

# Norsk Data

## TRACE ROUTINE

ND-60.046.02



# **TRACE ROUTINE**

**ND-60.046.02**

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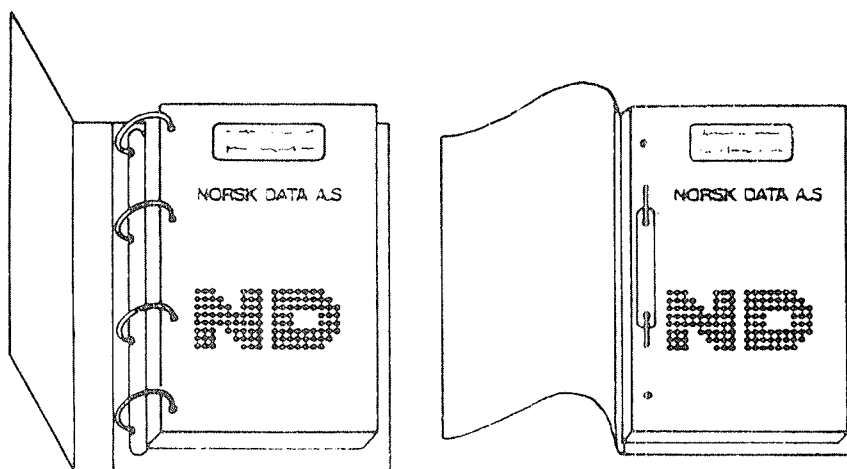
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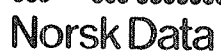
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1 INTRODUCTION

TR (Tracing Routine) is a program to run other programs instruction by instruction.

TR has control all the time (until control is passed to MAC) and extensive logging of the program execution may be obtained.

In the TSS, TR can simulate the IOT instruction, which is illegal. In this way a program may be run in TSS without modifications if IOT instructions are used.

Various protections are easily set and when violated, control is passed to MAC, and an error message is written out.

TR may also be added as an option to MACF (MAC-File) and MACM (MAC Mass Storage Assembler). Thus TR executes programs on mass storage files.



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## PURPOSE

The purpose of TR is to be a tool when debugging programs written in NORD-1 assembly language.

Using TR increases efficiency in two ways:

- The user is provided with handy tools which enable him to pinpoint faults much quicker and with less effort.
- The log produced by TR may be examined after a run and therefore the need for computer-time is diminished.

### 3 GENERAL INFORMATION

#### 3.1 Program Information

The trace routine must always operate together with the MAC assembler. It calls the routines INBT, OUTBT, ORT (floating point assembly) and OVER (disassembler). TR can be placed anywhere in core.

The TSS version of TR occupies about 3400<sub>8</sub> locations. The other version about 3300<sub>8</sub> locations.

TR uses two addresses in MAC, the B-register and the entry point. All symbols used in TR have 9 as first character.

#### 3.2 Some Words of Warning to the User

When TR executes a SMIL or JMP I (MAC instruction), this will not cause control to be passed to MAC, but will continue tracing inside MAC if this is legal area (see Section 5.3). If this is not legal area, ILL P or ILL J will be written out and control then passes to MAC.

The routines INBT and OUTBT in the TSS version of MAC use monitor call (MCALL).

If a program which calls INBT and/or OUTBT is traced, the 9 IOT switch must be zero. This is because IOT SKA n will just cause a skip if n is found in 9 DEVN (Section 6.3). If n is not found in 9 DEVN, an error message will be written out (Section 8.3).

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## MINIMUM REQUIREMENTS TO TRACE A PROGRAM

- 1        MAC with TRACE option is loaded. Note that this version of MAC should include the Disassembler option and Floating point assembly option as well.
- 2        The program to be traced is assembled.
- 3        Start address is set with command )9INN (Section 5.3).
- 4        To start tracing type )9TR. Now TR should start printing the value of Current Location (CL), T-, A- and X- registers. Thereafter these registers are printed only when they are changed. If no output occurs, check the trace area and rotation counter (Sections 5.2 and 5.3) if these are ok, something is wrong. Start again at point 1 or 2.

## 5 COMMUNICATION WITH TR

### 5.1 Definitions

Expression (denoted E) is an expression in MAC syntax. All symbols used must be defined.

Tracepoint (TPO) is an address where all specified outputs are written out.

On the TTY all the registers are specified with )9REG (see Section 5.3), and on the line printer all registers are specified.

