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%-----
%-----
% CI-2
%
% FLOATING POINT COMPUTATION INTERPRETER FOR PERSEUS-8 AND PERSEUS-9 (CPU:R6502)
%
% FILE_NAME: ASSEMBLY_CODE_CI-2_V2_0_0.PDF
%
% SPECIFICATION: SEE APPENDIX
%
% HAND ASSEMBLED
%
% VERSION AUG/05/2021      VER. 1.0.0
%          AUG/27/2021      VER. 1.1.0    IF THE MANTISSA IS ZERO, SET THE EXPONET PART TO ZERO.
%                                          OUTPUT SPACE AFTER DISPLAYING ZERO.
%          APR/09/2022      VER. 1.2.0    BUG FIX FOR SQRT FUNCTION ARGUMENT ZERO.
%          JULY/12/2022     VER. 1.2.1    TEMPORARY PATCH FOR ERROR IN PROM MAKING ($E6A4-$E6AE)
%          AUG/06/2022     VER. 1.3.1    PREVENT OUTPUT SPACE CODE IN FORMAT ;; ($E05D,EE30,FC57)
%          OCT/07/2022     VER. 1.3.2    CORRECTING LABEL NAME ERROR. ($E390)
%          DEC/09/2022     VER. 1.4.0    PREVENT CALCULATION STACK DESTRUCTION EVERY 256 CHAR.
%                                          ($F396-F3AE)
%          MAR/11/2023     VER. 1.5.0    ALLOW USER PROGRAM AREA LIMIT TO BE SET. ($E7A3-$E830)
%                                          (ADDRESS $0082 MUST BE SET TO $XX AT FIRST STARTUP.)
%                                          CORRECT NORMALISE($E2D0-) TO MAKE EXPONENT PART THE SAME
%                                          AS THE MINIMUM VALUE,1E-39,WHEN THE MANTISSA PART IS 0.
%          APR/20/2023     VER. 2.0.0    ADDED COMMAND `` FOR LOADING PROGRAM FROM EXTROM-2
%                                          CONNECTED PARALLEL INTERFACE.
%-----
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%-----
% ADDRESS MAPPING:
%          SYSTEM VARIABLES      (ADDRESS $0000 - $00A3)
%          SYSTEM STACK          (ADDRESS $0100 - $01FF)
%          LINE BUFFER            (ADDRESS $0200 - $027F)
%          DISPLAY BUFFER        (ADDRESS $0280 - $02FF)
%          USER VARIABLES        (ADDRESS $0300 - $03FF)
%          USER ARRAY VARIABLES  (ADDRESS $0400 - $0FFF)
%          USER PROGRAM AREA     (ADDRESS $1000 - $XFFF) (V.1.5.0 MAR/11/2023)
%          SYSTEM PROGRAM        (ADDRESS $E000 - $FFFF)
%-----
% SYSTEM VARIABLES
%
%          SYMBOL      DATA
%          LR0          $0000    LINE NUMBER OF THE NEW LINE
%          LR1          $0002    LINE NUMBER OF PROGRAM AREA
%          LINE_LENGTH_1 $0004
%          LINE_LENGTH_2 $0005
%          TEMP_9        $0006    ZERO SUPPRESS FLAG
%          (TEMP_8)      $0007    EXPONENT CORRECTION VALUE
%          TEMP_7 (SIGN_FLAG) $0008
%          TEMP_8 (TEMP_0) $0009
%          TEMP_1 (COL_COUNT) $000A (SAVING R0_3,EXPONENT PORTION OF R1_3)
%          TEMP_2,MUL_COUNT,QUO_COUNT $000B LOOP COUNTER, EXPONENT PORTION OF R0_3
%          TEMP_3        $000C    FOR SAVING ACC. FOR LOOP COUNTING
%          TEMP_4        $000D    EXPONENT CORRECTION, SHIFT OF MANTISSA
%          TEMP_5        $000E
%          TEMP_6        $000F
%          R0            $0010    32BIT FLOATING POINT REGISTER
%          R1            $0014    32BIT FLOATING POINT REGISTER
%          DR0           $0018    48BIT MULTIPLIER REGISTER
%          DR1           $0020    48BIT MULTIPLIER REGISTER
%          DR2           $0028    48BIT MULTIPLIER REGISTER
%          R2            $0030    32BIT FLOATING POINT REGISTER
%          R3            $0034    32BIT FLOATING POINT REGISTER
%          P0            $0040    16BIT POINTER
%          P1            $0042    16BIT POINTER CALCULATED BY R0
%          P2            $0044    16BIT POINTER
%          P3            $0046    MEMORY WRITE POINTER FOR VARIABLE
%          P4            $0048    16BIT POINTER FOR SAVING P0
%          P5            $004A    MEMORY WRITE POINTER FOR ARRAY
%          RUN_FLAG      $0050    EXECUTION FLAG

