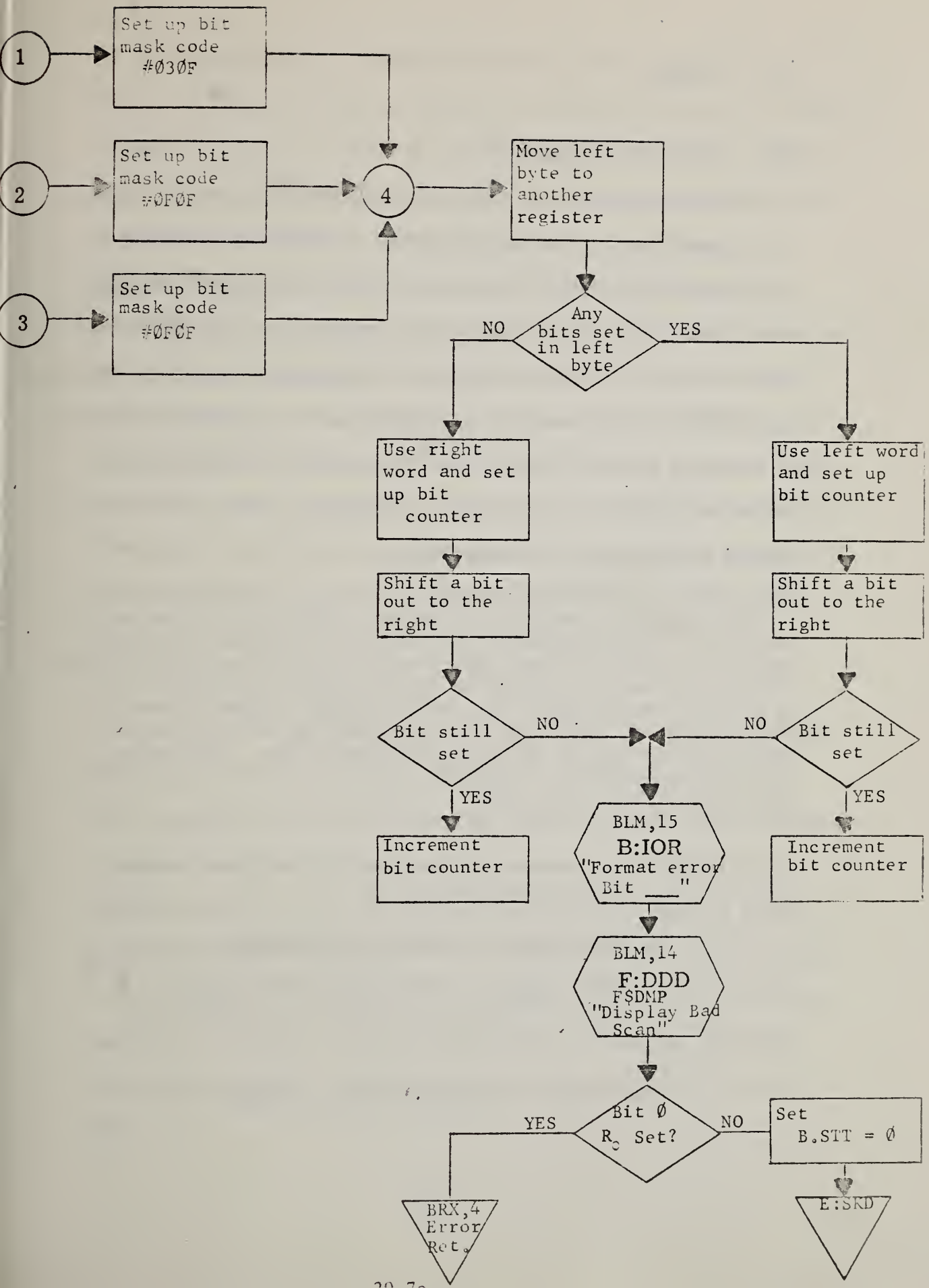
PARAMETER	SIZE	DESCRIPTION
NUBK	16	"NO. OF BLOCKS TO BE CHECKED" message.
BADNO	16	"INVALID CHAR, TASK ABORTED" message.
X.VAL	12	"FORMAT ERROR BIT 8" message.
FINSH	1Ø	"TASK COMPLETED" message.
QUIT	12	"FORMAT CHECK TERMINATED" message.
TAB	6	Table of mag tape track labels used to indicate errors present.
MTBUF	7Ø4Ø	Mag tape buffer.
FUDBF	28	Working buffer for DRFUD data.
FRS	7	Temporary storage for contents of registers 1 through 7.


F$FMT
Bit 1 switch reg set
YES
Refill large FUD buffer
NO
Request no. of blocks to be checked
BLM, 4
F:CVT
Negative block count R0
FINISHED YET
YES
BLM, 15
B:IOR
"Task Completed"
Set
B.STT=Ø
E:SKD
NO
BLM, 4
F:USE
BLM, 4
F:CHK
Increment block count R1
NO
BLOCK CNT Ø
YES


F:CVT
Set up registers
R_4 = Ø
R_{12} = 1Ø
Pick up one digit of operator response
E.35I
Is it Ø
YES
NO
Copy R_{11} into R_{13}
Subtract from R_{13} # 3Ø
Is it a neg no.?
YES
Is it less than 1Ø ?
NO
YES
The no. is ok go ahead and convert R_{11}
Set R_{11} = Ø
BRX,4
BLM, 15
B:IOR
"Invalid char task aborted"
Set B.STT=Ø
E:SKD
Increment R_3 to point to next digit of operator response
Is it a #Ø ?
YES
BRX,4
Copy R_{14} into R_{13}
Subtract from R_{13} #3Ø to convert
NEG NO. ?
YES
NO
Less than 1Ø?
NO
Multiply prev. digit by 1Ø (R_{12}). Convert latest digit in R_4
Add previous and latest digit into R_{11}