The last point traced before control is passed to MAC is also regarded as tracepoint.

### 5.2 Syntax of Input

Commands without parameters are written just as in MAC:

)9NN<sub>2</sub>

Commands to set the point tables

)9NNN<sub>1</sub> [ , / ? / CR ] E, E, E --->

where E is the expression according to Section 5.1.

The comma will cause the values to be appended to the values already in the table. The ( ? ) will cause the contents of the table to be listed out. The CR will cause the table to be reset.

If none of these are specified, the table will be reset and filled from the beginning.

Commands to set the area tables

)9NNN<sub>1</sub> [ , / ? / CR ] E < E, E < E --->

The lower limits must be less than the upper limits. Else analogous to the command above.

Command to specify output

)9REG<sub>1</sub> L, L, LLL, LLLL --->

where L denotes letters, only the first letter after comma is significant. Spaces are ignored.

Commands to examine and set the contents of the registers.

)9NVAL : L/ <reply> E

)9OVAL : LLL/ <reply> E

Where L denotes letters, only the first letter after the space is significant. When the slash is encountered, the content of the specified register is printed on the Teletype.

### 5.3 Description of the Commands

- )9INN           Start point of tracing.  
Maximum 1 point.  
Initial setting: none.
- )9STOP          Stop point. Run is aborted.  
The point also considered as a trace point.  
Maximum 12 points.  
Initial setting: none.
- )9TPO           Trace point according to the definition 5.1.  
Maximum 12 points.  
Initial setting: none.
- )9PPO           Printing points where the memory areas (see Section 5.3)  
are dumped. All the areas will be dumped.  
Maximum 12 points.  
Initial setting: none.
- )9LAR           Legal areas, no action is allowed outside these areas.  
Maximum 6 areas.  
Initial setting: 0 < 77777
- )9TAR           Tracing areas where the log is printed. The registers are  
only printed when changed if it is not a trace point. Old  
current location is only printed when  $CL \neq OCL + 1$ . The  
first and last entry inside a trace area are regarded as  
trace points (even if it is not the start or end point of the  
area).  
Maximum 6 areas.  
Initial setting: 0 < 77777
- )9BAR           Blocked areas where it is illegal to store or change the  
contents of the memory.  
Maximum 6 areas.  
Initial setting: none.

- )9MAR      Memory dump areas which are dumped when a printing point is reached.  
Maximum 6 areas.  
Initial setting: none.
- )9ROT      Takes two arguments. The first is the rotation counter (n). The second is the rotation address (A).  
A will be passed n times before any printing is done.
- )9LP       Selects the line printer as device for the trace output.  
Error messages will also appear on the Teletype.
- )9RLP      Resets output to Teletype.
- )9DS       If this command is given, the current instruction and memory dump will be disassembled. The memory dump will be in both octal and symbolic code. It will also set the current instruction switch.
- )9RDS      Resets disassembler and current instruction switch.  
Initial settings as if )9RD  
             )9RLP was given.
- )9STEP     Takes one argument if the argument is zero. TR will operate normal. If the argument (n) is different from zero, n instructions will be run for each start.  
Initial setting: 0.
- )9IOT      Takes one argument. Zero will cause the IOT SKA (nnn) instruction to be executed as a monitor call in TSS.  
Set to one, the IOT is simulated in the IOT SIMULATION routine (Chapter 6).  
Initial setting: 0.
- )9FLT      An argument different from zero will cause the T-A-D- registers to be printed as a floating point number.  
Initial setting: 0.
- )9TR       Start tracing at the address.  
Set with )9INN
- )9CON      Will continue tracing after an error stop or a stop address.
- )9PRIV     Takes one argument. Privileged instructions may be treated in four different ways dependant on the argument value:
- |   |   |                                    |
|---|---|------------------------------------|
| 0 | = | Execute                            |
| 1 | = | Ignore                             |
| 2 | = | Ignore, print message and continue |
| 3 | = | Ignore, print message and stop     |
- Initial setting: 2.



)9REG Command to set the print switches, syntax according to Section 5.2.

The possible symbols are:

CL	- current location
P	- P-register
T	- T-register
A	- A-register
D	- D-register
X	- X-register
L	- L-register
B	- B-register
STS	- STS-register
OCL	- old current location
REFADR	- reference address
I	- current instruction
Z	- will reset the switch table when read (only the switches specified after "Z" will be set).

