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ABSTRACTION OF IMP TAPES

by

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I. INTRODUCTION

The program PAR is used to read data from experiment tapes and write it onto abstract tapes in a more useful form. Data considered excessively redundant is compressed. Quantities such as sector number, A and B register contents, command state, etc. are decoded. Time sequencing of data is checked.

II. TAPE FORMAT

The abstract tape (ABT) is 9-track, 800 BPI with odd vertical parity and longitudinal redundancy character, i.e., the usual PDP-11 and IBM S/370 format. Each ABT contains one file terminated by a single EOF. Normally, data from two decom runs are abstracted onto an ABT. Thus an ABT typically contains slightly more than 8 days data.

Each record contains one album of experiment data, beginning with telemetry page 0. Missing data in an album is "one-filled," i.e., each bit is set to 1. The records are time ordered with gaps between records if necessary.

Each record contains 3 logical blocks, a label block, 64 bytes long, followed by an event block, 1024 bytes long, and a rate block, 768 bytes. The total record length is 1856 bytes.

The format of the three blocks is detailed below. Unless otherwise indicated all data is written as integers of the specified length. The reader should keep in mind the "right to left" structure of the PDP-11, i.e., bytes written on a tape in the sequence 0, 1, 2, 3, 4, 5, . . . will be typed in the sequence 1, 0, 3, 2, 5, 4, . . . by a PDP-11 word dump.

Table 1 illustrates the arrangement of the label block. Table entries with an asterisk in the "Note" column are discussed in Section III.

The 1024-byte event block is composed of 128 events, each of which requires 8 bytes. The events are written in sequence from the beginning of the album. The format of one eight-byte event is shown in Table 2.

Many of the data in the event words are taken directly from the experiment tape and are discussed in Internal Report's 43 and 50. Discussion of calculated quantities and a brief repetition of the discussion of the experiment data follows below:

The bits R0, R1, . . . , R10, R11 and RZ specify which detectors fired and the hazard flag. A0 to A11 and B0 to B12 are the decoded pulse heights. The LSB's are A0 and B0. The bits S0, S1, and S2 are the decoded sector number. S0 is the LSB. Sector number 0 is the first sector after the sun pulse. The bit X is 1 if any of the 6 experiment data channels showed a parity error, and 0 otherwise.

One of the 3 bits AT1, AT2, and AT3 will be set to specify analysis type 1, 2, or 3. The other 2 bits will be 0. The bit N is set if the event is not new and is 0 for a new event. UN is set if the assigned N value is uncertain. RE is set if the R-bits satisfy the RE equation in Internal Report 50. Y1 and Y0 are set to 00, 01, 10, or 11 if the calculated priority of the event is P0, P1, P2 or P3, respectively (P4 is inferred from RZ.). UY is set if the priority calculation is uncertain. RX is set if the R-bits do not satisfy any of the priority equations appropriate to the current command state or if $R5Hr\bar{5}$ is observed. DQ1 and DQ2 are set to 11 if the event is missing, 10 if data quality is uncertain, 01 if data quality is good, and 00 if data quality is excellent.

The VT bits are set to indicate if N and X are 0 and if the R-bits satisfy the appropriate rate equation as specified in Internal Report 50. The correspondence is:

VT1 for NEUT	VT5 for ELO
VT2 for PEN	VT6 for EHI
VT3 for D0*	VT7 for PLO
VT4 for D01*	VT8 for PHI

and VT9 is set if N and X are 0, priority is P0 or P1 and the R-bits do not satisfy any of the above 8 rate equations. (PMIS is used as a mnemonic for VT9). Note that EHI and PHI involve R2 in their definitions while only R2H

is read out. R2H is used in the calculation of VT6 and VT8 which are thus inaccurate to that extent.