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DISP_FLAG	\$0051	DISLAY FLAG
VAR_0	\$0052	DETECTED VARIABLE ADDRESS OFFSET
VAR_1	\$0053	DESTINATION VARIABLE ADDRESS OFFSET
TEMP_10	\$0054	FOR SAVING IY
TEMP_11	\$0055	FOR SAVING P0
TEMP_12	\$0056	FOR SAVING P0+1
TEMP_13	\$0057	FOR SAVING ACC
MONI_1	\$0058	SHIFI MONITOR CONVERSION FLOAT TO BINARY
MEM_VAL	\$005A	READING VALUE FROM MEMORY
MONI_2	\$005B	MONITOR FOR READING VALUE FROM MEMORY
TEMP_14,15,16,17	\$005C	32BIT REGISTER FOR ARRAY DUMMY WRITE
R4	\$0060	32BIT FLOATING POINT REGISTER
R5	\$0064	32BIT FLOATING POINT REGISTER
R6	\$0068	32BIT FLOATING POINT REGISTER
R7	\$006C	32BIT FLOATING POINT REGISTER
R8 (LOOP_COUNTER_2)	\$0070	32BIT FLOATING POINT REGISTER
R9	\$0074	32BIT FLOATING POINT REGISTER
R10	\$0078	32BIT FLOATING POINT REGISTER
R11	\$007C	32BIT FLOATING POINT REGISTER
P6	\$0080	16BIT POINTER FOR TABLE OF FUNCTION
MEM_END_U	\$0082	PROGRAM AREA LIMIT UPPER 8BIT (V.1.5.0)
LOOP_COUNTER	\$0090	8BIT LOOP COUNTER FOR FUNCTION
FUNC_SGN_FLAG	\$0091	SIGN FLAG FOR SINE FUNCTION
FUNC_SIN_FLG2	\$0092	
R12	\$00A0	32BIT FLOATING POINT REGISTER
%		
LINE_HEAD	\$0200	HEAD ADDRESS OF LINE BUFFER
OUT_BUF	\$0280	HEAD ADDRESS OF DISPLAY BUFFER
VAR_HEAD	\$0300	HEAD ADDRESS OF USER VARIABLES
PROG_P0_1	\$1000	HEAD ADDRESS OF USER PROGRAM AREA
%		
PARALLEL_PORT	\$4000	8BIT PARALLEL WRITE PORT AND READ PORT
ACIA_STATUS	\$8000	ACIA(68B50) STATUS REGISTER
ACIA_DATA	\$8001	ACIA(68B50) DATA REGISTER
%		

% CI-2 START ADDRESS	\$E8D0	

ADDRESS(HEX) DATA(HEX)		

% RESET VECTOR		

.ORIGIN \$FFFC		
	FFFC	D0 E8

UNIT TEST		

UNIT TEST FOR LINE EDITOR WITHOUT SERIAL INTERFACE.		

.ORIGIN \$E050		

EDITOR_TEST_1 CLC	E050	18
LDX #\$FF	E051	A2 FF
TXS	E053	9A
JSR LINE_EDITOR_1	E054	20 40 E7
L01 JMP L01	E057	4C 57 E0

% PATCH TO PREVENT OUTPUT SPACE CODE IN FORMAT ;;		
(V.1.3.1, AUG/06/2022)		