)9NVAL and )9OVAL

These commands enable the user to examine and change the contents of the new ()9NVAL) and old ()9OVAL) registers (Chapter 7).

Syntax according to Section 5.2.

The possible symbols are listed above, however, OCL and Z have no meaning in this connection.

The content of the specified register is printed on the Teletype. An expression terminated by carriage return will change the content of the register. Carriage return alone means no change.

## 6 THE IOT SIMULATION ROUTINE

This routine is only used in TSS version of TR. It prepares execution of MCALL (see "Reference Manual for the ND Time-Sharing System", Chapter 6) or simulates IOT by means of INBT and OUTBT.

### 6.1 Monitor Call

If the 9IOT switch is set to zero, IOT SKA will be executed as monitor call. It is illegal to specify higher monitor calls than 44.

### 6.2 IOT

If the 9IOT switch is set, IOT is simulated. IOT PIN and IOT SNI are illegal.

SKA will always cause a skip.

### 6.3 Device Numbers

The device number used in the IOT instruction must be found in the table 9DEVN

9DEVN	Initial setting	Corresponding file number
	3	1 - TTY1 output
	2	1 - TTY1 input
	7	3 - Tape punch
	22	2 - Tape reader
	67	5 - Line printer

The device numbers in 9DEVN can be changed according to the device numbers used in each specific case. This may be done by putting the correct device numbers in the 9DEVN table by means of MAC. In MACF and MACM the device numbers in 9DEVN must be changed outside the assembler, for instance from TSS or the OPR register. First examine the address of 9DEVN by using the colon command (:) in MAC.

Example:

A program is written for a system which uses 35 as device number. To run this program in TSS one would normally have to use a call of OUTBT instead of writing IOT ACT SKA 35; JMP -1.

In TR the IOT instruction can be simulated if this device number is set in the table 9DEVN. If now 9DEVN + 2/000007 35 is written, physical device number 35 is simulated by the equivalent logical device number 3.

IOT ACT 35 will be equivalent to SAT 3; JPL I (OUTBT. In TR SKA will always cause skip. Therefore IOT ACT SKA 35; JMP\* -1 is equivalent to SAT 3; JPL I (OUTBT.

## 7 THE INTERNAL REGISTERS

The registers are held in two register blocks, one for new values and one for old values.

### 7.1 New Values

CL	- Current location
P	- P-register
T	- T-register
A	- A-register
D	- D-register
X	- X-register
L	- L-register
B	- B-register
STS	- STS-register
R	- Reference address (abs)
I	- Current instruction

### 7.2 Old Values

CL	- Current location
P	- P-register
T	- T-register
A	- A-register
D	- D-register
X	- X-register
L	- L-register
B	- B-register
STS	- STS-register
R	- Reference address (abs)

If the instruction is not a memory reference instruction, R will be zero.

All these locations can be examined and changed if desired.

In this way TR can be used similar to break point by setting stop points and using )9CON.

## 8 MESSAGES FROM TR

### 8.1 Informative Messages

STOP - Stop address was reached.  
Run was aborted.

### 8.2 Error Messages from Input Section

TABL FULL - Table overflow. The table was filled up and the access data were lost.

UNDEF SYMBL - Expression contained undefined symbol.

L LIM ULIM - Lower limit, upper limit.

FORMAT ERR - Illegal character or syntax error in input.

### 8.3 Run Time Error Messages

ILL INSTR - Illegal instruction in TSS  
ION/IOF/INTDS/INTEN/MCL/MST/164---  
else only 164---.

ADR IN TR - A location inside TR was referred.

ILL JMP - Attempt to jump outside.  
Legal area (Section 5.3).

ILL LOAD - Attempt to load from location outside legal  
area (Section 5.3).

ILL STORE - Attempt to change a location outside legal  
area (Section 5.3).

BLOCKED STORE - Attempt to change or store in a location inside  
a blocked area (Section 5.3).

ILL MCALL - The 9IOT switch was zero during IOT or  
MCALL higher than 44 was specified (Section 6.1).

ILL IOT OR DEVNO -	IOT PIN/SNI was used or device number was found in DEVNO (Sections 6.2 and 6.3).
FATAL, ERR -	If this happens something is wrong with TR.



## 9 ASSEMBLING OF TR

This section contains information for the system people only, and can be skipped by the user.