F:USE
Save Registers 1 thru 6
Pick up mag tape pointer F.MTP
Pick up addr of large FUD buffer (MTBUF)
Set up counter in R_{13} = Ø
Pick up addr of small FUD buffer (FUDBF)
Is lrg buff empty ?
YES
NO
BLM, 15
B:IOR
Fill Large FUD Buffer
Reset mag tape pointer (F.MTP) to top of large FUD buffer
Load byte from MTBUF
Byte = 1Ø
YES
Convert to Ø
NO
Store in sml buffer at FUDBF
Increment F.MTP
Increment counter R_{13}
R_{13} = 55
NO
YES
Store "ØØ" at end of FUDBF
Restore Registers
BRX,4


F:CHK
Initialize Pointer
Set up format check codes
Get first word from FUDBF
Format o.k. ?
NO
YES
Increment pointer & get 2nd word
Format o.k. ?
NO
YES
Increment ptr & get 3rd word
Format o.k. ?
NO
YES
Increment pt and get 4th word
Format o.k.
NO
YES
1
2
3
Set new check code for main loop
Initialize Loop Counter = -21
Increment FUDBF Pointer
Get next word from FUDBF
Format o.k.?
NO
YES
Increment loop counter
Loop cnt still neg. ?
YES
NO
Increment FUDBF Pointer
Set format check = #3132
Exclusive or with FUDBF
Data o.k. ?
YES
NO
Set up bit mask code
Find bit in error
4
Increment rtn address by two locations
BRX,4 +2
Set format check = #2400
Increment FUDBUF Pointer
Exclusive or with FUDBF
Data o.k. ?
YES
NO
Set up bit mask code


1
Set up bit mask code #Ø3ØF
2
Set up bit mask code #ØFØF
3
Set up bit mask code #ØFØF
4
Move left byte to another register
Any bits set in left byte
NO
YES
Use right word and set up bit counter
Use left word and set up bit counter
Shift a bit out to the right
Shift a bit out to the right
Bit still set
NO
NO
Bit still set
YES
YES
Increment bit counter
BLM,15
B:IOR
"Format error Bit ___"
Increment bit counter
BLM,14
F:DDD
F$DMP
"Display Bad Scan"
Bit Ø R0 Set?
YES
NO
Set B.STT = Ø
BRX,4
Error Ret.
E:SRD

3Ø. F$DMP

3Ø.1 Functional Description

F$DMP enables the operator to display DRFUD data on the ASR 35 in a usable format. He can specify the parameters of the display as either time or number of data scans to be displayed. The data to be displayed is taken directly from FUDBF using byte addressing it is reformatted in the progress and is displayed in two lines, the first containing time and location information and the second being made up of the phase and amplitude values of the eight recorded channels. Before being displayed, the data is examined by F:CHK and errors are handled as explained in Chapter 29.

The program is entered in F:DMP from E:BSK bit Ø of the switch register is checked to determine whether or not a new block of data is to be read from mag tape. The initial dialog is then started to determine which option the operator wishes to use. The options are listed in the table below.

1. START TIME AND STOP TIME.
2. START TIME AND NUMBER OF DATA BLOCKS.
3. START IMMEDIATE AND NUMBER OF DATA BLOCKS.

Table 3Ø.1 Operator Display Options

The conversation is carried on via the B:IOR subroutine of E$TSI. Information from the operator is retrieved from E.35I (E$T35) at various points in F:DMP. F:FST first determines if the operator wants a start time, if not, it outputs a message requesting "NUMBER OF BLOCKS TO BE DUMPED." Operator response to this inquiry is converted to ASCII and set in a counter (BLKBF) that limits the display length. Each time a data scan is displayed, F:USE is entered and new data is transferred from MTBUF to FUDBF. If a start time is desired (option 1 or 2), a message is output stating "SPECIFY START TIME DESIRED." The operator's response is converted to binary (PACK) and held in NGSTR and NGSTR+1. The contents of MTBUF are scanned via FUDBF until the difference between the time requested and the time of the data scan is zero. The contents of MTBUF are automatically updated as explained in Chapter 29. A format check is performed prior to each time comparison to insure that the data contained in the time locations of FUDBF are not simply phase and amplitude data misplaced because of a dropped character. In the event that the DRFUD tape data was recorded sometime after the start time requested, a message is output stating this fact and control is returned to NUSTAD. Once the start time has been located, a message is output requesting a stop time (option 1) or a number of data blocks (option 2). The stop time is converted to a number of data scans (1/second) and stored in BLKBF. The number of blocks is converted from ASCII and stored in BLKBF. The display is continued until BLKBF reaches zero.

30.1.1 F:DMP

F:DMP is the program organizer for F$DMP. It serves three basic purposes:

a. Checks status of bit position Ø of switch register to determine if the operator wants to refill MTBUF with new data.

b. Calls for a start time message which gives the operator the three options previously mentioned (Section 3Ø.1).

c. Keeps track of the amount of data that has been displayed and returns to E$SKD when the assigned task is completed.

30.1.2 F:DDD

F:DDD simply repacks the DRFUD data one byte at a time into the format shown in Figure 3Ø.1. The data is stored in two separate locations, HEADR and DATA. HEADR contains time and location information and DATA contains phase and amplitude for eight DRFUD channels plus three fixed control characters that appear at the end of a data block. The two information blocks are output one at a time to avoid tying up the output channel with large message outputs.

30.1.3 F:FST

F:FST is the routine that sets the DRFUD tape to the desired starting position. It also performs some text analysis on operator responses to machine requests.

