

1. IDENTIFICATION
- 1.1 Digital-8-20-F-Bin
- 1.2 Four-Word Floating-Point Package
- 1.3 June 26, 1965

2. ABSTRACT

This program is almost identical to the 3-word Floating-Point Package (Digital-8-5-S) except that accuracy is carried to 35 bits, and 4 12-bit words are used for storage.

3. REQUIREMENTS

3.1 Storage

This program occupies registers 7; 40-61; 5600-7577 (octal).

4. USAGE

4.1 Loading

Binary Loader (Digital-8-2-U) or DECtape System.

4.2 Calling Sequence

Identical to Digital-8-5-S.

5. RESTRICTIONS

See Digital-8-5-S.

6. DESCRIPTION

The floating accumulator resides in memory locations 44, 45, 46, and 47. The instructions FGET, FPUT use 4-word arguments (11-bit exponent + sign; 35-bit mantissa + sign). The 4-word package contains all operations except for square root (0002) and square (0001).

7. METHODS

See Digital-8-5-S.

8. FORMAT (Not Applicable)

9. EXECUTION TIME

9.3 Average

Execution times are very difficult to estimate as they greatly depend upon the data on which the floating-point package is operating. Generally speaking:

FADD	=	382 μ sec + 42(N) where N is the number of shifts to align binary points.
FSUB	=	FADD time + 42 μ sec
FDIV	=	3.4 msec (approximately)

FMPY = 3.3 msec (approximately)
 FGET = 156 μ sec
 FPUT = 172 μ sec
 FNOR = $168 + N(42)$ μ sec where N is number of shifts;
 +84 μ sec if argument <0.
 FEXT = 140.5 μ sec

10. PROGRAM

10.4 Program Listing

/4 WORD FLOATING POINT
 /ARITHMETIC INTERPRETER
 /PAGE 1

*40

0040 0000 EX1, 0
 0041 0000 HIGH1, 0
 0042 0000 MID1, 0
 0043 0000 LOW1, 0
 0044 0000 EXP, 0
 0045 0000 HORDER, 0
 0046 0000 MIDDLE, 0
 0047 0000 LORDER, 0
 0050 0000 OVER2, 0

0051 0000 OVER1, 0
 *61
 0061 0000 FLAG, 0

/ARITHMETIC ERROR FLAG

*5600

5600 0000 FPNT, 0
 5601 7300 CLA CLL
 5602 3051 DCA OVER1
 5603 3050 DCA OVER2
 5604 1600 TAD I FPNT /GET INSTRUCTION
 5605 3257 DCA JUMP
 5606 1257 TAD JUMP
 5607 0265 AND PAGENO /PAGE 0??
 5610 7650 SNA CLA
 5611 5214 JMP .+3 /YES
 5612 1267 TAD MASK5 /NO - GET PAGE BITS
 5613 0200 AND FPNT
 5614 3262 DCA ADDRS
 5615 1270 TAD MASK7 /GET 7 BIT ADDRESS
 5616 0257 AND JUMP
 5617 1262 TAD ADDRS
 5620 3262 DCA ADDRS

5621	1266	TAD INDRCT	/BIT3=1??
5622	0257	AND JUMP	
5623	7650	SNA CLA	
5624	5227	JMP LOOP01	
5625	1662	TAD I ADDRS	/YES - DEFER
5626	3262	DCA ADDRS	
5627	2200	LOOP01, ISZ FPNT	
5630	1662	TAD I ADDRS	
5631	3040	DCA EXI	/EXPONENT
5632	1262	TAD ADDRS	
5633	3263	DCA SAVE	
5634	2263	ISZ SAVE	
5635	1663	TAD I SAVE	/HIGH ORDER
5636	3041	DCA HIGH1	
5637	2263	ISZ SAVE	
5640	1663	TAD I SAVE	
5641	3042	DCA MIDI	/MIDDLE BITS
5642	2263	ISZ SAVE	
5643	1663	TAD I SAVE	
5644	3043	DCA LOW1	/LOWER BITS
5645	1257	TAD JUMP	
5646	7106	CLL RTL	
5647	7006	RTL	
5650	0264	AND MASK3	/LOOK-UP ON TABLE
5651	1271	TAD TABLE	
5652	3260	DCA JUMP2	
5653	1660	TAD I JUMP2	
5654	3260	DCA JUMP2	
5655	4660	JMS I JUMP2	/EXECUTE
5656	5201	JMP FPNT+1	/GET NEXT
5657	0000	JUMP, 0	
5660	0000	JUMP2, 0	
5661	0000	GO2, 0	
5662	0000	ADDRS, 0	
5663	0000	SAVE, 0	
5664	0017	MASK3, 0017	
5665	0200	PAGENO, 0200	
5666	0400	INDRCT, 0400	
5667	7600	MASK5, 7600	
5670	0177	MASK7, 0177	
5671	5672	TABLE, .+1	
5672	5714	EXIT	
5673	6000	FLAD	
5674	6026	FLSU	
5675	6367	FLMY	
5676	6600	FLDV	
5677	5702	FLGT	
5700	5733	FLPT	
5701	6200	FNORM	

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/FLOATING GET=5000
5702 0000 FLGT, 0
5703 1040 TAD EX1
5704 3044 DCA EXP
5705 1041 TAD HIGH1
5706 3045 DCA HORDER
5707 1042 TAD MID1
5710 3046 DCA MIDDLE
5711 1043 TAD LOW1
5712 3047 DCA LORDER
5713 5201 JMP FPNT+1

/FLOATING EXIT OR SUBROUTINE=00XX
EXIT, 0
5714 0000 TAD JUMP
5715 1257 AND MASK3
5716 0264 SNA /BITS 8-11=0??
5717 7450 JMP I FPNT /YES:FEXT
5720 5600 TAD TABLE6 /NO:LOOKUP BITS 8-11
5721 1350 DCA JUMP2 /ON SUBROUTINE TABLE
5722 3260 TAD I JUMP2
5723 1660 DCA JUMP2
5724 3260 TAD FPNT /SAVE PSEUDO PC
5725 1200 DCA G02
5726 3261 JMS I JUMP2
5727 4660 TAD G02 /RESTORE PSEUDO PC
5730 1261 DCA FPNT
5731 3200 JMP FPNT+1 /RETURN
5732 5201