.ORIGIN \$E05D		

PATCH_ELP_5 JMP. ENDLINE_PRC_5A	E05D	4C 57 FC

% UNIT TEST FOR FLOATING POINT FOUR ARITHMETIC OPERATION.		

```

.ORIGIN $E060
%
ARITH_TEST    CLC                E060  18
               LDX #$FF          E061  A2 FF
               TXS                E063  9A
               JSR INIT_ACIA      E064  20 80 E0
               JSR INIT_REGISTER E067  20 8B E0
L01            JSR IN_1LINE        E06A  20 C0 E0
               JSR GET_FLOAT_3    E06D  20 F7 E0
               JSR NORMALISE_1    E070  20 D0 E2
               NOP                E073  EA
               NOP                E074  EA
               NOP                E075  EA
               JSR DISP_FLOAT_1   E076  20 E0 E1
               JSR DIST_BUFFER_1 E079  20 D0 E1
               BNE L01            E07C  D0 EC
               BEQ L01            E07E  F0 EA
%
%-----
%-----
%----- I/O & FLOATING POINT CONVERSION -----
%-----
%-----
INIT_ACIA      LDA #$03          E080  A9 03
               STA ACIA_STATUS   E082  8D 00 80
               LDA #$15          E085  A9 15
               STA ACIA_STATUS   E087  8D 00 80
               RTS              E08A  60
%
%-----
INIT_REGISTER RTS              E08B  60
%
%-----
% INPUT ONE CHARACTER FROM SERIAL INTERFACE.  (OUTPUT PARAMETER: ACC)
%-----
.ORIGIN $E090
%
IN_1CHA        LDA ACIA_STATUS   E090  A0 00 80
               LSR                E093  4A
               BCC IN_1CHA       E094  90 FA
               LDA ACIA_DATA     E096  AD 01 80    INPUT ONE CHARACTER.
               RTS              E099  60
%
%-----
% OUTPUT ONE CHARACTER TO SERIAL INTERFACE.  (INPUT PARAMETER: ACC)
%-----
OUT_1CHA       PHA                E09A  48
L02            LDA ACIA_STATUS   E09B  AD 00 80
               LSR                E09E  4A
               LSR                E09F  4A
               BCC L02           E0A0  90 F9
               PLA                E0A2  68
               STA ACIA_DATA     E0A3  8D 01 80    OUTPUT ONE CHARACTER.
               CMP #$0D          E0A6  C9 0D
               BEQ L03           E0A8  F0 05
               CMP #$0A          E0AA  C9 0A
               BEQ L04           E0AC  F0 05
               RTS              E0AE  60    IF IT'S NOT 'CR' OR 'LF', EXIT.
%
L03            LDA #$0A          E0AF  A9 0A    IN THE CASE OF 'CR', 'LF' IS SENT AFTER 'CR'.
               BNE OUT_1CHA      E0B1  D0 E7
%
L04            LDA #$0D          E0B3  A9 0D    IN THE CASE OF 'LF', PUT 'CR' TO ACC,
               RTS              E0B5  60    AND EXIT.
%
%-----
% ENTERING SINGLE LINE
%-----
.ORIGIN $E0B6
%
IN_1LINE_1     LDA #$00          E0B6  A9 00
               LDX #$00          E0B8  A2 00

```

L01	STA LINE_HEAD,X	E0BA	9D 00 02	CLEAR BUFFER (\$0200-\$02FF)
	INX	E0BD	E8	
	BNE L01	E0BE	D0 FA	
IN_1LINE	LDX #\$00	E0C0	A2 00	
L06	JSR IN_1CHA	E0C2	20 90 E0	
	JSR OUT_1CHA	E0C5	20 9A E0	
	CMP #\$08	E0C8	C9 08	IS IT 'BS' CODE?
	BEQ L05	E0CA	F0 09	
	STA LINE_HEAD,X	E0CC	9D 00 02	
	INX	E0CF	E8	
	CMP #\$0D	E0D0	C9 0D	
	BNE L06	E0D2	D0 EE	REPEAT UNTIL 'CR' CODE IS DETECTED.
	RTS	E0D4	60	
%				
L05	CPX #\$00	E0D5	E0 00	IS THE LINE POINTER POSITION
	BEQ L06	E0D7	F0 E9	THE INITIAL POSITION?
	DEX	E0D9	CA	LINE POINTER - 1.
	BNE L06	E0DA	D0 E6	
	BEQ L06	E0DC	F0 E4	
%				
%				
%	PATCH FOR GET FLOATING POINT VALUE.			
%				
	.ORIGIN \$E0E0			
%				
L08	INC TEMP_6	E0E0	E6 0F	SET DECIMAL POINT FLAG.
	JMP L07	E0E2	4C 28 E1	
%				
	NOP	E0E5	EA	
	NOP	E0E6	EA	
L09	LDY TEMP_6	E0E7	A4 0F	
	BEQ L11	E0E9	F0 02	IF DECIMAL POINT FLAG=0, EXIT.
	DEC TEMP_3	E0EB	C6 0C	IF THERE IS ALREADY A DECIMAL POINT,
L11	JMP L06	E0ED	4C 11 E1	DECIMAL POINT COUNTER -1.
%				
%				
%	GET FLOATING POINT VALUE FROM ASCII CODES ON LINE BUFFER.			
%				
	.ORIGIN \$E0F7			
%				
GET_FLOAT_3	LDX #\$00	E0F7	A2 00	
GET_FLOAT_1	JSR INIT_REG	E0F9	20 B3 E1	
L02	JMP GET_FLOAT_4	E0FC	4C B0 E6	ANALYZE ONE CHARACTER.
L13	CMP #\$2D	E0FF	C9 2D	
	BEQ L01	E101	F0 2C	IF IT'S '-' CODE, GO TO SIGN PROCESS.
	CMP #\$45	E103	C9 45	
	BEQ GET_EXP_1	E105	F0 30	IF IT'S 'E' CODE, GO TO INPUT EXPONENT PART.
	CMP #\$0D	E107	C9 0D	
	BEQ CORRECT_EXP_1	E109	F0 60	IF IT'S 'CR' CODE, CORRECT EXPONENT,EXIT.
	CMP #\$2E	E10B	C9 2E	IF IT'S '.' CODE,
	BNE L09	E10D	D0 D8	GO TO DECIMAL POINT PROCESS.
	BEQ L08	E10F	F0 CF	
%				
L06	STX TEMP_5	E111	86 0E	SAVE IX.
	STA TEMP_2	E113	85 0B	SAVE ACC.
	LDX #\$04	E115	A2 04	SET SHIFT BITS.
	LDY #\$13	E117	A0 13	
	LDA #\$FF	E119	A9 FF	SELECT R0_0.
	JSR SHIFT_L_NBIT	E11B	20 A0 E1	SHIFT LEFT.
	LDX TEMP_5	E11E	A6 0E	
	LDA TEMP_2	E120	A5 0B	
	AND #\$0F	E122	29 0F	EXTRACT LOWER 4 BITS OF ASCII CODE.
	ORA R0_0	E124	05 10	
	STA R0_0	E126	85 10	PUT BCD ONE DIGIT IN R0_0 LOWER 4 BITS.
L07	INX	E128	E8	
	CPX #\$FF	E129	E0 FF	
	BNE L02	E12B	D0 CF	
	BEQ GET_EXP_1	E12D	F0 08	
%				
L01	LDA #\$80	E12F	A9 80	SIGN FLAG D7='1'.
	STA TEMP_7	E131	85 08	
	NOP	E133	EA	

