RECOMP II USERS' PROGRAM NO. 1113

PROGRAM TITLE: TRACE

PROGRAM CLASSIFICATION: Utility

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PURPOSE: To print out a program in the sequence
                            in which it is executed, while the
                            program is being executed.

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DESCRIPTION:

The program to be traced is entered into the machine in the usual
manner, with the proper switches on, off, the data stored as usual,
etc. However, instead of setting the initial program location and
pressing the START button, read in the trace and in the first trace
location enter +00 BBBB.B +00 EEEE.E. Press START button. BBBB.B
is the first program location to be traced, and EEEE.E is the last
program location to be traced.

The trace, working along with the program, will allow the program
to be executed but completely controls the machine; the machine is
never under the control of the program. The trace causes the lo-
cation of each program instruction together with the instruction to
be printed out in one command format word.

Suppose it is desired to trace through the commands from L 1000.0
to L 1004.1 in the following program on the left. The result of
tracing is shown on the right.

PROGRAM TO BE TRACED   RESULT OF TRACE

      L 1000.0
                                    +0010000+6410000
                                    +0010001+6610500
+6410000+6610500   +0010010+5777611
+5777611+3077700
+0477720+3577760
+1277760+1277770   +0077611+3077700
+3077700+0477720   +0077620+0477720
                                    +0077621+3577760
                                    +0077630+1277760   +6000000-0044040
                                    +0077631+1277770   +0000000-0000040
                                    +0077640+3077700
      L 1050.0   +0077641+0477720
                                         END
+4000000-0000071
+0000000-0000040
+0400000-0011000
+0000000-0000050

THE TRACE WILL STOP FOR THREE REASONS:

1. The instruction at location EEEE.E has been executed.

   In this case END will be printed out, the location counter will display the next program location, and the A and R registers will not be destroyed.

2. Overflow occurs while executing a program instruction and is not followed by TOV.

   In this case OVERFLOW BUT NO TOV will be printed out, the location counter will display the next program location, and the A and R registers will not be destroyed.

3. A HTR instruction in the program has been executed.

   Here nothing is typed and the location counter will display 0100.0. It is necessary to set location 0054.0 and press START in order to restore the A and R registers and to set the location counter to the correct location.

LIMITATIONS:

1. This routine may be relocated only into two complete channels, for example, into 3400.0 but not into 3450.0. Thus relocate into XX00.0.

2. The location of an instruction that causes overflow and that is followed by TOV may not be used as EEEE.E. If it is used as the last instruction to be traced, the trace will ignore this fact and will continue to trace.

3. The X register is destroyed after the execution of all commands in the program except those that result in transfer of control (transfer of control includes negative commands but excludes HTR). A negative command is interpreted by the trace as a TRA 0000.0.

4. ALL TAPES PUNCHED BY A PROGRAM WHILE IT IS EXECUTED UNDER CONTROL OF THE TRACE ARE TO BE DISCARDED. Typeout, however, is okay.

5. It is not recommended to trace through RDY and RDZ commands. If, however, it is necessary to do so, the procedure is as follows:

   When the machine stops initially for entry of data, the location counter will display 0100.1. Set the location counter manually to 0054.0 and press START. Now the location counter will display the correct location, and the A and R registers will be restored.

Enter the data in the conventional manner. When data entry is complete and it is desired to resume tracing, DO NOT GIVE THE START CODE. It is necessary to enter again in the first trace location +00 BBBB.B +00 EEEE.E, and then to press START. The A, R, and X registers are destroyed when tracing is resumed. If it is not desired to resume tracing, then simply give the start code.

INSTRUCTIONS FOR THE USE OF TRACE:

1. Relocate into two complete, appropriate channels.

2. Set up everything completely for execution of the program which is to be traced, but do not START. (Do not forget switches, punch, etc.)

3. Read in relocated trace program prepared in step 1.

4. Enter into the first trace location +00 BBBB.B +00 EEEE.E where the left location is the program location where tracing is to begin and the right location is the final program location to be executed under control of the trace.

5. START

COMMENTS:

Since the trace always halts on the next program (not trace) instruction, pressing the START button will cause program execution to be continued under control of the program. This is useful when it is not desired to trace through a subroutine, but before the START button is pressed set the preset stop so that computing will stop after exiting from the subroutine. Upon resuming the trace, the contents of A, R, and X are destroyed.

DESCRIPTION OF PROGRAM OPERATION

The program instruction to be executed is stored by the trace into two separate locations, one called the dummy execution location, the other, the actual execution location. Test is made to see whether the program instruction is negative. If it is, the next program instruction is considered to be at location 0000.0. If not, the A and R registers are restored, and "dummy execution" takes place. This means that the actual program instruction is executed, but with dummy address, and will serve to catch all commands which result in transfer of control. If a transfer occurs, the actual address is examined and the next program instruction is taken from there. If no transfer is made, the A and R registers are restored again, (also the X register in the case where the previous instruction was a transfer-type instruction) and the trace continues to execute the program instruction again, this time with the correct address.