/FLOATING PUT=6000
FLPT, 0
5733 0000 TAD EXP
5734 1044 DCA I ADDRS
5735 3662 TAD HORDER
5736 1045 ISZ ADDRS
5737 2262 DCA I ADDRS
5740 3662 TAD MIDDLE
5741 1046 ISZ ADDRS
5742 2262 DCA I ADDRS
5743 3662 TAD LORDER
5744 1047 ISZ ADDRS
5745 2262 DCA I ADDRS
5746 3662 JMP FPNT+1
5747 5201

5750 5750 TABLE6, . /SUBROUTINE TABLE
5751 5770 EXIT6 /ABSOLUTE ADDRESSES
5752 5770 EXIT6 /OF SUBROUTINES
5753 5770 EXIT6
5754 5770 EXIT6
5755 5770 EXIT6 /EXIT6=DUMMY OR NOP
5756 5770 EXIT6

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5757	5770	EXIT6	
5760	5770	EXIT6	
5761	5770	EXIT6	
5762	5770	EXIT6	
5763	5770	EXIT6	
5764	5770	EXIT6	
5765	5770	EXIT6	
5766	5770	EXIT6	
5767	5770	EXIT6	

5770	0000	EXIT6,	0
5771	5770	JMP I	EXIT6

/FLOATING ADD=1000
*6000

6000	0000	FLAD,	0	
6001	4231	JMS ALIGN		/ALIGN WORDS
6002	5600	JMP I FLAD		/NO ALIGNMENT
6003	4312	JMS SCALE		
6004	7300	CLA CLL		/TRIPLE ADDITION
6005	1051	TAD OVER1		
6006	1050	TAD OVER2		
6007	3050	DCA OVER2		
6010	7004	RAL		/CARRY
6011	1043	TAD LOW1		
6012	1047	TAD LORDER		
6013	3047	DCA LORDER		
6014	7004	RAL		
6015	1042	TAD MID1		
6016	1046	TAD MIDDLE		
6017	3046	DCA MIDDLE		
6020	7004	RAL		
6021	1041	TAD HIGH1		
6022	1045	TAD HORDER		
6023	3045	DCA HORDER		
6024	4705	JMS I NORMAL		
6025	5600	JMP I FLAD		

/FLOATING SUBTRACT=2000

6026	0000	FLSU,	0	
6027	4706	JMS I OPMS		/NEGATE OPERAND
6030	5201	JMP FLAD+1	/ADD	

/ALIGN BINARY POINTS

6031	0000	ALIGN,	0	
6032	1045	TAD HORDER		
6033	7640	SZA CLA		
6034	5240	JMP .+4		

6035	1040		TAD EXI	/C(FAC)=0
6036	3044		DCA EXP	
6037	5272		JMP DONE	
6040	1041		TAD HIGH1	
6041	7650		SNA CLA	
6042	5631		JMP I ALIGN	/OPERAND=0
6043	1040		TAD EXI	
6044	7041		CMA IAC	
6045	1044		TAD EXP	
6046	7450		SNA	
6047	5272		JMP DONE	/EXPONENTS EQUAL - EXIT
6050	7500		SMA	
6051	7041		CMA IAC	
6052	3304		DCA AMOUNT	/NUMBER OF PLACES
6053	1304		TAD AMOUNT	
6054	1307		TAD TEST1	
6055	7710		SPA CLA	
6056	5274		JMP NOGO	/NO SHIFTING POSSIBLE
6057	1040		TAD EXI	
6060	7041		CMA IAC	
6061	1044		TAD EXP	
6062	7004		RAL	
6063	7620		SNL CLA	
6064	1310		TAD TCON1	/SHIFT OPERAND RIGHT
6065	1311		TAD TCON2	/SHIFT FAC RIGHT
6066	3303		DCA POINT	
6067	4703		JMS I POINT	
6070	2304		ISZ AMOUNT	
6071	5267		JMP .-2	
6072	2231	DONE,	ISZ ALIGN	
6073	5631		JMP I ALIGN	
6074	1040	NOGO,	TAD EXI	
6075	7041		CMA IAC	
6076	1044		TAD EXP	
6077	7700		SMA CLA	
6100	5631		JMP I ALIGN	
6101	5702		JMP I .+1	
6102	5703		FLGT+1	
6103	0000	POINT,	0	
6104	0000	AMOUNT,	0	
6105	6200	NORMAL,	FNORM	
6106	6306	OPMINS,	OPNEG	
6107	0045	TEST1,	0045	
6110	0023	TCON1,	SHFTOP-SHFTAC	
6111	6116	TCON2,	SHFTAC	

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/SCALE BOTH RIGHT
6112 0000 SCALE, 0
6113 4341 JMS SHFTOP
6114 4316 JMS SHFTAC
6115 5712 JMP I SCALE

/SCALE FLOATING AC RIGHT
6116 0000 SHFTAC, 0
6117 7300 CLA CLL
6120 1045 TAD HORDER
6121 7510 SPA
6122 7020 CML
6123 7010 RAR
6124 3045 DCA HORDER
6125 1046 TAD MIDDLE
6126 7010 RAR
6127 3046 DCA MIDDLE
6130 1047 TAD LORDER
6131 7010 RAR
6132 3047 DCA LORDER
6133 1050 TAD OVER2
6134 7010 RAR
6135 3050 DCA OVER2
6136 2044 ISZ EXP
6137 7000 NOP
6140 5716 JMP I SHFTAC

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/SCALE OPERAND RIGHT
6141 0000 SHFTOP, 0
6142 7300 CLA CLL
6143 1041 TAD HIGH1
6144 7510 SPA
6145 7020 CML
6146 7010 RAR
6147 3041 DCA HIGH1
6150 1042 TAD MID1
6151 7010 RAR
6152 3042 DCA MID1
6153 1043 TAD LOW1
6154 7010 RAR
6155 3043 DCA LOW1
6156 1051 TAD OVER1
6157 7010 RAR
6160 3051 DCA OVER1
6161 2040 ISZ EX1
6162 7000 NOP
6163 5741 JMP I SHFTOP

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/NORMALIZE FLOATING ACCUMULATOR