	NOP	E134	EA	
	BNE L07	E135	D0 F1	
%				
GET_EXP_1	INX	E137	E8	
	LDA LINE_HEAD,X	E138	BD 00 02	ANALYZE THE NEXT CHARACTER OF 'E' CODE.
	CMP #\$2D	E13B	C9 2D	IF IT'S '-' CODE,
	BEQ L03	E13D	F0 24	GO TO EXPONENT SIGN PROCESS.
	JMP GET_EXP_3	E13F	4C 90 E1	
%				
GET_EXP_2	NOP	E142	EA	
	STA TEMP_2	E143	85 0B	SAVE ACC.
	LDA R0_3	E145	A5 13	
	STA TEMP_0	E147	85 09	SAVE R0_3.
	ASL	E149	0A	SHIFT LEFT 4 BITS R0_3.
	ASL	E14A	0A	
	ASL	E14B	0A	
	ASL	E14C	0A	
	AND #\$30	E14D	29 30	EXTRACT D5,D4
	STA TEMP_1	E14F	85 0A	
	LDA TEMP_0	E151	A5 09	
	AND #\$C0	E153	29 C0	EXTRACT D7.D6 OF R0_3.
	ORA TEMP_1	E155	05 0A	SYNTHESIZE D7.D6,D5,D4.
	STA R0_3	E157	85 13	
	LDA TEMP_2	E159	A5 0B	NEW ONE ASCII CHARACTER.
	AND #\$0F	E15B	29 0F	EXTRACT LOWER 4 BITS OF ASCII CODE.
	ORA R0_3	E15D	05 13	
	STA R0_3	E15F	85 13	SYNTHESIZE EXPONENT VALUE AND NEW VALUE.
	BCC GET_EXP_1	E161	90 D4	
%				
L03	LDA TEMP_7	E163	A5 08	
	ORA #\$40	E165	09 40	
	STA TEMP_7	E167	85 08	SIGN FLAG D6='1'.
	BNE GET_EXP_1	E169	D0 CC	
%				
%-----				
% CORRECT EXPONENT PART				
%-----				
CORRECT_EXP_1	LDA TEMP_7	E16B	A5 08	
	ASL	E16D	0A	
	BPL L10	E16E	10 0B	IS EXPONENT POSITIVE?
	SEC	E170	38	IF IT'S NEGATIVE, CONVERT TO COMPLEMENT.
	SED	E171	F8	
	LDA #\$00	E172	A9 00	
	SBC R0_3	E174	E5 13	0 - EXPONENT(BCD)
	SEC	E176	38	
	SBC #\$20	E177	E9 20	AND MORE, - 20(BCD),
	STA R0_3	E179	85 13	TO MAKE IT COMPLEMENT OF 80(BCD)
L10	LDA R0_3	E17B	A5 13	
	CLC	E17D	18	
	SED	E17E	F8	
	ADC TEMP_3	E17F	65 0C	EXPONENT CORRECTION ADDITION.
	AND #\$7F	E181	29 7F	PREVENT THE RESULT OVERLAPPING
	STA R0_3	E183	85 13	SIGN OF MANTISSA.
	LDA TEMP_7	E185	A5 08	SIGN FLAG.
	AND #\$80	E187	29 80	EXTRACT SIGN FLAG OF MANTISSA.
	ORA R0_3	E189	05 13	SYNTHESIS EXPONENT AND MANTISSA SIGN.
	STA R0_3	E18B	85 13	
	RTS	E18D	60	
%				
%-----				
% PATCH FOR GET FLOATING POINT VALUE.				
%-----				
	.ORIGIN \$E190			
%				
GET_EXP_3	CMP #\$20	E190	C9 20	SPACE CODE?
	BEQ L01	E192	F0 07	
	CMP #\$0D	E194	C9 0D	'CR' CODE?
	BEQ CORRECT_EXP_1	E196	F0 D3	
	JMP GET_EXP_2	E198	4C 43 E1	GO TO EXPONENT PROCESS.
%				
L01	JMP G_FLOAT_4_L12	E19B	4C BA E6	GO TO CORRECTION EXPONENT
%				AND MOVE R0 TO R1, ANALYZE NEXT CHARACTER.