The 768-byte rate block consists of four groups of 48 rates with each rate requiring 4 bytes. Byte 0 is the least significant. The number of counts accumulated is written as an unsigned 30-bit integer. The remaining 2 bits, bits 7 and 6 of byte 3 are DQ1 and DQ2 as defined in the event block discussion. All rates were accumulated at the same time as the events in the event block, i.e., rates have been shifted to compensate for readout delays. Each of the four groups contain rates that were accumulated during one subcom state; the sequence of subcom states in the rate block is 4, 3, 2, 1. Table 3 specifies the sequence of rates in a 48-rate group. The A, B, C, and E rates in Table 3 each have eight entries corresponding to sectors 0 through 7 in that order. The columns labelled H4, H3, ..., J1 specify the mnemonic for the rate for IMP's H and J for subcom states 4, 3, 2, and 1.

III. NOTES ON SPECIAL VARIABLES AND PROGRAM ALGORITHMS

This section consists of a catalog of details which need documentation in addition to that provided in the previous section and references.

The ARN is a logical record number. An abstract tape (ABT) may contain duplicate records with the same ARN if mag tape errors are encountered when the ABT is written. Presumably, only the last of these records is readable.

The four-byte XRN consists of four 8-bit numbers, one for each page of data in the album. All "ones" implies that that page was missing on the experiment tape. Note that the GAP is an unsigned integer (0-255) with all numbers greater than 254 represented by 255.

If detector n is disabled then the n + 5th most significant bit of CST is set to 1.

For each of the status parameters the value written is the first available in that album for which data quality was good or excellent. If there were no such values or the available values were "inconsistent" then the parameter is set to all ones. Consistency is defined as follows:

ATX, PTX, ONF, BRT, OTM, CST - absolute agreement of all values.

TMP - both values agree to within 1°C.

SP - range of values is not greater than 10 msec.

The quality summary byte, QSM, contains 4 groups of 2 bits each. Each group denotes the minimum quality (as specified 4 times per sequence on the experiment tape) of the corresponding page of data. The group for page 0 uses the LSB's.

The code is:

11 => some or all data filled.

10 => some data of undetermined quality.

01 => all data of good or excellent quality.

00 => all data of excellent quality

Note that

$$VFL + VUN + VGD + VEX = 128,$$

the number of events per record.

The following block diagrams and notes specify exactly the algorithms used to derive various calculated quantities in an 8-byte event specification. Figure 1 shows the overall block diagram for event processing. In Figure 1, DQ stands for DQ1 and DQ2, Y for Y0 and Y1, AT for AT1, AT2, and AT3, A for A0 to A11, etc. Figure 2 details the calculation of N and UN, which is complicated in the case of IMP-H by the D0 with 0 pulse-height problem. The A, B, and S quantities in Figure 2 are not yet decoded, as may be seen from Figure 1. The quantities KRE and URE are the "current" RE and the uncertainty in the current RE, where "current" implies "of the most recent readout of a new event" as specified in the definition of RE in Internal Report #50. That is, KRE is the quantity used in the calculation of priority note the RE bit which is written on the tape. The illegal event flag, RX, is defined by

$$RX = (\overline{p0} \cdot \overline{p1} \cdot \overline{p2} \cdot \overline{p3}) + CR + H5 + CT$$

where

$$CR = (R0 \cdot C0) + (R1 \cdot C1) + (R2H \cdot C2) + \dots + (R9 \cdot C9)$$

$$H5 = R5H \cdot \overline{r5}$$

$$\text{and } CT = C10 \cdot (R9 \oplus R10)$$

for IMP-H. The logic symbols are \cdot = and, $+$ = or, and, \oplus = exclusive or.

On IMP-J the definitions are modified to

$$CR = (R1 \cdot C1) + (R2H \cdot C2) + \dots + (R9 \cdot C9)$$

and

$$CT = C10 \cdot (R9 \oplus R10) + C0 \cdot (R1 \oplus R0)$$

The uncertain priority flag is calculated as shown in Figure 3. Note that P4 events fit the criteria for P0, P1, or P3 and will be flagged as such with the uncertain priority flag set.