*6200

6200	0000	FNORM,	0	
6201	7300		CLA CLL	
6202	3361		DCA MP1	/0 # OF SHIFTS
6203	3363		DCA MP3	/RESET SWITCH
6204	1045		TAD HORDER	
6205	7510		SPA	/INPUT<0
6206	2363		ISZ MP3	/YES-SET SWITCH
6207	7640		SZA CLA	/FAC=0?
6210	5224		JMP G06	/NO
6211	1046		TAD MIDDL	
6212	7640		SZA CLA	
6213	5224		JMP G06	
6214	1047		TAD LORDER	
6215	7640		SZA CLA	
6216	5224		JMP G06	/NO
6217	1050		TAD OVER2	
6220	7640		SZA CLA	
6221	5224		JMP G06	/NO
6222	3044		DCA EXP	/YES
6223	5600		JMP I FNORM	/EXIT
6224	1363	G06,	TAD MP3	
6225	7640		SZA CLA	/WAS INPUT <0
6226	4261		JMS ACNEG	/YES
6227	1045	SHIFT,	TAD HORDER	
6230	7104		CLL RAL	
6231	7710		SPA CLA	/TOO FAR?
6232	5251		JMP NOREXT	/YES:EXIT ROUTINE
6233	1050		TAD OVER2	/NO
6234	7104		CLL RAL	
6235	3050		DCA OVER2	/SHIFT LEFT
6236	1047		TAD LORDER	
6237	7004		RAL	
6240	3047		DCA LORDER	
6241	1046		TAD MIDDL	
6242	7004		RAL	
6243	3046		DCA MIDDL	
6244	1045		TAD HORDER	
6245	7004		RAL	
6246	3045		DCA HORDER	
6247	2361		ISZ MP1	/ADD 1 TO COUNT
6250	5227		JMP SHIFT	/CONTINUE
6251	1361	NOREXT,	TAD MP1	/SUBTRACT COUNT FROM
6252	7041		CMA IAC	/EXPONENT
6253	1044		TAD EXP	
6254	3044		DCA EXP	
6255	1363		TAD MP3	/WAS INPUT<0??
6256	7640		SZA CLA	
6257	4261		JMS ACNEG	/YES
6260	5600		JMP I FNORM	/EXIT

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/NEGATE FLOATING AC
6261 0000 ACNEG, 0
6262 7300 CLA CLL
6263 1050 TAD OVER2
6264 7041 CMA IAC
6265 3050 DCA OVER2
6266 1047 TAD LORDER
6267 7040 CMA
6270 7430 SZL
6271 7101 CLL IAC
6272 3047 DCA LORDER
6273 1046 TAD MIDDLE
6274 7040 CMA
6275 7430 SZL
6276 7101 CLL IAC
6277 3046 DCA MIDDLE
6300 1045 TAD HORDER
6301 7040 CMA
6302 7430 SZL
6303 7101 CLL IAC
6304 3045 DCA HORDER
6305 5661 JMP I ACNEG
/NEGATE OPERAND

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6306 0000 OPNEG, 0
6307 7300 CLA CLL
6310 1051 TAD OVER1
6311 7041 CMA IAC
6312 3051 DCA OVER1
6313 1043 TAD LOW1
6314 7040 CMA
6315 7430 SZL
6316 7101 CLL IAC
6317 3043 DCA LOW1
6320 1042 TAD MID1
6321 7040 CMA
6322 7430 SZL
6323 7101 CLL IAC
6324 3042 DCA MID1
6325 1041 TAD HIGH1
6326 7040 CMA
6327 7430 SZL
6330 7101 CLL IAC
6331 3041 DCA HIGH1
6332 5706 JMP I OPNEG

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6333	0000	MULTIP,	0
6334	3361		DCA MP1
6335	3364		DCA MPSCON
6336	1365		TAD THIR
6337	3363		DCA MP3
6340	7100		CLL
6341	1361		TAD MP1
6342	7010		RAR
6343	3361		DCA MP1
6344	1364		TAD MPSCON
6345	7420		SNL
6346	5351		JMP .+3
6347	7100		CLL
6350	1362		TAD MP2CON
6351	7010		RAR
6352	3364		DCA MPSCON
6353	2363		ISZ MP3
6354	5341		JMP MULTIP+6
6355	1361		TAD MP1
6356	7010		RAR
6357	7100		CLL
6360	5733		JMP I MULTIP
6361	0000	MP1,	0
6362	0000	MP2CON,	0
6363	0000	MP3,	0
6364	0000	MPSCON,	0
6365	7764	THIR,	-14
6366	6400	FMULT1,	FMULT
6367	0000	FLMY,	0
6370	4766		JMS I FMULT1
6371	4200		JMS FNORM
6372	3050		DCA OVER2
6373	2777		ISZ I SIGN1
6374	5767		JMP I FLMY
6375	4261		JMS ACNEG
6376	5767		JMP I FLMY
6377	6750	SIGN1,	SGNTST

*6400

/FLOATING MULTIPLY

/(A*2↑24+B*2↑12+C)*(D*2↑24+E*2↑12+F)

6400	0000	FMULT,	0
6401	7201		CLA IAC
6402	1040		TAD EX1
6403	1044		TAD EXP
6404	3044		DCA EXP
6405	1377		TAD SMACLA
6406	3772		DCA I SGNSW
6407	4773		JMS I SIGNP

/ADD EXPONENTS

/SET UP SIGN ROUTINE

/GO THERE

6410	1043	TAD LOW1	
6411	3775	DCA I MP2	
6412	1047	TAD LORDER	/C*F
6413	4774	JMS I DMULT	
6414	7200	CLA	
6415	1776	TAD I MP5	
6416	3371	DCA MUL5	
6417	1046	TAD MIDDLE	
6420	3775	DCA I MP2	
6421	1043	TAD LOW1	/B*F
6422	4774	JMS I DMULT	
6423	1371	TAD MUL5	
6424	3371	DCA MUL5	
6425	7004	RAL	
6426	1776	TAD I MP5	
6427	3370	DCA MUL4	
6430	7004	RAL	
6431	3367	DCA MUL3	
6432	1042	TAD MID1	
6433	3775	DCA I MP2	
6434	1047	TAD LORDER	/C*E
6435	4774	JMS I DMULT	
6436	1371	TAD MUL5	
6437	3371	DCA MUL5	
6440	7004	RAL	
6441	1370	TAD MUL4	
6442	1776	TAD I MP5	
6443	3370	DCA MUL4	
6444	7004	RAL	
6445	1367	TAD MUL3	
6446	3367	DCA MUL3	
6447	1045	TAD HORDER	
6450	3775	DCA I MP2	
6451	1043	TAD LOW1	/A*F
6452	4774	JMS I DMULT	
6453	1370	TAD MUL4	
6454	3370	DCA MUL4	
6455	7004	RAL	
6456	1367	TAD MUL3	
6457	1776	TAD I MP5	
6460	3367	DCA MUL3	
6461	7004	RAL	
6462	3366	DCA MUL2	
6463	1041	TAD HIGH1	
6464	3775	DCA I MP2	
6465	1047	TAD LORDER	/D*C
6466	4774	JMS I DMULT	
6467	1370	TAD MUL4	
6470	3370	DCA MUL4	
6471	7004	RAL	