If the trace routine has been relocated properly (into two complete channels) any type commands, when executed for the first time will type only blanks, or will not cause any typing at all. TYC commands will type only blanks as the "dummy address" ends in two zeros (LL00.1) and TYW commands will attempt to type the contents of LL00 and LL00 + 1 in BCD but the terminate code is given immediately in LL00.0. Thus printout will occur only when the type commands are executed for the second time with the correct address.

The dummy execution location and the actual execution location are each a complete word. Since the program is traced one instruction at a time, the other half word in each of these locations is filled with a store command and the address of an unused trace location. A +40 0000.0 is not used because it destroys the X register, as stated before, the restoration of the X register previous to executing an actual program instruction is valid only if the preceding instruction is of transfer-type.

Of course, if the program instruction is in the left half word, the program instruction would be executed before the store is executed, and so the previous paragraph about using store instead of no-op. is not applicable.

Note that after transfer-type instructions when the X register has been restored, the A and R registers still remain to be restored previous to executing the program instruction in the actual execution location. By good fortune, the FCA command does not destroy the X register, and so all three registers are present correctly for the execution of the program instruction.

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0000	–	00	00000			CLA		
	–	00	00000			CLA		
01	+	00	00000			CLA		
	+	33	01570			EXT		
02	+	60	00050			STO		
	+	00	00000			CLA		
03	+	40	00240			ARS		
	+	01	01610			ADD		
04	+	60	00060			STO		
	+	57	00061			TRA		
05	–	00	00000			CLA		
	–	00	00000			CLA		
06	–	00	00000			CLA		
	–	00	00000			CLA		
07	+	60	01760			STO		
	+	00	00060			CLA		
0010	+	33	01770			EXT		
	+	50	00230			TZE		
11	+	30	00760			FCA		
	+	35	01000			FST		
12	+	00	01761			CAM		
	+	33	01570			EXT		
13	+	60	00730			STO		
	+	01	00740			ADD		
14	+	60	00570			STO		
	+	60	00530			STO		
15	+	33	01610			EXT		
	+	50	00340			TZE		
16	+	00	00750			CLA		
	+	42	00531			STA		
17	+	57	00440			TRA		
	–	00	00000			CLA		

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0020	+	77	77771			HTR		
	–	00	00000			CLA		
21	+	00	00000			CLA		
	+	53	00541			TOV		
22	–	00	00000			CLA		
	–	00	00000			CLA		
23	+	30	00760			FCA		
	+	35	01000			FST		
24	+	00	01760			CLA		
	+	33	00200			EXT		
25	+	51	00350			TMI		
	+	01	00210			ADD		
26	+	60	00530			STO		
	+	01	01600			ADD		
27	+	60	00570			STO		
	+	00	00750			CLA		
0030	+	42	00530			STA		
	+	00	00570			CLA		
31	+	40	00240			ARS		
	+	01	01610			ADD		
32	+	60	00730			STO		
	+	57	00440			TRA		
33	–	00	00000			CLA		
	–	00	00000			CLA		
34	+	00	00730			CLA		
	+	57	00361			TRA		
35	+	60	01750			STO		
	+	02	01750			CLS		
36	+	40	00240			ARS		
	+	60	01750			STO		
37	+	00	00060			CLA		
	+	60	01720			STO		

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0040	+	41	00240			ALS		
	+	01	01750			ADD		
41	+	60	01750			STO		
	+	00	01610			CLA		
42	+	42	00061			STA		
	+	57	01370			TRA		
43	−	00	00000			CLA		
	−	00	00000			CLA		
44	+	72	00370			TYC		
	+	72	00100			TYC		
45	+	00	00060			CLA		
	+	41	00240			ALS		
46	+	01	00730			ADD		
	+	60	00730			STO		
47	+	72	00330			TYC		
	+	12	00730			TYW		
0050	+	57	00521			TRA		
	−	00	00000			CLA		
51	−	00	00000			CLA		
	−	00	00000			CLA		
52	−	00	00000			CLA		
	+	30	01700			FCA		
53	−	00	00000			CLA		
	−	00	00000			CLA		
54	+	53	00541			TOV		
	+	40	00000			ARS		
55	+	00	01720			CLA		
	+	33	01620			EXT		
56	+	15	01730			SAX		
	+	30	01700			FCA		
57	−	00	00000			CLA		
	−	00	00000			CLA		

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0060	+	53	01100			TOV		
	+	35	01700			FST		
61	+	00	00050			CLA		
	+	03	00060			SUB		
62	+	50	01441			TZE		
	+	00	00060			CLA		
63	+	01	01770			ADD		
	+	60	00060			STO		
64	+	33	01770			EXT		
	+	50	00061			TZE		
65	+	57	00110			TRA		
	-	00	00000			CLA		
66	+	00	00060			CLA		
	+	60	01720			STO		
67	+	00	00730			CLA		
	+	42	00061			STA		
0070	+	72	00370			TYC		
	+	72	00100			TYC		
71	+	00	01720			CLA		
	+	03	00050			SUB		
72	+	50	01461			TZE		
	+	57	00061			TRA		
73	-	00	00000			CLA		
	-	00	00000			CLA		
74	+	60	01730			STO		
	-	00	00000			CLA		
75	+	00	01001			CAM		
	+	00	01001			CAM		
76	+	74	00000			PNC		
	+	57	00660			TRA		
77	+	00	00000			CLA		
	-	00	00000			CLA		

