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LAWRENCE LIVERMORE LABORATORY

University of California/Livermore, California

**OCTAL DEBUGGING PROGRAM (ODT)
FOR MCS-8 COMPUTER**

E. Fisher

J. English

11/13/72

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APPROVED <i>A. Kray</i>				REV.
				PAGE 1 OF 14

ODT (Octal Debugging Technique) is a program written for the MCS-8 which allows the user to modify a program via the teletype keyboard. The program occupies 400 octal words, and must be located in the lowest memory slot of the MCS-8 system, since the program uses the RESTART instructions.

Memory locations 375, 376, and 377 of random access memory (RAM) 10a are also used with the G command. All addresses of memory locations and contents of memory locations are referred to in octal numbers. A (?) question mark will be typed for any illegal input.

The minimum system requirements for using ODT are as follows:

MCS-8 computer set

ODT programmable read only memory (PROM) at memory page 000

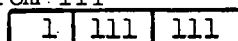
256 word (RAM) at page 010

Teletype interface with the following codes

012 - SEND ACSII character

004 - Input word from TTY

006 - Read flags



Sending Done

Word Received

The following example illustrates a typical debugging operation. It is assumed that a program has been assembled, and that the program is in the INTEL P-N format described on page 3. A program listing and a detailed description of the command set follow the example:

1. Set the memory field with the S command, and read the tape with the R command.

11S.	/ SET MEMORY FIELD TO 11
0R	/ START READER ON TTY
?	/ WHEN TAPE IS READ IN RESTART ODT

2. Start the program with the G command.

11S	
0G	
TEST PWOGRAM	/ TYPED BY PROGRAM

3. Change location (27) to correct output.

11S	
27 / 327 322	
0G	
TEST PROGRAM	/ CORRECTED OUTPUT

.....

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XLIST

/ODT TEST PROGRAM
/11-30-72

/DEFINITIONS

ODTNUM=0	/FIELD OF ODT RAM
MEMNUM=2	/FIELD PROGRAM IS TO EXECUTE IN
OCTALP=305	/OCTAL TYPE OUT ROUTINE
SEND=50	/ODT SEND ROUTINE
CRLF=70	/ODT CR LF ROUTINE
FLAG=6	/TTY FLAG

/PROGRAM PROPER

*0
LHI;MEMNUM /SET UP HI ADDRESS
LLI;TABLE /SET UP LO ADDRESS
LOOP, LAM /GET ENTRY
CPI;0

JTZ;END;MEMNUM /IF 0 END OF LIST

RST SEND /TYPE CHARACTER
INL /BUMP POINTER
JMP;LOOP;MEMNUM

END, RST CRLF /SEND CR LF
HLT

0000	0056		
0001	0002		
0002	0066		
0003	0021		
0004	0307	LOOP,	
0005	0074		
0006	0000		
0007	0150		
0010	0017		
0011	0002		
0012	0055		
0013	0060		
0014	0104		
0015	0004		
0016	0002		
0017	0075	END,	
0020	0377		
0021	0324	TABLE,	324
0022	0305		305
0023	0323		323
0024	0324		324
0025	0240		240
0026	0320		320
0027	0327		327
0030	0317		317
0031	0307		307
0032	0322		322
0033	0301		301
0034	0315		315

/T
/E
/S
/T
/SPACE
/P
/W FOR ERROR
/O
/G
/R
/A
/M

S

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ODT

COMMANDS

(/) - SLASH -

Open the current address and type the contents in octal.

(LF) - LINE FEED -

Close the currently open address, and open the next sequential address. The contents of the open register may be changed by typing the Octal number required and then typing (LF).

(CR) - CARRIAGE RETURN -

Close the currently open register. The contents of the open register may be changed by typing in the Octal number required and then typing a (CR).

(.) - PERIOD -

This operator may be used before the (/) operator to open the address last used.

(n₈S) -

The SET command is used to set the H register in the MCS8008 to the memory page to be accessed.