3Ø.1.4 F:TIM

F:TIM converts both operator requested DOY and DRFUD DOY to binary for comparison, then performs a greater than or equal to check to see if the tape is positioned at the correct DOY. If the DOY requested is less than the DOY contained on the DRFUD tape, a message (PASTD) is output informing the operator of this fact. If the DOY's are the same, a branch is executed to F:BBT which converts the DRFUD time data to binary. A comparison is made between the DRFUD time and the requested time resulting in either an additional read to advance the mag tape or an output message (PASTT) informing the operator that the tape is positioned past the time desired. Once both comparisons are satisfied, a request is output for stop time information. The stop time requested is simply converted to a number of data scans (1/second) and stored in BLKBF. If during the time search, an error is detected, the task is aborted and control is returned to E:SKD.

3Ø.1.5 F:BBT

F:BBT converts BCD to binary time and returns with the result in registers 12 and 13.

3Ø.2 Called Subroutines

SUBROUTINE	PROGRAM	FUNCTION
F:CHK	F$FMT	Performs the checking sequence in F$FMT and enters an error locating routine (F.BAD) if an error is detected.
B:IOR	E$TSI	Background program I.O. request routine.
F:CVT	F$FMT	Routine to convert operator response to ASCII.
E:SKD	E$SKD	Scheduler reentry point.
F:USE	F$FMT	Routine that transfers data from MTBUF to FUDBF.

3Ø.3 Data Formats

3Ø.3.1 DRFUD Data Formats

DRFUD data is input in the format shown in Figure 29.1 and is output in the format shown in Figure 3Ø.1. If an error is detected, the standard output format will be preceded by an error statement as shown in Figure 3Ø.2.

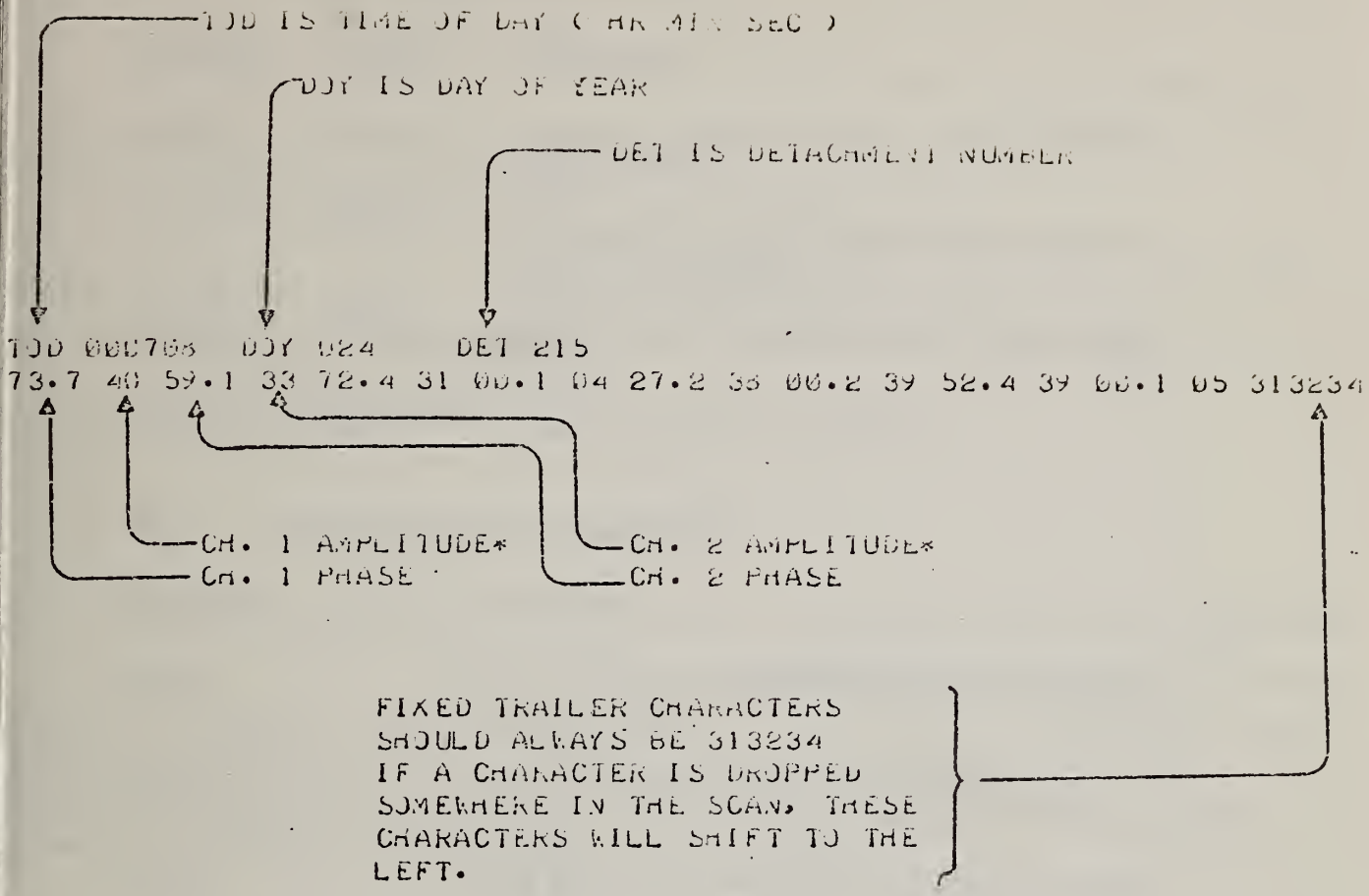
3Ø.3.2 Operator Response (Time Data)

Operator response to a time request is changed to a format compatible with DRFUD data.

```
(DOY)(Time)                (Time)
123 123456 is repacked to 123456 (DROP DOY)
```

3Ø.3.3 Operator Response (Parameter Format)

Operator responses to machine request for parameter information are outlined in Appendix III.