IV. ABSTRACTION PROGRAM

A. Dialog

The program will print out a version number, then request information on the data destination (abstract tape), data source (experiment tape), XTABLE option, number of experiment tapes, and XDUMP option. A sample dialog is presented below.

```
PAR-VERSION 214,8-2-73

1) ABST TAPE #HAF065
2)  UNIT : FILE : RECORD = 3:1:1

3) XPT TAPE #HXP012
4)  UNIT : FILE : RECORD = 2:1:2

5) XTABLE?N

6) NUMBER OF XPT TAPES = 1

7) XDUMP?N

1: 00157134772 000000000000 F:      1 R:      2 AR:      1
3: 00157134772 000000000000 F:      1 R:      2 AR:      1
1: 00157134772 000000000000 F:      1 R:      2 AR:      1
3: 00157134772 000000000000 F:      1 R:      2 AR:      1
3: 00157137472 00157137272 F:      1 R:     20 AR:     21
3: 00157137772 00157137472 F:      1 R:     20 AR:     22
MTS=0100000001010100

2: 00157147752 00157147752 F:      1 R:     83 AR:     85
1: 00157147772 00157147752 F:      2 R:      5 AR:     85

.
.
.
.
```

All user responses are terminated by a carriage return. The response to 1) or 3) is any six character name. The response to 2) is octal with colons as separators. FILE should always be 1. Record is normally 1 but may be any reasonable number or the character L. If a record number greater than 1 is specified, PAR will read parameters, such as command state, from the preceding record on the abstract tape (or earlier records if necessary due to filled data). Specifying L will cause PAR to write the first new record after the Last old one, i.e., at the EOF.

In response to 4), FILE is specified as the initial file to be processed - normally 1. RECORD is normally 2 since record 1 should be a header record. NO or YES may be specified for 5). Further dialog is generated if YES is specified. This option is used to specify order of processing of files and records. See Section IV. B.

Question 6) is used to determine the number of experiment tapes to be processed before an EOF is written on the abstract tape.

NO or YES may be specified for 6). YES will generate further dialog. This option is used for dumping experiment tapes. See Section IV. C.

The sample dialog also illustrates the three classes of messages which are typed by the program during execution. The program types 1, 2, or 3 to specify which message class, then a colon and 2 PSC's, then file and record numbers on the experiment tape and record number on the abstract tape.

Message class 1 is typed whenever a new experiment tape file is opened.

The first PSC specifies time at the beginning of the file. The second PSC specifies the end time of the previous file. Message class 2 is typed when the file is closed. Both PSC's specify the time at the end of the file.

Message class 3 specified that a data gap between the second PSC and the first PSC was encountered. The first two messages are repeated since the program reads the first several records of the experiment tape once just to determine the command state and then again to process the other data.

B. XTABLE Option

PAR contains a table (XTABLE) at octal location 12706 which specified the order in which files and records are to be processed. This table normally specifies all files and all records except header records, in the order in which they appear. This may be modified if the user wishes to dump certain

records only (see XDUMP description in Section IV. C.) or if data is not properly time-ordered on tape. The table initially has the appearance:

<u>Address</u>	<u>Contents</u>	<u>Comments</u>
XTABLE	1	file 1
XTABLE + 2	2	start at rec 2
XTABLE + 4	0	end at rec 0 => go to EOF
XTABLE + 6	2	file 2
XTABLE + 8	2	.
XTABLE + 10	0	.
.	.	.
.	.	.
.	.	.
XTABLE + 294	50	file 50
XTABLE + 296	2	start at rec 2
XTABLE + 298	0	go to EOF

Initially the XTABLE pointer in the program will point at the file specified in query 4). The order of processing files can be changed by modifying the table. The value octal 177777 at a file location causes the program to stop processing at that point and check for the next experiment tape. For example if you wish to process file 3, records 4 to 48, then file 8, records 2 to EOF, and nothing more, XTABLE should be modified as follows:

<u>Address</u>	<u>Octal Location</u>	<u>Contents (octal)</u>	<u>Comments</u>
XTABLE + 12	12722	3	file 3
XTABLE + 14	12724	4	start at record 4
XTABLE + 16	12726	60	stop at record 48
XTABLE + 18	12730	10	file 8
XTABLE + 20	12732	2	start at record 2
XTABLE + 22	12734	0	stop at EOF
XTABLE + 24	12736	17777	end processing

The means of modifying the table is illustrated in the following sample dialog. Briefly, what happens is that the program branches to a section containing an ODT breakpoint if the answer YES is given to query 5). Then ODT may be used to modify the table and execution is resumed by giving a "37100;G" command to ODT.