(EX) 10S H=Q10₈

(n₈R) -

The READ operator is used to start a sequential memory loading program. The command should be preceded by a (nS) command to select the memory page to be loaded. The loading operation will start at location "n" at the selected page. After the (R) operator is given the teletype reader should be manually started and the loading will proceed. After the tape has passed through the reader, ODT must be started manually. The tape format must be as follows:

Begin
B N N P N P P N P F
1 1 0 1 0 0 1 0 Finish

(n₈G) -

The GO routine is used to start a program in memory. The Octal number typed before the "G" operator will set the starting address in memory. The "G" operator should be preceded by a (nS) command to select the desired page. This routine uses the A, B, C, H, and L registers and locations 375, 376, 377, in memory page 10

UTILITY ROUTINES

The following subroutines are available to the users as utility routines for other programs:

005	RST ODT	Restart ODT program. This is useful error branching in program debugging.
055	RST SEND	Send the ASCII character presently in the "A" register.
065	RST READ	Wait for a character to be received from the teletype and return with the ASCII character in the "A" register. The "A" and "B" registers are used in this routine.
075	RST CRLF	Send a carriage return and a line feed to the teletype. The "A" register is used in this routine.
106	CAL OCTOUT	Send a space and type in Octal the three digit number in the "A" register.
305	305	
000	0	
		The A, B, and E registers are used in the routine.

RESTART LOCATIONS

Several of the valuable restart locations of the MCS 8008 have been used by ODT; in particular, 0, 50, 60, and 70. These however, have been utilized for utility routines as noted in the section under that name. The remaining locations 10, 20, 30, and 40 have been programmed with JUMP instructions to page 10 to provide users with access to these locations.

The listing below shows the free Restart locations programming;

ADDRESS	OCTAL EQUIVALENT	
10	104	JMP
11	340	340
12	110	10
13	0	
--	0	
17	0	
20	104	JMP
21	350	350
22	10	10
23	0	
--	0	
27	0	
30	104	JMP
31	360	360
32	10	10
33	0	
--	0	
37	0	
40	104	JMP
41	370	370
42	10	10
43	0	

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XLIST

/ODT FOR MCS-8008

/EUGENE FISHER AND JIM ENGLISH 9/12/72

FLAG=6

TTY0=12

MEMNO=0

TTY=4

*0

LAI,

RST SEND

RST CRLF

XRA

/CLEAR AC

JMP,

0000 0006 ERROR,
 0001 0277 277
 0002 0055
 0003 0075
 0004 0250 BEGIN,
 0005 0104
 0006 0077 BEG,
 0007 0000 MEMNO

0010 0104
 0011 0340 340,
 0012 0010 10
 0013 0000
 0014 0000 0,
 0015 0000 0,
 0016 0000 0,
 0017 0000 0,

JMP,

/FIRST RESTART LOCATION

0,

0020 0104
 0021 0350 350,
 0022 0010 10
 0023 0000
 0024 0000 0,
 0025 0000 0,
 0026 0000 0,
 0027 0000 0,

JMP,

0,

0030 0104
 0031 0360 360,
 0032 0010 10
 0033 0000
 0034 0000 0,
 0035 0000 0,
 0036 0000 0,
 0037 0000 0,