6472	1367	TAD MUL3	
6473	1776	TAD I MP5	
6474	3367	DCA MUL3	
6475	7004	RAL	
6476	1366	TAD MUL2	
6477	3366	DCA MUL2	
6500	1046	TAD MIDDLE	
6501	3775	DCA I MP2	
6502	1042	TAD MIDI	/B*D
6503	4774	JMS I DMULT	
6504	1370	TAD MUL4	
6505	3370	DCA MUL4	
6506	7004	RAL	
6507	1367	TAD MUL3	
6510	1776	TAD I MP5	
6511	3367	DCA MUL3	
6512	7004	RAL	
6513	1366	TAD MUL2	
6514	3366	DCA MUL2	
6515	1045	TAD HORDER	
6516	3775	DCA I MP2	
6517	1042	TAD MIDI	/A*E
6520	4774	JMS I DMULT	
6521	1367	TAD MUL3	
6522	3367	DCA MUL3	
6523	7004	RAL	
6524	1366	TAD MUL2	
6525	1776	TAD I MP5	
6526	3366	DCA MUL2	
6527	7004	RAL	
6530	3365	DCA MUL1	
6531	1041	TAD HIGH1	
6532	3775	DCA I MP2	
6533	1046	TAD MIDDLE	/B*D
6534	4774	JMS I DMULT	
6535	1367	TAD MUL3	
6536	3367	DCA MUL3	
6537	7004	RAL	
6540	1366	TAD MUL2	
6541	1776	TAD I MP5	
6542	3366	DCA MUL2	
6543	7004	RAL	
6544	1365	TAD MUL1	
6545	3365	DCA MUL1	
6546	1045	TAD HORDER	
6547	3775	DCA I MP2	
6550	1041	TAD HIGH1	/A*D
6551	4774	JMS I DMULT	
6552	1366	TAD MUL2	

6553	3046		DCA MIDDLE
6554	7004		RAL
6555	1365		TAD MUL1
6556	1776		TAD I MP5
6557	3045		DCA HORDER
6560	1367		TAD MUL3
6561	3047		DCA LORDER
6562	1370		TAD MUL4
6563	3050		DCA OVER2
6564	5600		JMP I FMULT
6565	0000	MUL1,	0
6566	0000	MUL2,	0
6567	0000	MUL3,	0
6570	0000	MUL4,	0
6571	0000	MUL5,	0
6572	6740	SGNSW,	SGNSWT
6573	6727	SIGNP,	SIGNCL
6574	6333	DMULT,	MULTIP
6575	6362	MP2,	MP2CON
6576	6364	MP5,	MP5CON
6577	7700	SMACLA,	SMA CLA

/FLOATING DIVIDE=4000

*6600

6600	0000	FLDV,	0	
6601	1040		TAD EXI	/SUBTRACT EXPONENTS
6602	7041		CMA IAC	
6603	1044		TAD EXP	
6604	7001		IAC	
6605	3044		DCA EXP	
6606	1326		TAD SPACLA	
6607	3340		DCA SGNSWT	
6610	4327		JMS SIGNCL	/SET UP SIGNS
6611	1041		TAD HIGH1	
6612	7650		SNA CLA	/DIVISOR=0?
6613	5303		JMP DVER	/YES - ERROR
6614	7300		CLA CLL	
6615	3320		DCA QUOL	
6616	3321		DCA QUOH	
6617	1325		TAD MIF	
6620	3324		DCA DIVCNT	
6621	5233		JMP DVX	
6622	1047	DV3,	TAD LORDER	
6623	7004		RAL	
6624	3047		DCA LORDER	
6625	1046		TAD MIDDLE	
6626	7004		RAL	

6627	3046		DCA MIDDLE	
6630	1045		TAD HORDER	
6631	7004		RAL	
6632	3045		DCA HORDER	
6633	1043	DVX,	TAD LOWI	/PARTIAL SUBTRACT
6634	1047		TAD LORDER	
6635	3322		DCA DTEM1	
6636	7004		RAL	
6637	1042		TAD MIDI	
6640	1046		TAD MIDDLE	
6641	3323		DCA DTEM2	
6642	7004		RAL	
6643	1041		TAD HIGH1	
6644	1045		TAD HORDER	
6645	7420		SNL	/DIVISOR<DIVIDEND?
6646	5254		JMP DV2-1	/NO
6647	3045		DCA HORDER	/YES:C(L)=QUOTIENT BIT
6650	1323		TAD DTEM2	
6651	3046		DCA MIDDLE	
6652	1322		TAD DTEM1	
6653	3047		DCA LORDER	
6654	7200		CLA	
6655	1320	DV2,	TAD QUOL	/SHIFT BIT INTO
6656	7004		RAL	/QUOTIENT
6657	3320		DCA QUOL	
6660	1321		TAD QUOH	
6661	7004		RAL	
6662	3321		DCA QUOH	
6663	1050		TAD OVER2	
6664	7004		RAL	
6665	3050		DCA OVER2	
6666	2324		ISZ DIVCNT	/DONE?
6667	5222		JMP DV3	/NO
6670	1320		TAD QUOL	
6671	3047		DCA LORDER	
6672	1321		TAD QUOH	
6673	3046		DCA MIDDLE	
6674	1050		TAD OVER2	
6675	3045		DCA HORDER	
6676	3050		DCA OVER2	
6677	4717		JMS I NORMIT	
6700	2350	DEXIT,	ISZ SGNTST	
6701	4746		JMS I FACNEG	
6702	5600		JMP I FLDV	