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%-----
% SHIFT LEFT 3 BYTES SECTION.
%-----
                .ORIGIN $E1A0
%
SHIFT_L_NBIT STA P0+1          E1A0  85 41
              STY P0           E1A2  84 40
L69           CLC              E1A4  18
              LDY #$FD         E1A5  A0 FD
L68           LDA (P0),Y       E1A7  B1 40
              ROL              E1A9  2A
              STA (P0),Y       E1AA  91 40
              INY              E1AC  C8
              BNE L68          E1AD  D0 F8
              DEY              E1AF  CA
              BNE L69          E1B0  D0 F2
              RTS              E1B2  60
%
%-----
% INITIALIZE REGISTERS.
%-----
INIT_REG      LDA #$06         E1B3  A9 06
              STA TEMP_3       E1B5  85 0C
              LDA #$00         E1B7  A9 00
              STA R0_0         E1B9  85 10
              STA R0_1         E1BB  85 11
              STA R0_2         E1BD  85 12
              STA R0_3         E1BF  85 13
              STA TEMP_6       E1C1  85 0F
              STA TEMP_7       E1C3  85 08
              RTS              E1C5  60
              INITIALIZE DECIMAL POINT COUNTER
              CLEAR R0_0-3
              CLEAR DECIMAL POINT FLAG.
              CLEAR NEGATIVE FLAG OF MANTISSA
              AND EXPONENT PART.
%
%-----
% DISPLAY BUFFER
% SERIAL OUTPUT THE ASCII CODE ON THE DISPLAY BUFFER UNTIL THE 'CR' CODE IS DETECTED.
%-----
                .ORIGIN $E1D0
%
DISP_BUFFER_1 LDY #$00         E1D0  A0 00
L11           LDA OUT_BUF,Y    E1D2  B9 80 02
              INY              E1D5  C8
              BEQ L12          E1D6  F0 07
              JSR OUT_1CHA     E1D8  20 9A E0
              CMP #$0D         E1DB  C9 0D
              BNE L11          E1DD  D0 F3
L12           RTS              E1DF  60
              INITIALIZE BUFFER POINTER.
              TERMINATE AT 256 CHARACTERS.
              IF 'CR' CODE IS DETECTED, TERMINATE.
%
%-----
% DISPLAY FLOATING POINT VALUE.
% CONVERT FLOATING POINT REGISTER VALUE TO ASCII CODES, AND STORE IT TO DISPLAY BUFFER.
%-----
                .ORIGIN $E1E0
%
DISP_FLOAT_1  LDA #$07         E1E0  A9 07
              STA TEMP_8       E1E2  85 07
              LDY #$00         E1E4  A0 00
              STY TEMP_9       E1E6  84 06
              LDX #$03         E1E8  A2 03
              LDA R0_3         E1EA  A5 13
              BPL L03           E1EC  10 06
              LDA #$2D         E1EE  A9 2D
              STA OUT_BUF,Y    E1F0  99 80 02
              INY              E1F3  C8
DET_UPPER     LDA R0_0-1,X     E1F4  B5 0F
              LSR              E1F6  4A
              LSR              E1F7  4A
              LSR              E1F8  4A
              LSR              E1F9  4A
              STA TEMP_2       E1FA  85 0B
              BEQ L01           E1FC  F0 02
              INC TEMP_9       E1FE  E6 06
              IF SIGN IS NEGATIVE, OUTPUT '-' CODE.
              EXTRACT R0 UPPER 4 BITS.
              IS IT ZERO?
              IT IS NOT ZERO, FLAG +1