JMP,

0,

0040 0104
 0041 0370 370,
 0042 0010 10
 0043 0000
 0044 0326 PER,
 0045 0104
 0046 0102 NEXTC,
 0047 0000 MEMNO

JMP,

0

LCL

JMP,

0050 0133 SEND,

OUT TTY0

/ROUTINE TO OUTPUT ONE ASCII CHAR

0051 0107

INP FLAG

/BUSY FLAG

0052	0032		RAR	
0053	0032		RAR	
0054	0043		RTC	
0055	0104		JMP	
0056	0051	SEND+1		
0057	0000	MEMNO		
0060	0107	READ	INP FLAG	/ROUTINE TO READ ONE CHAR FROM TTY
0061	0032		RAR	
0062	0100		JFC	
0063	0060	READ		
0064	0000	MEMNO		
0065	0105		INP TTY	
0066	0310		LBA	
0067	0007		RET	
0070	0006	CRLF	LAI	
0071	0215	215		
0072	0055		RST SEND	
0073	0006		LAI	
0074	0212	212		
0075	0055		RST SEND	
0076	0007		RET	
0077	0036	BEG	LDI	
0100	0004	4		
0101	0320	SAV	LCA	
0102	0065	NEXTC	RST READ	/GET CHAR FROM TTY
0103	0301		LAB	
0104	0024		SUI	
0105	0270	270		
0106	0120		JFS	
0107	0234	TERM		
0110	0000	MEMNO		/>270 MUST BE TERMINATOR OR ILLEGAL DIGIT
0111	0301		LAB	
0112	0024		SUI	
0113	0260	260		/<260 ?
0114	0160		JTS	
0115	0234	TERM		
0116	0000	MEMNO	/YES	
0117	0031		DCD	/>260 MUST BE DIGIT BUMP BUFFER CNT
0120	0150		JTZ	
0121	0000	ERROR		
0122	0000	MEMNO	/BUFFER OVERFLOW	
0123	0310		LBA	
0124	0302		LAC	/GET PREVIOUS INPUTS
0125	0022		RAL	
0126	0022	RAL		
0127	0022	RAL		
0130	0140		JTC	
0131	0000	ERROR		
0132	0000	MEMNO	/IF CARRY, NUMBER WAS TOO BIG	
133	0201		ADB	
134	0104		JMP	
0135	0101	SAV		
0136	0000	MEMNO		

0137	0362	SLASH,	LLC	/C CONTAINS ADDRESS
0140	0307	GETCON,	LAM	/GET CONTENTS
0141	0106		CAL)	
0142	0305	OCTALP,		
143	0000	MEMNO		
0144	0006		LAI)	
0145	0240	240		
0146	0055		RST SEND	/SEND A SPACE
0147	0250		XRA	
0150	0104		JMP,	
0151	0077	BEG,		
0152	0000	MEMNO		
0153	0303	LF,	LAD	
0154	0024		SUI)	
0155	0004	4		
0156	0150		JTZ)	
0157	0162	NINP,		
0160	0000	MEMNO	/IF CNT IS STILL 4 NO INPUT WAS RECEIVED	
0161	0372		LMC	/IF CNT <4 DEPOSIT INPUT IN MEMORY
0162	0006	NINP,	LAI)	
0163	0215	215		
0164	0055		RST SEND	/TYPE A CR
0165	0060		INL	/BUMP ADDRESS
0166	0305		LAH	/GET HI PART
0167	0106		CAL)	
0170	0305	OCTALP,		
0171	0000	MEMNO	/TYPE HI ADDRESS	
0172	0306		LAL	/GET LOW PART
0173	0106		CAL)	
0174	0305	OCTALP,		
0175	0000	MEMNO	/TYPE LO ORDER ADDRESS	
0176	0104		JMP)	
0177	0140	GETCON,		
0200	0000	MEMNO		
0201	0075	CR,	RST CRLF	/SEND A LF
0202	0303		LAD	
0203	0024		SUI)	
0204	0004	4	/BUFCNT =4 ?	
0205	0150		JTZ)	
0206	0004	BEGIN,		
0207	0000	MEMNO	/YES, NO INPUT SINCE LAST TERMINATOR	
0210	0372		LMC	/LOAD MEMORY WITH INPUT
0211	0104		JMP)	
0212	0004	BEGIN,		
0213	0000	MEMNO		
0214	0075	GO,	RST CRLF	
0215	0315		LBH	/SAVE HI PART
0216	0066		LLI)	
0217	0375	375	/SET THE LOW ADDRESS	
0220	0056		LHI)	
0221	0010	10	/SET THE HI ADDRESS	
222	0076		LMI)	
223	0104	JMP	/SET UP JMP INSTRUCTION IN RAM	
0224	0060		INL	/BUMP ADDRESS
0225	0302		LAC	/GET THE ADDRESS
0226	0370		LMA	/SET UP ADDRESS FOR JMP INSTRUCTION