6703	7240	DVER,	CLA CMA	/DIVIDE ERROR
6704	3047		DCA LORDER	
6705	7240		CLA CMA	
6706	3046		DCA MIDDLE	
6707	7040		CMA	
6710	7110		CLL RAR	
6711	3045		DCA HORDER	
6712	1045		TAD HORDER	
6713	3044		DCA EXP	
6714	2061		ISZ FLAG	
6715	7000		NOP	
6716	5300		JMP DEXIT	

6717	6200	NORMIT,	FNORM	
6720	0000	QUOL,	0	
6721	0000	QUOH,	0	
6722	0000	DTEM1,	0	
6723	0000	DTEM2,	0	
6724	0000	DIVCNT,	0	
6725	7735	MIF,	-43	/STEP COUNT
6726	7710	SPACLA,	SPA CLA	

/TEST SIGN SUBROUTINE

6727	0000	SIGNCL,	0	
6730	1351		TAD RESTOR	
6731	3350		DCA SGNTST	
6732	1045		TAD HORDER	
6733	7700		SMA CLA	
6734	5337		JMP .+3	
6735	4746		JMS I FACNEG	
6736	2350		ISZ SGNTST	
6737	1041		TAD HIGH1	
6740	7700	SGNSWT,	SMA CLA	/OR SPA CLA
6741	5727		JMP I SIGNCL	
6742	4747		JMS I OPNEGS	
6743	2350		ISZ SGNTST	
6744	7000		NOP	
6745	5727		JMP I SIGNCL	

6746	6261	FACNEG,	ACNEG
6747	6306	OPNEGS,	OPNEG
6750	0000	SGNTST,	0
6751	7776	RESTOR,	-2

ACNEG	6261	MPSCON	6364
ADDRS	5662	MP1	6361
ALIGN	6031	MP2	6575
AMOUNT	6104	MP2CON	6362
DEXIT	6700	MP3	6363
DIVCNT	6724	MP5	6576
DMULT	6574	MULTIP	6333
DONE	6072	MUL1	6565
DTEM1	6722	MUL2	6566
DTEM2	6723	MUL3	6567
DVER	6703	MUL4	6570
DVX	6633	MUL5	6571
DV2	6655	NOGO	6074
DV3	6622	NOREXT	6251
EXIT	5714	NORMAL	6105
EXIT6	5770	NORMIT	6717
EXP	0044	OPMINS	6106
EX1	0040	OPNEG	6306
FACNEG	6746	OPNEGS	6747
FLAD	6000	OVER1	0051
FLAG	0061	OVER2	0050
FLDV	6600	PAGENO	5665
FLGT	5702	POINT	6103
FLMY	6367	QUOH	6721
FLPT	5733	QUOL	6720
FLSU	6026	RESTOR	6751
FMULT	6400	SAVE	5663
FMULT1	6366	SCALE	6112
FNORM	6200	SGNSW	6572
FPNT	5600	SGNSWT	6740
G02	5661	SGNTST	6750
G06	6224	SHFTAC	6116
HIGH1	0041	SHFTOP	6141
HORDER	0045	SHIFT	6227
INDRCT	5666	SIGNCL	6727
JUMP	5657	SIGNP	6573
JUMP2	5660	SIGN1	6377
LOOP01	5627	SMACLA	6577
LORDER	0047	SPACLA	6726
LOW1	0043	TABLE	5671
MASK3	5664	TABLE6	5750
MASK5	5667	TCON1	6110
MASK7	5670	TCON2	6111
MIDDLE	0046	TEST1	6107
MIDI	0042	THIR	6365
MIF	6725		

/4/17/65-HB-DEC
/4 WORD
/FLOATING POINT I/O ROUTINES
/REQUIRES FLOATING POINT INTERPRETER
/ENTRY AT 0007

*7
0007 5600 FPNT, 5600

*44
0044 0000 EXPONT, 0
0045 0000 HORDER, 0
0046 0000 MIDDLE, 0
0047 0000 LORDER, 0

*52
0052 0000 FPAC1, 0
0053 0000 0
0054 0000 0
0055 0000 0
0056 7777 SWIT1, 7777 /IF = 0, NO CR-LF AFTER OUTPUT
0057 7777 SWIT2, 7777 /IF = 0, NO LF AFTER CR IN INPUT
0060 0000 CHAR, 0 /CONTAINS LAST CHARACTER READ
0061 0000 DSWIT, 0 /= 0 IF NO CONVERSION TOOK PLACE

*6767
6767 0000 PRCHAR, 0
6770 1057 TAD SWIT2
6771 7650 SNA CLA
6772 5767 JMP I PRCHAR
6773 1377 TAD LFED
6774 4776 JMS I OPUT
6775 5767 JMP I PRCHAR
6776 7345 OPUT, OUT
6777 0212 LFED, 0212

/DOUBLE PRECISION DECIMAL-BINARY
/INPUT AND CONVERSION
*7000

7000 0000 DECONV, 0
7001 7200 CLA /INITIALIZE MANTISSA
7002 3045 DCA HORDER
7003 3046 DCA MIDDLE
7004 3047 DCA LORDER
7005 3266 DCA SIGN
7006 3267 DCA DNUMBR
7007 4350 JMS INPUT