.B55762

*15204;G

PAR-VERSION 214,8-2-73

ABST TAPE #HAE068

UNIT : FILE : RECORD = 3:1:1

XPT TAPE #HXP234

UNIT : FILE : RECORD = 2:3:4

XTABLE?Y

USE ODT XTABLE:12706, THEN 37100;G

BE037076

*12722/000003

012724 /000002 4

012726 /000000 60

012730 /000004 10

012732 /000002 2

012734 /000000 0

012736 /000005 177777

*37100;G

NUMBER OF XPT TAPES = 1

XDUMP?N

1:	00210443052	000000000000	F:	3	R:	4	AR:	1
3:	00210442772	000000000000	F:	3	R:	4	AR:	1
1:	00210443052	000000000000	F:	3	R:	4	AR:	1
3:	00210442772	000000000000	F:	3	R:	4	AR:	1

MTS=0011000001000000

.REWRITE 1

MTS=0011000001000000

.REWRITE 1

2:	00210450532	00210450532	F:	3	R:	48	AR:	46
1:	00210520112	00210450532	F:	8	R:	2	AR:	46
3:	00210520072	00210450472	F:	8	R:	2	AR:	47

MTS=0011000001000000

.REWRITE 1

MTS=0100000001010100

2:	00210532752	00210532752	F:	8	R:	88	AR:	133
----	-------------	-------------	----	---	----	----	-----	-----

MTS=0100000001000000

EOF ON ABSTRACT TAPE:G

C. The XDUMP Option

XDUMP is a subroutine of PAR which may be used to dump onto the PDP-11 teletype all or part of the contents of one experiment tape subrecord (page), as well as heading information from the abstract tape output buffer. The subrecord is broken into 3 logical groups - parameters, rates, and events. The printed data has been swapped and compressed into the format discussed in the experiment tape writeup, Internal Report #43. Overflows will be indicated by asterisk. If the user request XDUMP by replying YES to query 7) the program will ask "OCTAL S3S2S1S0=" where the four bits S3 to S0 specify what is to be dumped. The meaning of the bits is as follows:

S0 = 1 => heading will be printed.

S1 = 1 => parameters will be printed.

S2 = 1 => rates will be printed.

S3 = 1 => events will be printed.

Any combination is accepted. The bits are combined to specify a binary number which is converted to octal for the user's response to the query. Thus if headings, rates, and events are desired the binary number is 1011 = octal 13, which is the response:

OCTAL S3S2S1S0 = 13

A sample dialog and output follows. (page 15)

TABLE 1. LABEL BLOCK FORMAT

<u>1st byte this line</u>	<u>No. of bytes this line</u>	<u>Notation</u>	<u>Note</u>	<u>Description</u>	
0	6	ATN		Abstract Tape Name (ASCII)	} label
6	2	ARN	*	Abstract Tape Record Number	
8	6	XTN		eXperiment Tape Number (ASCII)	} data source
14	1	APV		Abstraction Program Version number	
15	1	XFN		eXperiment tape File Number	
16	4	XRN	*	eXperiment tape Record Numbers	} time
20	4	PSC		Pseudo-Sequence Counter at beginning of album	
24	1	GAP	*	GAP counter = number of missing albums since previous record	
25	1	YR		YeaR of data (72 => 1972)	} time
26	2	DAY		DAY in the year of data (1 => Jan 1)	
28	4	MSC		MilliSeCond in day of first bit of album	
32	1	HR		GMT HouR (Ø to 23)	
33	1	MIN		GMT MINute (Ø to 59)	
34	1	TQF		reserved for Time Quality Flag	
35	1	RBN		oRBit Number	
36	4			spare	

TABLE 1. (continued)