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B227 0000

INL

/BUMP ADDRESS

0230	0371		LMB	
0231	0104		JMP,	/SET UP HI ADDRESS FOR JMP INSTRUCT
232	0375	375,		
233	0010	10		/GO THERE
0234	0301	TERM,	LAB	
0235	0024		SUI,	
0236	0212	212		
0237	0150		JTZ,	
0240	0153	LF,		
0241	0000	MEMNO	/LF ?	
0242	0024		SUI,	
0243	0003	3		
0244	0150		JTZ,	
0245	0201	CR,		
0246	0000	MEMNO	/CR ?	
0247	0024		SUI,	
0250	0041	41		
0251	0150		JTZ,	
0252	0044	PER,		
0253	0000	MEMNO		
0254	0024		SUI,	
0255	0001	1		
0256	0150		JTZ,	
0257	0137	SLASH,		
0260	0000	MEMNO	/ / ?	
0261	0024		SUI,	
0262	0030	30		
0263	0150		JTZ,	
0264	0214	GO,		
0265	0000	MEMNO	/G ?	
0266	0024		SUI,	
0267	0013	13		
0270	0150		JTZ,	
0271	0337	ST,		
0272	0000	MEMNO	/R ?	
0273	0024		SUI,	
0274	0001	1		
0275	0110		JFZ,	
0276	0000	ERROR,		
0277	0000	MEMNO	/FOURN AN ERROR	
0300	0352	SET,	LHC	/SAME HI ADDRESS
0301	0075		RST CRLF	/SEND A CRLF
0302	0104		JMP ,	
0303	0004	BEGIN,		
0304	0000	MEMNO		
0305	0016	OCTALP,	LBI,	
0306	0004	4	/SET CNTR	
0307	0002		RLC	
0310	0002		RLC	
0311	0340		LEA	/SAVE AC
0312	0006		LAI,	
0313	0240	240	/SEND A SPACE	
0314	0055		RST SEND	
0315	0304		LAE	/GET THE AC
0316	0044		NDI,	

031.	7	0003	3	/MASK
0320	0011	DECR,	DCB	/DECR
0321	0053		RTZ	/DONE ?
0322	0004		ADI	
0323	0260	260	/NO	
0324	0055		RST SEND	
0325	0304		LAE	/GET AC
0326	0002		RLC	
0327	0002		RLC	
0330	0002		RLC	
0331	0340		LEA	/SAVE AC
0332	0044		NDI	
0333	0007	7	/MASK	
0334	0104		JMP	
0335	0320	DECR		
0336	0000	MEMNO		
0337	0362	ST,	LLC	/GET THE ADDRESS
0340	0250		XRA	/CLEAR AC
0341	0340		LEA	
0342	0065	READC,	RST READ	/READ FROM TTY
0343	0074		CPI	
0344	0302		302	
0345	0110		JFZ	
0346	0342	READC,		
0347	0000	MEMNO	/B?	
0350	0065	NEXTR,	RST READ	/YES GET ANOTHER
0351	0074		CPI	
0352	0306		306	
0353	0150		JTZ	
0354	0373	DEPSIT,		
0355	0000	MEMNO	/F?	
0356	0304		LAE	/NO
0357	0002		RLC	
0360	0340		LEA	/SAVE AC
0361	0301		LAB	/GET CHAR BACK
0362	0074		CPI	
0363	0316		316	
0364	0110		JFZ	
0365	0350	NEXTR,		
0366	0000	MEMNO	/N?	
0367	0040		INE	/YES INCREMENT E REG
0370	0104		JMP	
0371	0350	NEXTR,		
0372	0000	MEMNO		
0373	0374	DEPSIT,	LME	/DEPOSIT IN MEMORY
0374	0060		INL	/BUMP ADDRESS POINTER
0375	0104		JMP	
0376	0340	ST+1,		
0377	0000	MEMNO		