7010	1340		TAD PLUS	/TEST FOR SIGN
7011	7450		SNA	
7012	5220		JMP DECON	
7013	1337		TAD MINUS	
7014	7440		SZA	
7015	5221		JMP .+4	
7016	7240		CLA CMA	
7017	3266		DCA SIGN	/IF-, SET SWITCH
7020	4350	DECON,	JMS INPUT	
7021	7200		CLA	
7022	1060		TAD CHAR	/IS IT A DIGIT
7023	1341		TAD MIN9	
7024	7500		SMA	
7025	5600		JMP I DECONV	/NO
7026	1342		TAD PLUS12	
7027	7510		SPA	
7030	5600		JMP I DECONV	/NO
7031	3265		DCA DIGIT	/YES
7032	1045		TAD HORDER	
7033	0343		AND MASK	/OVERFLOW?
7034	7440		SZA	
7035	5220		JMP DECON	/YES-IGNORE
7036	2061		ISZ DSUIT	
7037	2267		ISZ DNUMBR	/INDEX NUMBER OF DIGITS
7040	4242		JMS MULT10	
7041	5220		JMP DECON	/CONTINUE
7042	0000	MULT10,	0	/ROUTINE TO MULTIPLY
7043	1047		TAD LORDER	/DOUBLE PRECISION WORD
7044	3043		DCA 43	/BY TEN (DECIMAL)
7045	1046		TAD MIDDLE	
7046	3042		DCA 42	
7047	1045		TAD HORDER	/REMAIN=REMAINDER
7050	3041		DCA 41	
7051	3040		DCA 40	
7052	4270		JMS MULT2	/CALL SUBROUTINE TO
7053	4270		JMS MULT2	/MULTIPLY BY TWO
7054	4307		JMS DUBLAD	/CALL DOUBLE ADD
7055	4270		JMS MULT2	
7056	1265		TAD DIGIT	/ADD LAST DIGIT RECEIVED
7057	3043		DCA 43	
7060	3042		DCA 42	
7061	3041		DCA 41	
7062	4307		JMS DUBLAD	
7063	1040		TAD 40	/EXIT WITH REMAINDER
7064	5642		JMP I MULT10	/IN AC
7065	0000	DIGIT,	0	/STORAGE FOR DIGIT
7066	0000	SIGN,	0	/=0 IF PLUS: =7777 IF MINUS
7067	0000	DNUMBR,	0	/=NUMBER OF DIGITS
7070	0000	MULT2,	0	/MULTIPLY LORDER, HORDER BY 2