40	1	ONF		experiment power ($\emptyset \Rightarrow$ ON, 1 \Rightarrow oFf)	} status * parameters
41	1	BRT		Bit RaTe ($\emptyset \Rightarrow$ high, 1 \Rightarrow low)	
42	1	OTM		OA/TM mode ($\emptyset \Rightarrow$ OA, 1 \Rightarrow TM)	
43	1			spare	
44	2	TMP		instrument TeMPerature (units of 0.1 ^o C)	
46	2	SP		Spin Period (units of msec)	
48	2	CST	*	Command SStatus	
50	1	ATX		Analog Transmitter power ($\emptyset \Rightarrow$ off, 1 \Rightarrow on)	
51	1	PTX		PCM Transmitter power ($\emptyset \Rightarrow$ off, 1 \Rightarrow on)	
52	4			spare	
56	1	QSM	*	Quality SuMmary ($\emptyset \Rightarrow$ excellent)	} album summary
57	1	VFL	*	number of FiLled eVents in this album	
58	1	VUN	*	number of eVents of UNcertain quality	
59	1	VGD	*	number of eVents of GooD quality	
60	1	VEX	*	number of eVents of EXcellent quality	
61	1	VPE		number of eVEnt Parity Errors	
62	1	VHZ		number of new eVents with HaZard or RX flags	
63	1	VNW		number of NeW eVents without S, RZ, or RX flags	

TABLE 2. EVENT FORMAT

byte no. bit no.	1	0	3	2	5	4	7	6
MSB = 7	AT1	R5	Y1	A7	S2	B7	VT1	VT9
6	AT2	R5H	Y0	A6	S1	B6	VT2	X
5	AT3	R6	UY	A5	S0	B5	VT3	N
4	R0	R7	RE	A4	B12	B4	VT4	UN
3	R1	R8	A11	A3	B11	B3	VT5	RZ
2	R2H	R9	A10	A2	B10	B2	VT6	RX
1	R3	R10	A9	A1	B9	B1	VT7	DQ1
LSB = 0	R4	R11	A8	A0	B8	B0	VT8	DQ2

TABLE 3. RATE BLOCK GROUP FORMAT

<u>entry no.</u>	<u>rate line</u>	<u>snapshot no.</u>	<u>H4</u>	<u>H3</u>	<u>H2</u>	<u>H1</u>	<u>J4</u>	<u>J3</u>	<u>J2</u>	<u>J1</u>
1 - 8	A	0 - 3	PL0	ELO	PL0	ELO				
9 - 16	B	0 - 3	EHI	PHI	EHI	PHI	PHI	EHI	PHI	EHI
17 - 24	C	0 - 3	D2H	D5	DØ*	DØ	D5	D2H	DØ	DØ*
25 - 32	E	0 - 3	PEN	D11	DØ1*	ADC			ADC	DØ1*
33	F1	0, 1	HAZ	D8	D6	D1				
34	F1	2, 3								
35	F2	0, 1	D2	D9	D7	D3				
36	F2	2, 3								
37	F3	0	D10	D5H	D1Ø	D4				
38	F3	1								
39	F3	2								
40	F3	3								
41	F4	0	NEUT	NEUT	NEUT	NEUT				
42	F4	1								
43	F4	2								
44	F4	3								
45	F5	0	D2H	D5	DØ*	DØ	D5	D2H	DØ	DØ*
46	F5	1								
47	F5	2								
48	F5	3								