* ALL EIGHT CHANNELS OF AMPLITUDE AND PHASE ARE DUMPED.

EXAMPLE: DRFUD DATA DUMP FORMAT.

Fig. 30.1

```
x   DFC:                                    {OPERATOR CALLS FOR A DRFUD
                                            {FORMAT CHECK.

NO. OF BLOCKS TO BE CHECKED?4096            {OPERATOR WANTS 4096 SCANS TO
                                            {BE CHECKED.

FORMAT ERROR BIT 5                          {SOMEWHERE IN THE CHECKING
                                            {PROCESS, THE ROUTINE DETECTED
                                            {AN EOF CODE AS IS SHOWNIN
                                            {THE DUMP AS A ??.

TOD ??0925  DOY 024    DET 215
73.5 42 58.8 33 73.4 31 00.1 04 28.1 39 00.2 39 53.2 40 00.1 05 313234

FORMAT CHECK TERMINATED                     {TERMINATION STATEMENT
                                            {INDICATING THAT BIT 0
                                            {OF THE SWITCH REG WAS SET.


x   DFC:

NO. OF BLOCKS TO BE CHECKED?700

TASK COMPLETED                              {TERMINATION STATEMENT INDICATE
                                            {CHECK OF ALL 700 SCANS DETEC-
                                            {NO ERRORS.  THERE IS NO DUMP
                                            {INITIATED IF NO ERRORS ARE
                                            {DETECTED.
```

EXAMPLE: DRFUD FORMAT CHECK.

Fig. 30.2

3Ø.4 Input Parameter Descriptions

PARAMETER	PROGRAM	DESCRIPTION
F.DBF	F$FMT	External reference name for the DRFUD data buffer (FUDBF).
B.STT	E$SKD	Background status flag, set to Ø for no task in progress.
E.34I	E$T35	Address of first character of input from ASR 35.
F.MTP	F$FMT	Location pointer for MTBUF.

3Ø.5 Output Parameter Descriptions

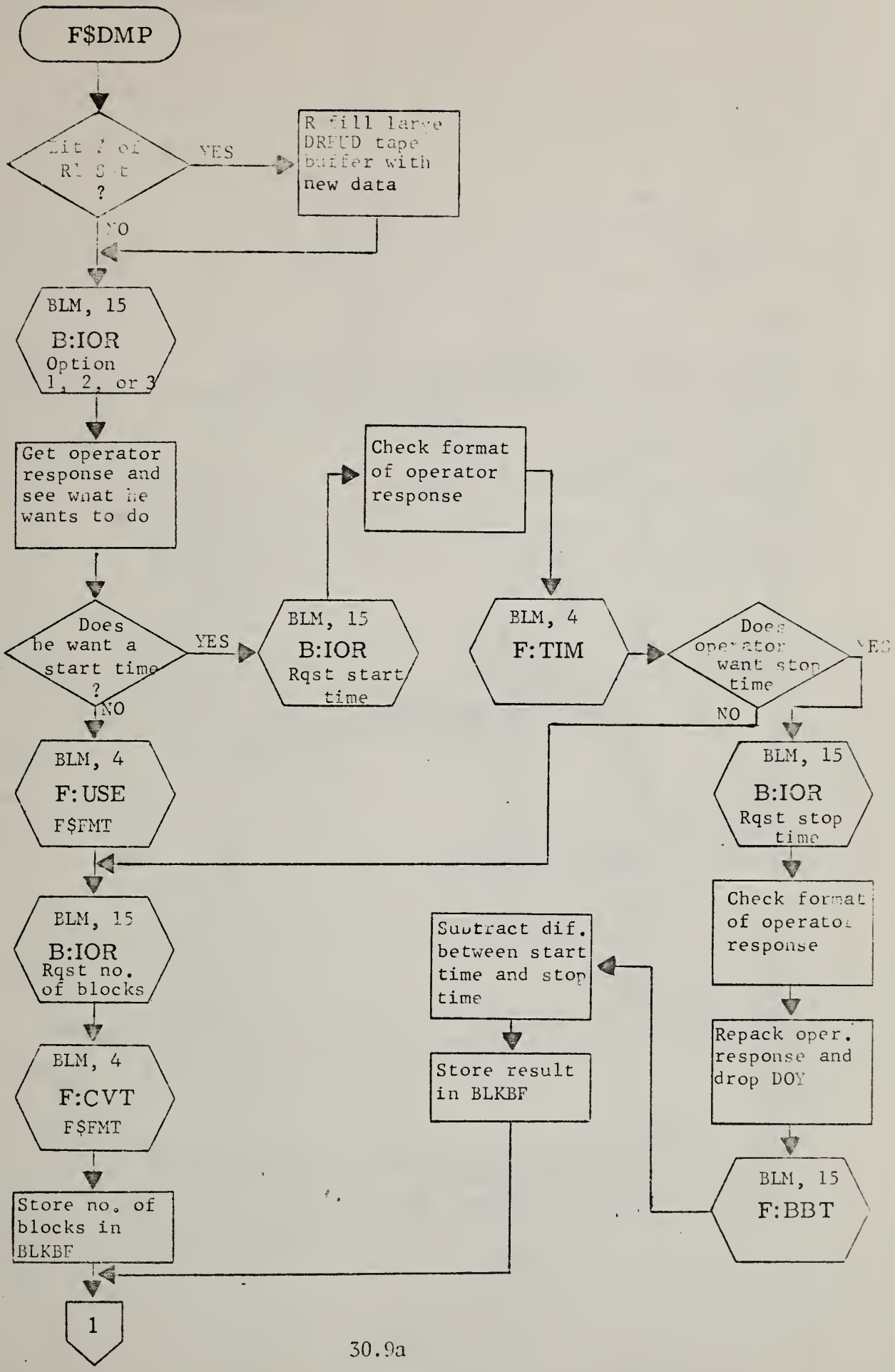
PARAMETER	SIZE	DESCRIPTION
F:DMP		Entry point for DRFUD data display routine (Section 3Ø.1.1)
F:FST		Entry point for section of program that requests one of the three options (Section 3Ø.1.3)
F:BBT		Entry point for conversion routine to change BCD to binary time (Section 3Ø.1.5).
F:TIM		Entry point to routine that finds the time requested on mag tape (Section 3Ø.1.4)
F:DDD		Entry point to the routine that formats the data and displays it on the ASR 35 (Section 3Ø.1.2)