7071	7300		CLA CLL	
7072	1047		TAD LORDER	
7073	7004		RAL	
7074	3047		DCA LORDER	
7075	1046		TAD MIDDLE	
7076	7004		RAL	
7077	3046		DCA MIDDLE	
7100	1045		TAD HORDER	
7101	7004		RAL	
7102	3045		DCA HORDER	
7103	1040		TAD 40	
7104	7004		RAL	
7105	3040		DCA 40	
7106	5670		JMP I MULT2	
7107	0000	DUBLAD,	0	/DOUBLE PRECISION ADDITION
7110	7300		CLA CLL	
7111	1047		TAD LORDER	
7112	1043		TAD 43	
7113	3047		DCA LORDER	
7114	7004		RAL	
7115	1046		TAD MIDDLE	
7116	1042		TAD 42	
7117	3046		DCA MIDDLE	
7120	7004		RAL	
7121	1045		TAD HORDER	
7122	1041		TAD 41	
7123	3045		DCA HORDER	
7124	7004		RAL	
7125	1040		TAD 40	
7126	3040		DCA 40	
7127	5707		JMP I DUBLAD	
7130	0000	MSIGN,	0	/ROUTINE TO FORM
7131	7300		CLA CLL	/2'S COMPLEMENT
7132	2266		ISZ SIGN	/IF C(SIGN)=7777
7133	5730		JMP I MSIGN	
7134	4736		JMS I .+2	
7135	5730		JMP I MSIGN	
7136	6261		6261	/"ACNEG" IN INTERPRETER
7137	7776	MINUS,	253-255	/TEST FOR SIGN
7140	7525	PLUS,	-253	
7141	7506	MIN9,	-272	/TEST FOR DIGIT
7142	0012	PLUS12,	272-260	
7143	7600	MASK,	7600	/TEST FOR OVERFLOW
7144	7775	C.10,	7775	
7145	3146		3146	
			7146 3146	3146
7147	3147		3147	

```

/INPUT A CHARACTER, IF CR, TEST
/INPUT SWITCH TO SEE IF LF SHOULD
/BE TYPED. IF RUBOUT, RESTART INPUT
7150 0000 INPUT, 0 /INPUT A CHARACTER
7151 7200 CLA
7152 6031 KSF
7153 5352 JMP .-1
7154 6036 KRB
7155 3060 DCA CHAR
7156 1060 TAD CHAR
7157 4774 JMS I OUTPUT
7160 1060 TAD CHAR
7161 7450 SNA
7162 5351 JMP INPUT+1 /IGNORE BLANKS
7163 1376 TAD MRBOUT
7164 7450 SNA
7165 5775 JMP I RESTRT /RUBOUT-RESTART INPUT
7166 1377 TAD MINCR
7167 7650 SNA CLA
7170 4773 JMS I PRINT /CR - SEE IF TO BE FOLLOWED
7171 1060 TAD CHAR /BY LF
7172 5750 JMP I INPUT /EXIT ROUTINE

7173 6767 PRINT, PRCHAR
7174 7345 OUTPUT, OUT
7175 7401 RESTRT, FLINTP+1
7176 7401 MRBOUT, -377
7177 0162 MINCR, 377-215

/FLOATING OUTPUT "E" FORMAT
/USES: TSF
/ JMP .-1
/ TLS
*7200
7200 0000 FLOUTP, 0
7201 4217 JMS FOUTCN /CONVERT MANTISSA AND OUTPUT
7202 1324 TAD BEXP
7203 3044 DCA EXPONT
7204 1343 TAD CHE
7205 4345 JMS OUT
7206 4737 JMS I FEXPPT /CONVERT EXPONENT AND OUTPUT
7207 1056 TAD SWIT1 /PRINT CR-LF?
7210 7650 SNA CLA
7211 5600 JMP I FLOUTP /NO-EXIT
7212 1341 TAD CARRIN /YES
7213 4345 JMS OUT
7214 1342 TAD LNFEED
7215 4345 JMS OUT
7216 5600 JMP I FLOUTP /EXIT

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/THIS WHOLE SUBROUTINE MAY BE ALTERED TO BUFFER
 /THE OUTPUT DIGITS : CHANGE JMS OUTDG TO DCA I 10, ETC.
 FOUTCN, 0

7217	0000		CLA CLL	
7220	7300		TAD HORDER	/NUMBER>0??
7221	1045		SPA CLA	
7222	7710		CLA CML	/NO SET LINK
7223	7220		TAD SPLUS	/YES
7224	1327		SZL	
7225	7430		TAD SMINUS	/NO
7226	1330		JMS OUT	
7227	4345		JMS OUTDG	/OUTPUT "0"
7230	4353		TAD PERIOD	
7231	1331		JMS OUT	/OUTPUT "."
7232	4345		CLA CLL	
7233	7300		TAD HORDER	
7234	1045		SMA CLA	
7235	7700		JMP FG01	
7236	5242		CMA	/NUMBER IS NEGATIVE
7237	7040		DCA I SNPT	/NEGATE
7240	3733		JMS I MSNPT	
7241	4732		CLA CMA	/SUBTRACT 1 FROM BINARY EXPON
7242	7240	FG01,	TAD EXPONT	/COMPENSATE AT FG04
7243	1044		DCA EXPONT	
7244	3044		DCA BEXP	/INITIALIZE DECIMAL EXPONENT
7245	3324		TAD EXPONT	/IS -4<EXPONENT<-1
7246	1044	FG02,	SMA	
7247	7500		JMP FG03	/TOO LARGE: MULTIPLY BY 1/10
7250	5263		TAD FOUR	
7251	1326		SMA CLA	
7252	7700		JMP FG04	
7253	5270		JMS I FPNT	/TOO SMALL-TIMES TEN
7254	4407		FMPY I TENPT	/TEN
7255	3740		FEXT	
7256	0000		CLA CMA	
7257	7240		TAD BEXP	
7260	1324		DCA BEXP	
7261	3324		JMP FG02	
7262	5246		JMS I FPNT	
7263	4407	FG03,	FMPY I PRC.10	/ONE TENTH
7264	3744		FEXT	
7265	0000		ISZ BEXP	
7266	2324		JMP FG02	
7267	5246			

7270	3734	FG04,	DCA I DPT	/MULTIPLY BY TWO
7271	4736		JMS I M2PT	/IE.SHIFT LEFT
7272	4735		JMS I M10PT	/MULTIPLY BY TEN
7273	7410		SKP	
7274	4360	FG05A,	JMS DIVTWO	/COMPENSATE FOR
7275	2044		ISZ EXPONT	/BINARY EXPONENT
7276	5274		JMP FG05A	
7277	7450		SNA	/IS FIRST DIGIT A ZERO
7300	5311		JMP FG07	/YES, IGNORE
7301	4353	FG06,	JMS OUTDG	/MULTIPLICATIONS YIELD
7302	1325		TAD MINUS7	/DECIMAL DIGITS AS HIGH
7303	3044		DCA EXPONT	/ORDER REMAINDERS
7304	4735	FG06A,	JMS I M10PT	/IE. .672X10=6+.72.. ETC
7305	4353		JMS OUTDG	
7306	2044		ISZ EXPONT	/7 DIGITS OUTPUT??
7307	5304		JMP FG06A	/NO: CONTINUE
7310	5617		JMP I FOUTCN	/YES:EXIT
7311	7240	FG07,	CLA CMA	/IGNORE FIRST DIGIT
7312	1324		TAD BEXP	/SUBTRACT 1 FROM
7313	3324		DCA BEXP	/DECIMAL EXPONENT
7314	1045		TAD HORDER	
7315	7640		SZA CLA	
7316	5322		JMP .+4	/IS MANTISSA ZERO?
7317	1047		TAD LORDER	
7320	7650		SNA CLA	
7321	3324		DCA BEXP	/YES:EXP=0
7322	7240		CLA CMA	
7323	5302		JMP FG06+1	
7324	0000	BEXP,	0	/CONTAINS DECIMAL EXPONENT
7325	7767	MINUS7,	-11	/NUMBER OF DIGITS OUTPUT
7326	0004	FOUR,	0004	
7327	0253	SPLUS,	253	
7330	0002	SMINUS,	255-253	
7331	0256	PERIOD,	256	
7332	7130	MSNPT,	MSIGN	
7333	7066	SNPT,	SIGN	/POINTERS
7334	7065	DPT,	DIGIT	
7335	7042	M10PT,	MULT10	
7336	7070	M2PT,	MULT2	
7337	7523	FEXPPT,	FEXC	
7340	7504	TENPT,	TEN	
7341	0215	CARRTN,	0215	
7342	0212	LNFEED,	0212	
7343	0305	CHE,	305	
7344	7144	PRC.10,	C.10	

7345	0000	OUT,	Ø	/OUTPUT ONE ASCII CHARACTER