### 9.1 External Symbols

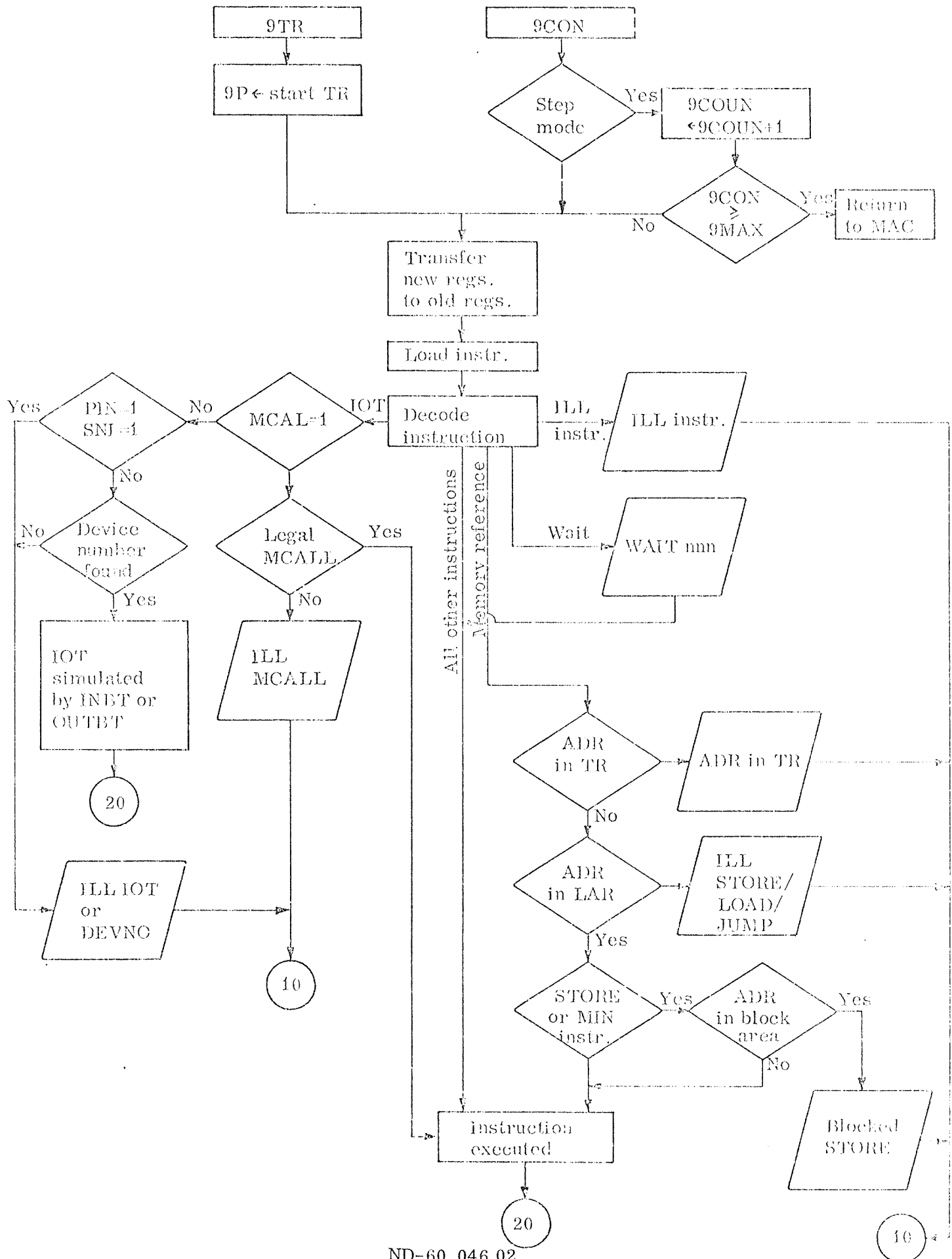
The following symbols must be defined (only the first four if BRF output):