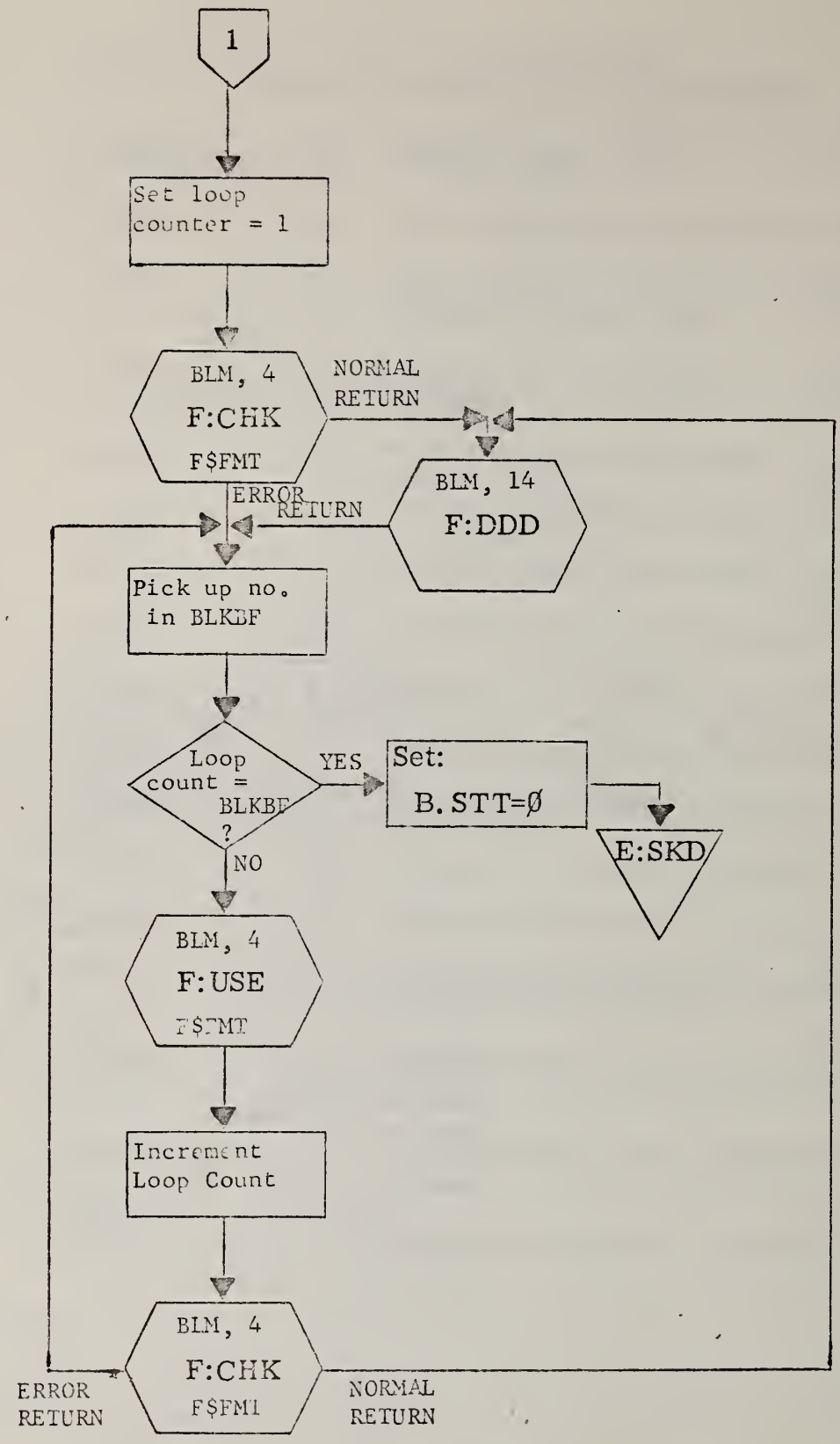
3Ø.6 Internal Data Descriptions

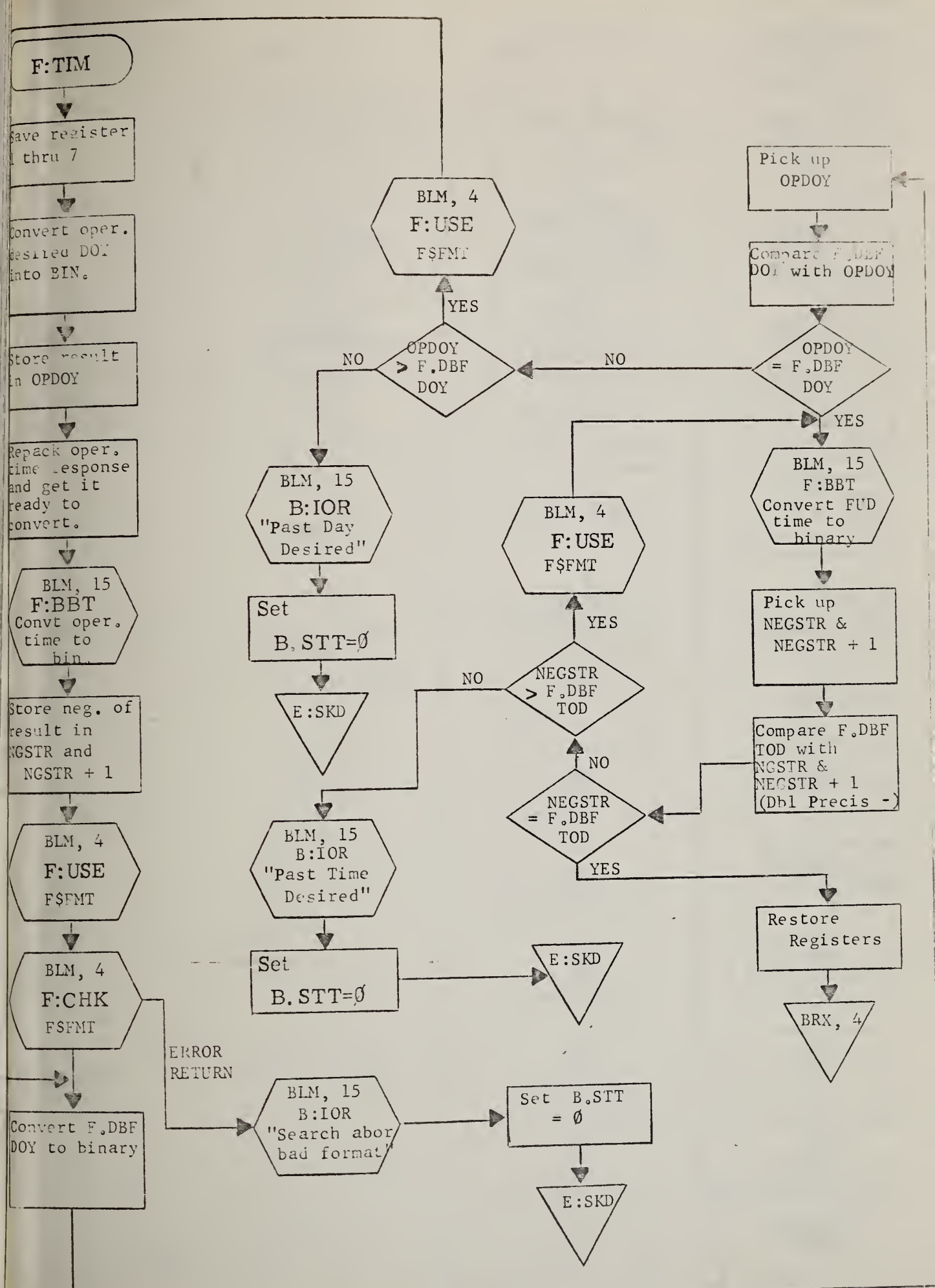
PARAMETER	SIZE	DESCRIPTION
BLKBF	1	Storage for a block count value.