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L01	LDA TEMP_9	E200	A5 06	IF FLAG=0, DO NOT OUTPUT.
	BEQ DET_LOWER	E202	F0 16	
	LDA TEMP_2	E204	A5 0B	
	ORA #\$30	E206	09 30	CONVERT TO ASCII CODE.
	STA OUT_BUF,Y	E208	99 80 02	OUTPUT TO DISPLAY BUFFER.
	INY	E20B	C8	DISPLAY BUFFER POINTER + 1.
	DEC TEMP_8	E20C	C6 07	EXPONENT CORRECTION VALUE - 1
	LDA TEMP_9	E20E	A5 06	
	CMP #\$01	E210	C9 01	
	BNE DET_LOWER	E212	D0 06	IF ZERO SUPPRESS FLAG=1,
	JMP FLOAT_PATCH_1	E214	4C B5 E2	OUTPUT DECIMAL POINT.
	%			
	NOP	E217	EA	
	NOP	E218	EA	
	NOP	E219	EA	
DET_LOWER	LDA R0_0-1,X	E21A	B5 0F	EXTRACT R0 LOWER 4 BITS.
	AND #\$0F	E21C	29 0F	
	STA TEMP_2	E21E	85 0B	
	BEQ L04	E220	F0 02	IS IT ZERO?
	INC TEMP_9	E222	E6 06	IT IS NOT ZERO, FLAG +1
L04	LDA TEMP_9	E224	A5 06	IF FLAG=0, DO NOT OUTPUT.
	BEQ L06	E226	F0 18	
	LDA TEMP_2	E228	A5 0B	
	NOP	E22A	EA	
	NOP	E22B	EA	
	ORA #\$30	E22C	09 30	CONVERT TO ASCII CODE.
	STA OUT_BUF,X	E22E	99 80 02	OUTPUT TO DISPLAY BUFFER.
	INY	E231	C8	DISPLAY BUFFER POINTER + 1.
	DEC TEMP_8	E232	C6 07	EXPONENT CORRECTION VALUE - 1
	LDA TEMP_9	E234	A5 06	
	CMP #\$01	E236	C9 01	
	BNE L06	E238	D0 06	
	JMP FLOAT_PATCH_2	E23A	4C C0 E2	IF ZERO SUPPRESS FLAG=1,
%				OUTPUT DECIMAL POINT.
	NOP	E23D	EA	
	NOP	E23E	EA	
	NOP	E23F	EA	
L06	DEX	E240	CA	R0 POINTER - 1.
	BNE DET_UPPER	E241	D0 B1	
OUT_EXP_1	CPY #\$00	E243	C0 00	DISPLAY EXPONENT PART.
	BNE L07	E245	D0 0C	
	JMP DISP_ZERO	E247	4C 67 E4	IF MANTISSA=0, DISPLAY '0', SPACE 'CR'.
%				(AUG.27,2021)
	.ORIGIN \$E253			
%				
L07	JMP OUT_EXP_2	E253	4C 90 E2	IF MANTISSA IS NOT ZERO, GO TO
%				DISPLAY EXPONENT PART.
%				
	.ORIGIN \$E25A			
%				
OUT_EXP_4	BCC L08	E25A	90 0D	IF IT'S GREATER THAN \$3F, IT'S NEGATIVE.
	LDA #\$2D	E25C	A9 2D	
	STA OUT_BUF,Y	E25E	99 80 02	OUTPUT '-' CODE.
	INY	E261	C8	
	SEC	E262	38	
	LDA #\$00	E263	A9 00	CONVERT COMPLEMENT TO ABSOLUTE.
	SBC TEMP_2	E265	E5 0B	
	STA TEMP_2	E267	85 0B	
L08	LDA TEMP_2	E269	A5 0B	
	LSR	E26B	4A	SHIFT RIGHT 4 BIT.
	LSR	E26C	4A	
	LSR	E26D	4A	
	LSR	E26E	4A	
	BEQ L09	E26F	F0 06	IF UPPER IS ZERO, DO NOT OUTPUT.
	ORA #\$30	E271	09 30	
	STA OUT_BUF,Y	E273	99 80 02	
	INY	E276	C8	
L09	LDA TEMP_2	E277	A5 0B	
	AND #\$0F	E279	29 0F	
	NOP	E27B	EA	
	NOP	E27C	EA	IF LOWER IS ZERO, DO NOT OUTPUT.
	ORA #\$30	E27D	09 30	

```

%      STA OUT_BUF,Y          E27F 99 80 02
%      INY                    E282 C8
%      LDA #$0D                E283 A9 0D
%      STA OUT_BUF,Y          E285 99 80 02    OUTPUT 'CR' CODE.
%      RTS                     E288 60
%-----