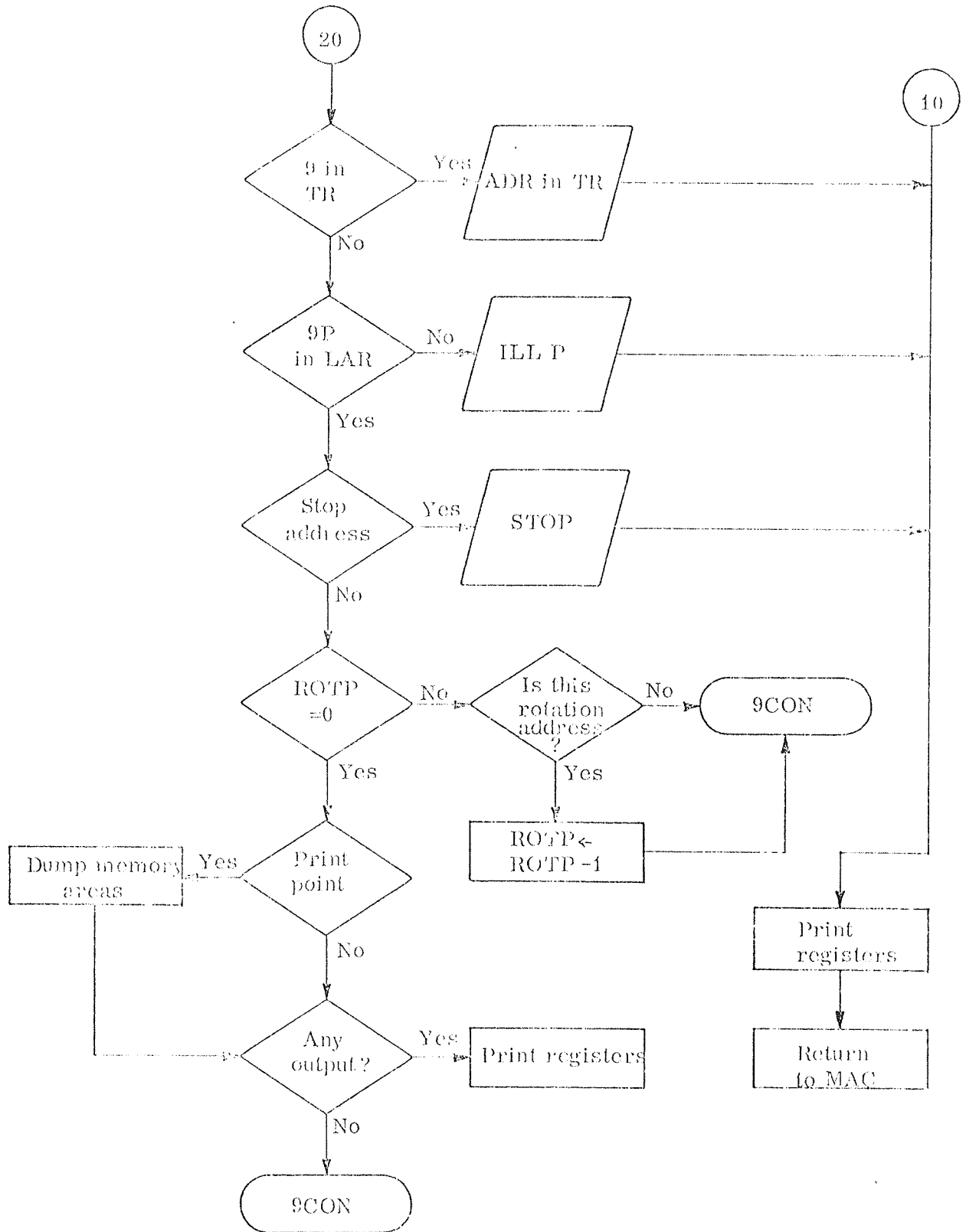
LLS	-	In MAC
SOKS	-	In MAC
STOP9	-	In MAC
A	-	In MAC
FLAG	-	In MAC
ENTRY	-	In MAC
DGET	-	Special for MACM or MACF
OVER	-	In Disassembler option
ORT	-	In Floating point assembly option
INBT	-	In I/O system
OUTBT	-	In I/O system

### 9.2 Conditional Assembly Symbols

99BRF	--	For BRF output
99TSS	--	For TSS versions
MAC	-	For MAC versions
MACM	-	For MACM versions
MACF	--	For MACF versions

## 10 FLOWCHART FOR TR





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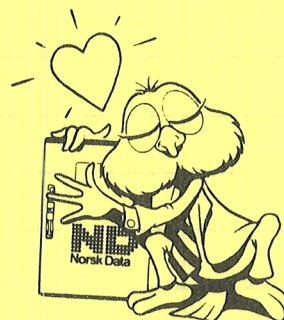


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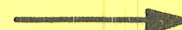
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