SVDDD	13	Temporary storage for registers 1 through 7 and 1Ø through 15.

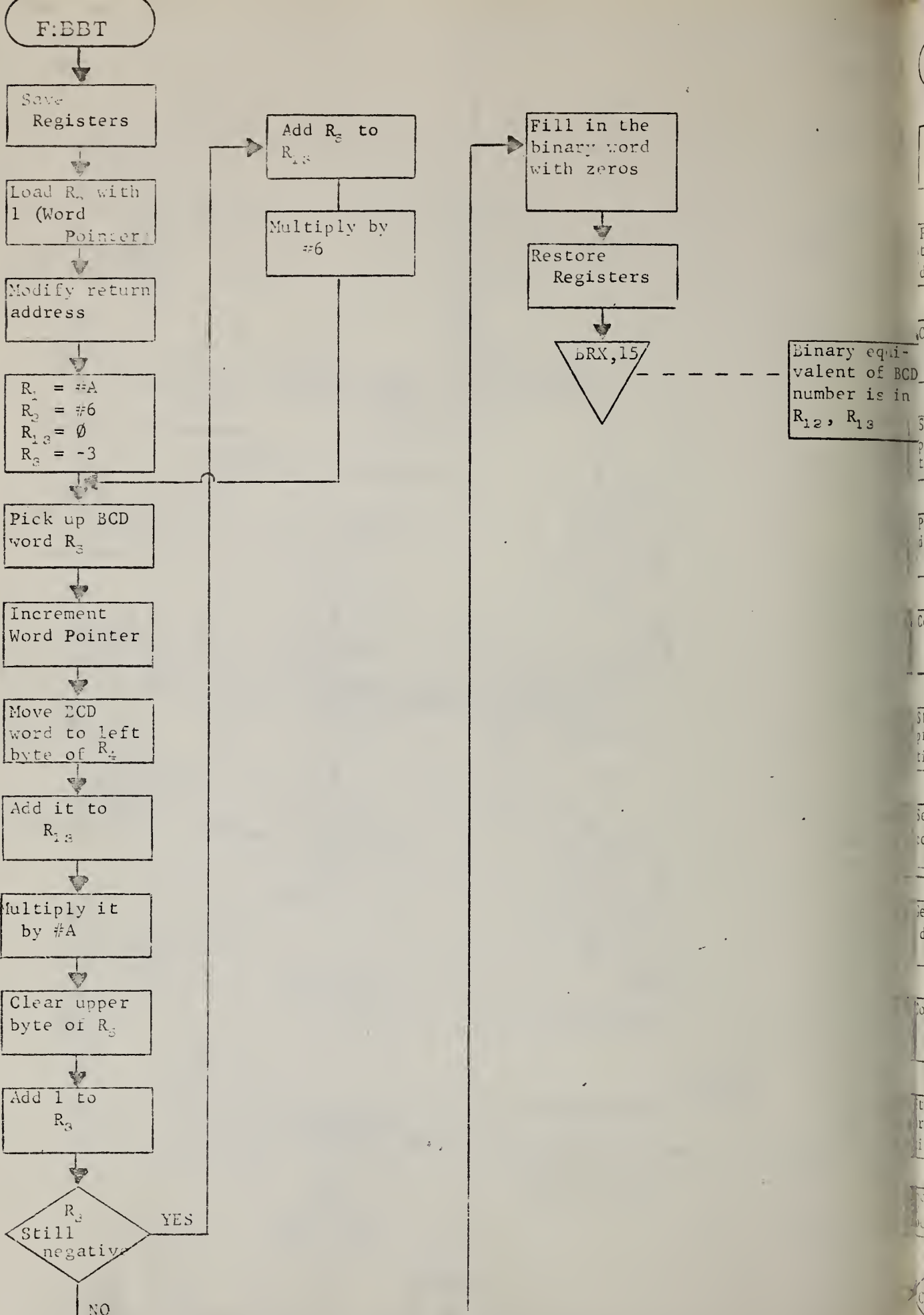
30.6 Internal Data Descriptions (continued)