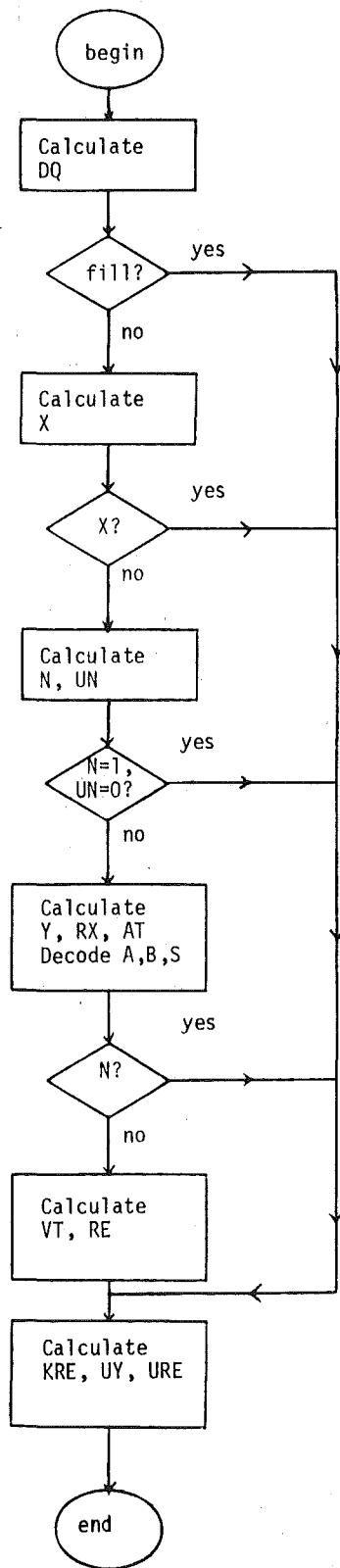
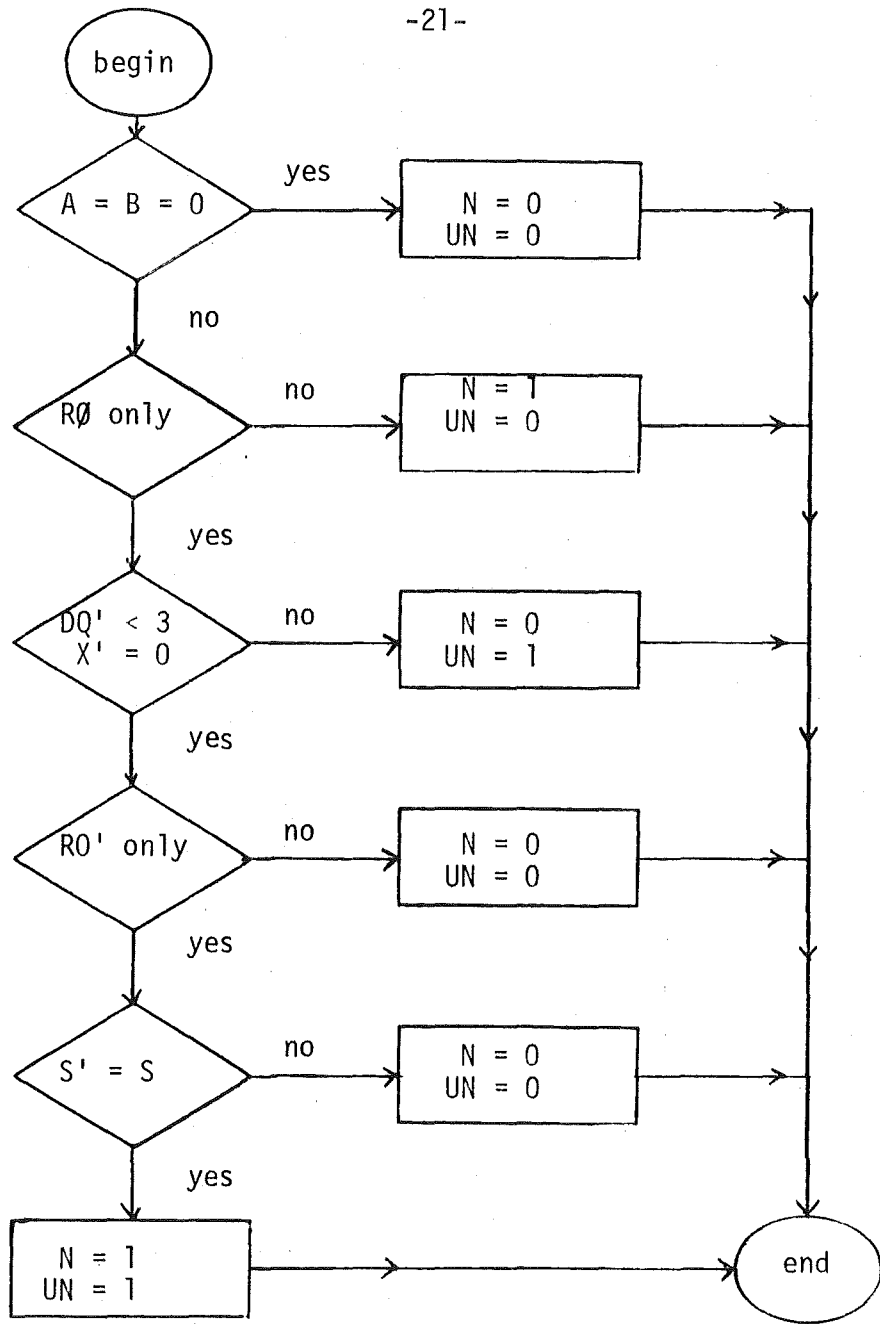