ACB	0210
CB	0211
CC	0212
ACD	0213
ACE	0214
ACH	0215
ACI	0014

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ACL 0216
ACM 0217
ADA 0200
ADB 0201
ADC 0202
ADD 0203
ADE 0204
ADH 0205
ADI 0204
ADL 0206
ADM 0207
BEG 0077
BEGIN 0004
CAL 0106
CFC 0102
CFP 0132
CFS 0122
CFZ 0112
CPA 0270
CPB 0271
CPC 0272
CPD 0273
CPE 0274
CPH 0275
CPI 0074
CPL 0276
CPM 0277
CR 0201
CRLF 0070
CTC 0142
CTP 0172
CTS 0162
CTZ 0152
DCB 0011
DCC 0021
DCD 0031
DCE 0041
DCH 0051
DCL 0061
DECR 0320
DEPSIT 0373
ERROR 0000
FLAG 0006
GETCON 0140
GO 0214
HLT 0377
INB 0010
INC 0020
IND 0030
INE 0040
INH 0050
INL 0060
INP 0101
FC 0100
FP 0130
JFS 0120
JFZ 0110
JMP 0104
JTC 0140

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JTP	0170
JTS	0160
JTZ	0150
JA	0300
LAB	0301
LAC	0302
LAD	0303
LAE	0304
LAH	0305
LAI	0006
LAL	0306
LAM	0307
LBA	0310
LBB	0311
LBC	0312
LBD	0313
LBE	0314
LBH	0315
LBI	0016
LBL	0316
LBM	0317
LCA	0320
LCB	0321
LCC	0322
LCD	0323
LCE	0324
LCH	0325
LCI	0026
LCL	0326
LCM	0327
LDA	0330
LDB	0331
LDC	0332
LDD	0333
LDE	0334
LDH	0335
LDI	0036
LDL	0336
LDM	0337
LEA	0340
LEB	0341
LEC	0342
LED	0343
LEE	0344
LEH	0345
LEI	0046
LEL	0346
LEM	0347
LF	0153
LHA	0350
LHB	0351
LHC	0352
LHD	0353
LE	0354
LH	0355
LHI	0056
LHL	0356
LHM	0357
LLA	0360

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L LB 0361
LLC 0362
LLD 0363
LE 0364
LH 0365
LLI 0066
LLL 0366
LLM 0367
LMA 0370
LMB 0371
LMC 0372
LMD 0373
LME 0374
LMH 0375
LMI 0076
LML 0376
MEMNO 0000
NDA 0240
NDB 0241
NDC 0242
NDD 0243
NDE 0244
NDH 0245
NDI 0044
NDL 0246
NDM 0247
NEXTC 0102
NEXTR 0350
NINP 0162
OCTALP 0305
ORA 0260
ORB 0261
ORC 0262
ORD 0263
ORE 0264
ORH 0265
ORI 0064
URL 0266
ORM 0267
OUT 0121
PER 0044
RAL 0022
RAR 0032
READ 0060
READC 0342
RET 0007
RFC 0003
RFP 0033
RFS 0023
RFZ 0013
RLC 0002
RRC 0012
RST 0005
TC 0043
TP 0073
RTS 0063
RTZ 0053
SAV 0101
SBA 0230

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SBD	0231
SBC	0232
SBD	0233
SBE	0234
SBH	0235
SBI	0034
SBL	0236
SBM	0237
SEND	0050
SET	0300
SLASH	0137
ST	0337
SUA	0220
SUB	0221
SUC	0222
SUD	0223
SUE	0224
SUH	0225
SUI	0024
SUL	0226
SUM	0227
TERM	0234
TTY	0004
TTYO	0012
XRA	0250
XRB	0251
XRC	0252
XRD	0253
XRE	0254
XRH	0255
XRI	0054
XRL	0256
XRM	0257

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