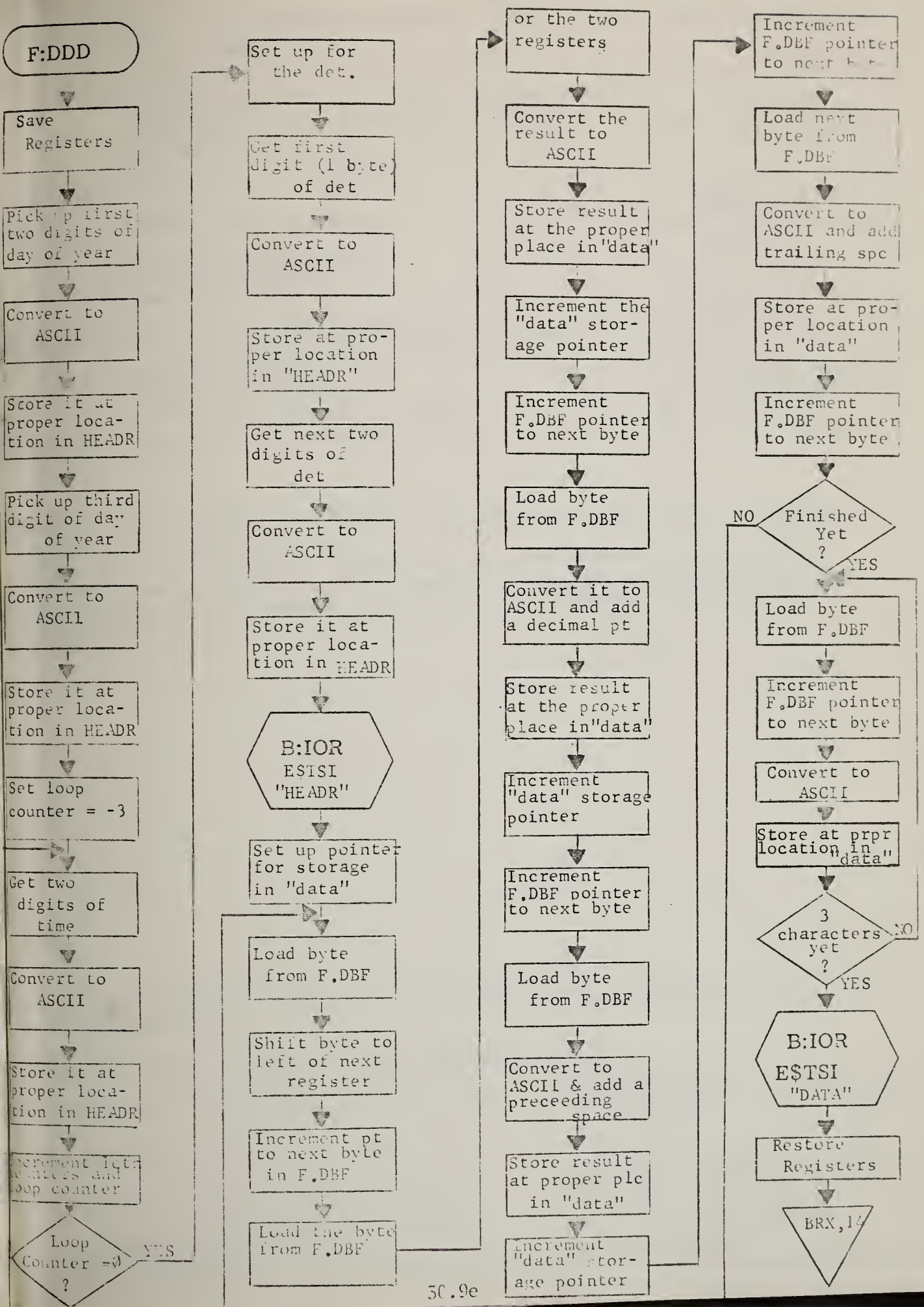
PARAMETER	SIZE	DESCRIPTION
HEADR	18	"TOD 123456 DOY 123 DET 515" output message.
DATA	37	Phase and amplitude display message for eight channels of DRFUD data.
OPTS	20	"SPECIFY ACTION DESIRED, 1, 2 or 3." output message.
NOBLK	16	"NO. OF BLOCKS TO BE DUMPED" output message.
TIME	16	"SPECIFY START TIME DESIRED" output message.
QUIT	15	"SPECIFY STOP TIME DESIRED" output message.
FORM	17	"INVALID FORMAT ON TIME REQUEST" output message.
T.MBF	6	Address of first BCD word of time used in F:BBT.
RFCRS	7	Temporary storage for registers 1 through 7.
OPDOY	1	Storage for operator requested day of year.
NGSTR	2	Storage for operator requested time of day.
SAVER	7	Temporary storage for registers 1 through 7.
PASTT	22	"FUD TAPE POSITIONED PAST TIME DESIRED" output message.
PASTD	22	"FUD TAPE POSITIONED PAST DAY DESIRED" output message.
NOGO1	19	"SEARCH ABORTED DUE TO FORMAT ERROR" output message.
BBTSV	7	Temporary storage for registers 1 through 7.