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0100	+	74	00000			PNC		
	+	57	00660			TRA		
01	+	00	00000			CLA		
	–	00	00000			CLA		
02	–	00	00000			CLA		
	–	00	00000			CLA		
03	–	00	00000			CLA		
	–	00	00000			CLA		
04	–	00	00000			CLA		
	–	00	00000			CLA		
05	–	00	00000			CLA		
	–	00	00000			CLA		
06	–	00	00000			CLA		
	–	00	00000			CLA		
07	–	00	00000			CLA		
	–	00	00000			CLA		
0110	+	35	01700			FST		
	+	00	01740			CLA		
11	+	60	01750			STO		
	+	00	00060			CLA		
12	+	01	01770			ADD		
	+	42	01151			STA		
13	+	42	01251			STA		
	+	42	01271			STA		
14	+	60	01630			STO		
	+	33	01770			EXT		
15	+	50	01251			TZE		
	+	00	00000			CLA		
16	+	42	01751			STA		
	+	33	01640			EXT		
17	+	03	01650			SUB		
	+	50	01340			TZE		

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0120	+	00	01540			CLA		
	+	72	77600			TYA		
21	+	00	01550			CLA		
	+	72	77600			TYA		
22	+	00	01560			CLA		
	+	72	77600			TYA		
23	+	00	01770			CLA		
	+	01	00060			ADD		
24	+	42	00061			STA		
	+	42	01521			STA		
25	+	57	01520			TRA		
	+	00	00000			CLA		
26	+	40	00240			ARS		
	+	42	01751			STA		
27	+	40	00000			ARS		
	+	00	00000			CLA		
0130	+	33	01660			EXT		
	+	03	01670			SUB		
31	+	50	01340			TZE		
	+	57	01200			TRA		
32	-	00	00000			CLA		
	-	00	00000			CLA		
33	-	00	00000			CLA		
	-	00	00000			CLA		
34	+	00	01630			CLA		
	+	60	01720			STO		
35	+	41	00240			ALS		
	+	01	01750			ADD		
36	+	60	01750			STO		
	+	42	00061			STA		
37	+	72	00370			TYC		
	+	72	00100			TYC		

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0140	+	72	00330		TYC			
	+	12	01750		TYW			
41	+	72	00370		TYC			
	+	72	00100		TYC			
42	+	00	01720		CLA			
	+	03	00050		SUB			
43	+	50	01461		TZE			
	+	57	00061		TRA			
44	−	00	00000		CLA			
	+	00	01770		CLA			
45	+	01	00060		ADD			
	+	60	00060		STO			
46	+	42	01521		STA			
	+	00	00060		CLA			
47	+	42	01521		STA			
	+	00	01530		CLA			
0150	+	72	77600		TYA			
	+	00	01720		CLA			
51	+	33	01620		EXT			
	+	15	01730		SAX			
52	+	30	01700		FCA			
	+	77	00000		HTR			
53	+	75	01020					
	−	20	13041		DSM			
54	+	75	02140					
	+	70	12461		MTM			
55	+	13	04620		MPR			
	+	44	74020		FSQ			
56	−	63	01100		MTW			
	+	43	61020		XAR			
57	+	00	00000		CLA			
	+	77	77771		HTR			

ABSOLUTE LOCATION	S	OPRN	ADDRESS	LOCATION SYMBOL	S	OPRN	ADDRESS	REMARKS
0160	+	00	00000			CLA		
	-	00	00331			CAM		
61	+	00	00000			CLA		
	Z	PP	PPPPP			CLA		
62	+	00	00000			CLA		
	-	00	77771			CAM		
63	-	00	00000			CLA		
	-	00	00000			CLA		
64	+	00	00000			CLA		
	+	77	00000			HTR		
65	+	00	00000			CLA		
	+	53	00000			TOV		
66	+	77	00000			HTR		
	-	00	00000			CLA		
67	+	53	00000			TOV		
	-	00	00000			CLA		
0170	-	00	00000			CLA		
	-	00	00000			CLA		
71	-	00	00000			CLA		
	-	00	00000			CLA		
72	-	00	00000			CLA		
	-	00	00000			CLA		
73	-	00	00000			CLA		
	-	00	00000			CLA		
74	+	00	00000			CLA		
	+	53	00000			TOV		
75	+	00	00000			CLA		
	+	53	00000			TOV		
76	-	00	00000			CLA		
	-	00	00000			CLA		
77	+	00	00000			CLA		
	-	00	00001			CAM		