7346	6041		TSF	
7347	5346		JMP .-1	
7350	6046		TLS	
7351	7200		CLA	
7352	5745		JMP I OUT	

7353	0000	OUTDG,	Ø	/OUTPUT ONE DIGIT
7354	1357		TAD C260	
7355	4345		JMS OUT	
7356	5753		JMP I OUTDG	

7357	0260	C260,	0260	
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7360	0000	DIVTWO,	Ø	/DIVIDE BY TWO IE.
7361	7110		CLL RAR	/ROTATE RIGHT
7362	3345		DCA OUT	/TEMPORARY STORAGE
7363	1045		TAD HORDER	
7364	7010		RAR	
7365	3045		DCA HORDER	
7366	1046		TAD MIDDLE	
7367	7010		RAR	
7370	3046		DCA MIDDLE	
7371	1047		TAD LORDER	
7372	7010		RAR	
7373	3047		DCA LORDER	
7374	1345		TAD OUT	
7375	5760		JMP I DIVTWO	

/FLOATING POINT INPUT
*7400

7400	0000	FLINTP,	Ø	
7401	7240		CLA CMA	/INITIALIZE "PERIOD SWITCH"
7402	3314		DCA PRSW	
7403	3061		DCA DSWIT	
7404	4717		JMS I DPCVPT	/7777 = NO PERIOD
7405	7200		CLA	
7406	1060		TAD CHAR	
7407	1313		TAD PER	
7410	7640		SZA CLA	
7411	5220		JMP FIG01	
7412	1314		TAD PRSW	/PERIOD FOUND
7413	7650		SNA CLA	/SECOND PERIOD
7414	5222		JMP FIG02	/YES, TERMINATE
7415	3722		DCA I DPN	/NO - SET NUMBER OF DIGITS TO
7416	3314		DCA PRSW	/SET PERIOD SWITCH TO Ø
7417	5720		JMP I DPCSPT	/CONVERT REST OF STRING

7420	1314	FIG01,	TAD PRSW	/PERIOD READ IN PREVIOUSLY?
7421	7650		SNA CLA	
7422	1722	FIG02,	TAD I DPN	/YES:-NUMBER OF DIGITS IN SER
7423	7041		CMA IAC	/NO
7424	3315		DCA SEXP	
7425	4721		JMS I MSGNPT	/TEST SIGN
7426	1312	FIG03,	TAD C43	
7427	3044		DCA EXPONT	
7430	4407		JMS I FPNT	/NORMALIZE F.P. NUMBER
7431	7000		FNOR	
7432	6052		FPUT FPAC1	/SAVE NUMBER
7433	0000		FEXT	
7434	1060		TAD CHAR	
7435	1311		TAD MINUSE	
7436	7640		SZA CLA	/"E" READ IN?
7437	5252		JMP ENDFI	/NO
7440	4717		JMS I DPCVPT	/YES - CONVERT DECIMAL EXPONEN
7441	4721		JMS I MSGNPT	/TEST SIGN
7442	1045		TAD HORDER	/EXPONENT TOO LARGE??
7443	7510		SPA	
7444	7001		IAC	
7445	7640		SZA CLA	
7446	5277		JMP EXCESS	/YES
7447	1047		TAD LORDER	/NO:DECIMAL POINT IS
7450	1315		TAD SEXP	/C(SEXP)PLACES TO RIGHT
7451	3315		DCA SEXP	/OF LAST DIGIT

/END OF FLOATING POINT INPUT
/COMPENSATE FOR DECIMAL EXPONENTS

7452	4407	ENDFI,	JMS I FPNT	/RESTORE MANTISSA
7453	5052		FGET FPAC1	
7454	0000		FEXT	
7455	1315		TAD SEXP	
7456	7450		SNA	
7457	5600		JMP I FLINTP	
7460	7700		SMA CLA	
7461	5270		JMP FIG04	
7462	4407		JMS I FPNT	/. IS TO THE LEFT:
7463	3710		FMPY I PC.10	/TIMES .1000
7464	0000		FEXT	
7465	2315		ISZ SEXP	
7466	5255		JMP ENDFI+3	
7467	5600		JMP I FLINTP	

7470	4407	FIGO4,	JMS I FPNT	/. IS TO THE RIGHT:
7471	3304		FMPY TEN	/MULTIPLY BY 10
7472	0000		FEXT	
7473	7240		CLA CMA	
7474	1315		TAD SEXP	
7475	3315		DCA SEXP	
7476	5255		JMP ENDFI+3	
7477	1316	EXCESS,	TAD C3777	
7500	3044		DCA EXPONT	
7501	1316		TAD C3777	
7502	3045		DCA HORDER	
7503	5600		JMP I FLINTP	
7504	0004	TEN,	0004	
7505	2400		2400	
7506	0000		0000	
7507	0000		0000	
7510	7144	PC.10,	C.10	/.10
7511	7473	MINUSE,	-305	
7512	0043	C43,	0043	
7513	7522	PER,	-256	
7514	0000	PRSW,	0	
7515	0000	SEXP,	0	/CONTAINS DECIMAL EXPONENT
7516	3777	C3777,	3777	
7517	7000	DPCVPT,	DECONV	
7520	7020	DPCSPT,	DECON	
7521	7130	MSGNPT,	MSIGN	
7522	7067	DPN,	DNUMBR	
				/OUTPUT THE EXPONENT
7523	0000	FEXC,	0	
7524	7300		CLA CLL	
7525	1044		TAD EXPONT	
7526	7510		SPA	
7527	7061		CMA IAC CML	
7530	3044		DCA EXPONT	
7531	1367		TAD C253	
7532	7430		SZL	
7533	1370		TAD C255	
7534	4775		JMS I DGPT	
7535	3045		DCA HORDER	
7536	1044		TAD EXPONT	
7537	2045		ISZ HORDER	
7540	1371		TAD M144	
7541	7500		SMA	
7542	5337		JMP .-3	

7543	1372	TAD	C144
7544	3044	DCA	EXPONT
7545	7040	CMA	
7546	1045	TAD	HORDER
7547	7440	SZA	
7550	4775	JMS	I DGPT
7551	3045	DCA	HORDER
7552	1044	TAD	EXPONT
7553	2045	ISZ	HORDER
7554	1373	TAD	M12
7555	7500	SMA	
7556	5353	JMP	.-3
7557	1374	TAD	C12
7560	3047	DCA	LORDER
7561	7240	CLA	CMA
7562	1045	TAD	HORDER
7563	4775	JMS	I DGPT
7564	1047	TAD	LORDER
7565	4775	JMS	I DGPT
7566	5723	JMP	I FEXC

7567	7773	C253,	0253-260
7570	0002	C255,	255-253
7571	7634	M144,	7634
7572	0144	C144,	0144
7573	7766	M12,	7766
7574	0012	C12,	0012
7575	7353	DGPT,	OUTDG

BEXP	7324
CARRTN	7341
CHAR	0060
CHE	7343
C.10	7144
C12	7574
C144	7572
C253	7567
C255	7570
C260	7357
C3777	7516
C43	7512
DECON	7020
DECONV	7000
DGPT	7575
DIGIT	7065
DIVTWO	7360
DNUMBR	7067
DPCSPT	7520

DPCVPT	7517	MINUSE	7511
DPN	7522	MINUS7	7325
DPT	7334	MIN9	7141
DSWIT	0061	MRBOUT	7176
DUBLAD	7107	MSGNPT	7521
ENDFI	7452	MSIGN	7130
EXCESS	7477	MSNPT	7332
EXPONT	0044	MULT10	7042
FEXC	7523	MULT2	7070
FEXPPT	7337	M10PT	7335
FG01	7242	M12	7573
FG02	7246	M144	7571
FG03	7263	M2PT	7336
FG04	7270	OPUT	6776
FG05A	7274	OUT	7345
FG06	7301	OUTDG	7353
FG06A	7304	OUTPUT	7174
FG07	7311	PC.10	7510
FIG01	7420	PER	7513
FIG02	7422	PERIOD	7331
FIG03	7426	PLUS	7140
FIG04	7470	PLUS12	7142
FLINTP	7400	PRCHAR	6767
FLOUTP	7200	PRC.10	7344
FOUR	7326	PRINT	7173
FOUTCN	7217	PRSW	7514
FPAC1	0052	RESTRT	7175
FPNT	0007	SEXP	7515
HORDER	0045	SIGN	7066
INPUT	7150	SMINUS	7330
LFED	6777	SNPT	7333
LNFEED	7342	SPLUS	7327
LORDER	0047	SWIT1	0056
MASK	7143	SWIT2	0057
MIDDL	0046	TEN	7504
MINCR	7177	TENPT	7340
MINUS	7137		

11. DIAGRAMS (Not Applicable)

12 REFERENCES

See Digital-8-5-S.