F$DMP
Bit 7 of R1 S-t ?
YES
R fill large DRFUD tape buffer with new data
NO
BLM, 15
B:IOR
Option 1, 2, or 3
Get operator response and see what he wants to do
Does he want a start time ?
YES
NO
BLM, 15
B:IOR
Rqst start time
Check format of operator response
BLM, 4
F:TIM
Does operator want stop time
YES
NO
BLM, 4
F:USE
F$FMT
BLM, 15
B:IOR
Rqst stop time
Check format of operator response
Repack oper. response and drop DOY
BLM, 15
F:BBT
Subtract dif. between start time and stop time
Store result in BLKBF
BLM, 15
B:IOR
Rqst no. of blocks
BLM, 4
F:CVT
F$FMT
Store no. of blocks in BLKBF
1


1
Set loop counter = 1
BLM, 4
F:CHK
F$FMT
NORMAL RETURN
ERROR RETURN
BLM, 14
F:DDD
Pick up no. in BLKBF
Loop count = BLKBF ?
YES
Set:
B.STT=Ø
E:SKD
NO
BLM, 4
F:USE
F$FMT
Increment Loop Count
BLM, 4
F:CHK
F$FM1
ERROR RETURN
NORMAL RETURN


F:TIM
Save register 1 thru 7
Convert oper. desired DOY into BIN.
Store result in OPDOY
Repack oper. time response and get it ready to convert.
BLM, 15 F:BBT Convt oper. time to bin.
Store neg. of result in NGSTR and NGSTR + 1
BLM, 4 F:USE F$FMT
BLM, 4 F:CHK FSFMT
ERROR RETURN
Convert F.DBF DOY to binary
BLM, 15 B:IOR "Search abor bad format"
Set B.STT = Ø
E:SKD
BLM, 4 F:USE F$FMT
YES
OPDOY > F.DBF DOY
NO
BLM, 15 B:IOR "Past Day Desired"
Set B.STT=Ø
E:SKD
BLM, 15 B:IOR "Past Time Desired"
Set B.STT=Ø
E:SKD
NEGSTR > F.DBF TOD
NO
YES
BLM, 4 F:USE F$FMT
NEGSTR = F.DBF TOD
NO
YES
Compare F.DBF TOD with NGSTR & NEGSTR + 1 (Dbl Precis -)
Pick up NEGSTR & NEGSTR + 1
BLM, 15 F:BBT Convert FUD time to binary
OPDOY = F.DBF DOY
NO
YES
Compare F.DBF DOY with OPDOY
Pick up OPDOY
Restore Registers
BRX, 4


F:BBT
Save Registers
Load R_2 with 1 (Word Pointer)
Modify return address
R_1 = #A
R_2 = #6
R_{13} = Ø
R_3 = -3
Pick up BCD word R_3
Increment Word Pointer
Move BCD word to left byte of R_4
Add it to R_{13}
Multiply it by #A
Clear upper byte of R_3
Add 1 to R_3
R_3 Still negative
YES
NO
Add R_3 to R_{13}
Multiply by #6
Fill in the binary word with zeros
Restore Registers
BRX,15
Binary equivalent of BCD number is in R_{12}, R_{13}


F:DDD
Save Registers
Pick up first two digits of day of year
Convert to ASCII
Store it at proper location in HEADR
Pick up third digit of day of year
Convert to ASCII
Store it at proper location in HEADR
Set loop counter = -3
Get two digits of time
Convert to ASCII
Store it at proper location in HEADR
Increment ptrs & loop counter
Loop Counter =0 ?
YES
Set up for the det.
Get first digit (1 byte) of det
Convert to ASCII
Store at proper location in "HEADR"
Get next two digits of det
Convert to ASCII
Store it at proper location in HEADR
B:IOR E$TSI "HEADR"
Set up pointer for storage in "data"
Load byte from F.DBF
Shift byte to left of next register
Increment pt to next byte in F.DBF
Load the byte from F.DBF
or the two registers
Convert the result to ASCII
Store result at the proper place in "data"
Increment the "data" storage pointer
Increment F.DBF pointer to next byte
Load byte from F.DBF
Convert it to ASCII and add a decimal pt
Store result at the proper place in "data"
Increment "data" storage pointer
Increment F.DBF pointer to next byte
Load byte from F.DBF
Convert to ASCII & add a preceeding space
Store result at proper plc in "data"
Increment "data" storage pointer
Increment F.DBF pointer to next byte
Load next byte from F.DBF
Convert to ASCII and add trailing spc
Store at proper location in "data"
Increment F.DBF pointer to next byte
NO
Finished Yet ?
YES
Load byte from F.DBF
Increment F.DBF pointer to next byte
Convert to ASCII
Store at prpr location in "data"
3 characters yet ?
NO
YES
B:IOR E$TSI "DATA"
Restore Registers
BRX,14

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