%      .ORIGIN $E290
%
OUT_EXP_2 LDA #$45            E290 A9 45
        STA OUT_BUF,Y        E292 99 80 02    OUTPUT 'E' CODE.
        INY                   E295 C8         DISPLAY BUFFER POINTER + 1.
        LDA R0_3              E296 A5 13     EXTRACT EXPONENT PART.
        AND #$7F              E298 29 7F
        STA TEMP_2            E29A 85 0B     SAVE ACC.
        JMP TEST_2            E29C 4C BF EC
%-----
OUT_EXP_5 SEC                 E29F 38
        SBC TEMP_8            E2A0 E5 07     EXPONENT CORRECTION
        STA TEMP_2            E2A2 85 0B     BY DECIMAL POINT POSITION.
        ASL                   E2A4 0A
        BPL L07               E2A5 10 07     IF D6='1', ADD 20(BCD)
        LDA TEMP_2            E2A7 A5 0B     TO MAKE IT COMPLEMENT OF 100(BCD).
        CLC                   E2A9 18
        ADC #$20              E2AA 69 20
        STA TEMP_2            E2AC 85 0B
L07     LDA TEMP_2            E2AE A5 0B
        CMP #$3F              E2B0 C9 3F     IS IT GREATER THAN %3F?
        JMP OUT_EXP_4         E2B2 4C 5A E2
%-----
% PATCH FOR DISPLAY FLOATING VALUE.
% WHEN A DECIMAL POINT IS OUTPUT, ADD 1 TO THE ZERO SUPPRESS FLAG,
% AND DO NOT DISPLAY THE DECIMAL POINT NEXT TIME.
%-----
FLOAT_PATCH_1 LDA #$2E        E2B5 A9 2E
        STA OUT_BUF,Y        E2B7 99 80 02
        INY                   E2BA C8
        INC TEMP_9            E2BB E6 06
        JMP DET_LOWER         E2BD 4C 1A E2
%-----
FLOAT_PATCH_2 LDA #$2E        E2C0 A9 2E
        STA OUT_BUF,Y        E2C2 99 80 02
        INY                   E2C5 C8
        INC TEMP_9            E2C6 E6 06
        JMP L06               E2C8 4C 40 E2
%-----
%----- FOUR ARITHMETIC OPERATIONS -----
%-----
% NORMALISE (SHIFT MANTISSA TO R0_2 UPPER, AND CORRECT EXPONENT PART. (V.1.5.0 MAR/11/2023))
%-----
%      .ORIGIN $E2D0
%
NORMALISE_1 LDA #$06           E2D0 A9 06
        STA TEMP_1           E2D2 85 0A     INITIALIZE LOOP COUNTER.
        LDA #$00             E2D4 A9 00
        STA TEMP_3           E2D6 85 0C     INITIALIZE EXPONENT CORRECTION VALUE.
L02     LDA R0_2              E2D8 A5 12
        AND #$F0             E2DA 29 F0     EXTRACT R_0 UPPER.
        BNE CORRECT_EXP_2    E2DC D0 14     IF IT IS NOT ZERO, TERMINATE SHIFTING.
        LDX #$04             E2DE A2 04     SHIFT BITS.
        LDY #$13             E2E0 A0 13
        LDA #$FF             E2E2 A9 FF
        JSR SHIFT_L_NBIT1    E2E4 20 54 EC   SHIFT LEFT.
        INC TEMP_3           E2E7 E6 0C     EXPONENT CORRECTION VALUE + 1.