Figure 1 - Overall Block Diagram for Event Processing

IMP-H



IMP-J

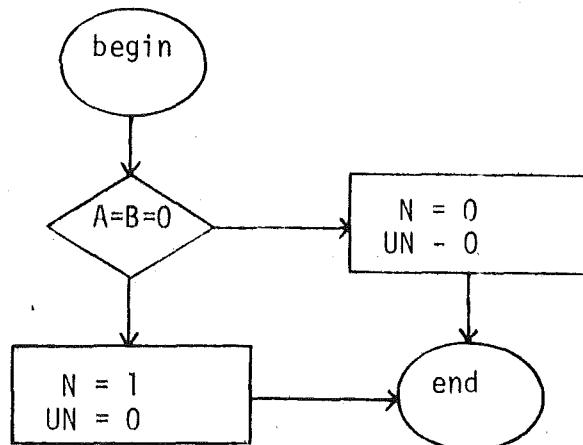


FIGURE 2 - Calculation of N and UN

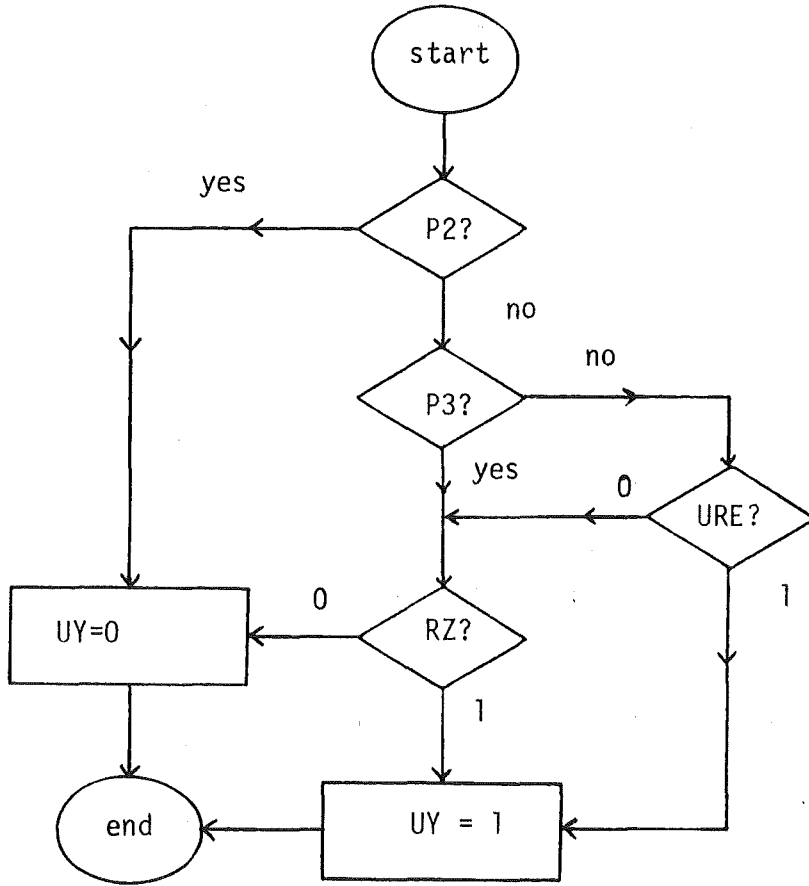


FIGURE 3. Calculation of UY