```


	DEC TEMP_1	E2E9	C6 0A	
	BNE L02	E2EB	D0 EB	SHIFT ENDS TO THE BOTTOM.
	LDA #\$42	E2ED	A9 42	WHEN THE MANTISSA IS ZERO,
	STA R0_3	E2EF	85 13	SET THE EXPONENT PART TO MINIMUM.
	RTS	E2F1	60	(MAR/11/2023 V.1.5.0)
%				
CORRECT_EXP_2	SED	E2F2	F8	
	LDA R0_3	E2F3	A5 13	
	STA TEMP_0	E2F5	85 09	EXPONENT CORRECTION.
	AND #\$7F	E2F7	29 7F	REMOVE SIGN BIT OF MANTISSA.
	STA TEMP_2	E2F9	85 0B	
	ASL	E2FB	0A	
	BPL L01	E2FC	10 07	
	LDA TEMP_2	E2FE	A5 0B	IF D6='1', ADD 20(BCD),
	CLC	E300	18	TO MAKE IT COMPLEMENT OF 100(BCD).
	ADC #\$20	E301	69 20	
	STA TEMP_2	E303	85 0B	
L01	LDA TEMP_2	E305	A5 0B	
	SEC	E307	38	
	SBC TEMP_3	E308	E5 0C	SUBTRACT EXPONENT CORRECTION VALUE.
	STA TEMP_2	E30A	85 0B	
	CMP #\$3F	E30C	C9 3F	IF IT'S GREATER THAN \$3F, IT'S NEGATIVE.
	BCC L03	E30E	90 07	
	LDA TEMP_2	E310	A5 0B	SUBTRACT 20(BCD)
	SEC	E312	38	TO MAKE IT COMPLEMENT OF 80(BCD).
	SBC #\$20	E313	E9 20	
	STA TEMP_2	E315	85 0B	
L03	LDA TEMP_0	E317	A5 09	
	AND #\$80	E319	29 80	
	ORA TEMP_2	E31B	05 0B	RESTORE THE SIGN BIT OF MANTISSA.
	STA R0_3	E31D	85 13	
	RTS	E31F	60	
%				
%-----				
%	ALIGN EXPONENT PART BEFORE FLOATING POINT ADDITION AND SUBTRACTION.			
%-----				
	.ORIGIN \$E335			
%				
PRE_ADD_3	SEC	E335	38	
	SBC TEMP_2	E336	E5 0B	EXPONENT OF R1 - EXPONENT OF R0.
	STA TEMP_2	E33B	85 0B	
	BEQ L01	E33A	F0 17	IF THE EXPONENT IS THE SAME, BRANCH.
	BCC L02	E33C	90 16	IN CASE R1 < R0, BRANCH
	JSR SHIFT_WIDTH	E33E	20 C2 E3	IN CASE R1 > R0, SET SHIFT WIDTH.
	NOP	E341	EA	
	LDA R0_3	E342	A5 13	
	AND #\$80	E344	29 80	
	ORA TEMP_0	E346	05 09	SYNTHESIS R0_3 SIGN AND R1_3 EXPONENT.
	STA R0_3	E348	85 13	
	LDX TEMP_3	E34A	A6 0C	SET SHIFT WIDTH.
	LDY #\$10	E34C	A0 10	
	LDA #\$00	E34E	A9 00	
	JSR SHIFT_R_NBIT	E350	20 6F E3	SHIFT RIGHT R0
L01	RTS	E353	60	
%				
L02	SEC	E354	38	
	LDA #\$00	E355	A9 00	
	SBC TEMP_2	E357	E5 0B	IN CASE R1 < R0, COMPLEMENT DIFFERENCE.
	JSR SHIFT_WIDTH	E359	20 C2 E3	SET SHIFT WIDTH.
	NOP	E35C	EA	
	LDA R1_3	E35D	A5 17	
	AND #\$80	E35F	29 80	
	ORA TEMP_1	E361	05 0A	SYNTHESIS R1_3 SIGN AND R0_3 EXPONENT.
	STA R1_3	E363	85 17	MOVE TO R1_3.
	LDX TEMP_3	E365	A6 0C	
	LDY #\$14	E367	A0 14	
	LDA #\$00	E369	A9 00	
	JSR SHIFT_R_NBIT	E36B	20 6F E3	
	RTS	E36E	60	
%				
%-----				

% SHIFT RIGHT WITH 3 BYTE SECTION.

% SHIFT BITS: IX, REGISTER HEAD ADDRESS LOWER: IY, REGISTER HEAD ADDRESS UPPER: IX,

%-----

SHIFT_R_NBIT	STY P0	E36F	84 40
	STA P0+1	E371	85 41
L67	CLC	E373	18
	LDY #\$02	E374	A0 02
L66	LDA (P0),Y	E376	B1 40
	ROR	E378	6A
	STA (P0),Y	E379	91 40
	DEY	E37B	88
	BPL L66	E37C	10 F8
	DEX	E37E	CA
	BNE L67	E37F	D0 F2
	RTS	E381	60

%

%-----

% ALIGN EXPONENT PART BEFORE FLOATING POINT ADDITION AND SUBTRACTION.

%-----

.ORIGIN \$E390

%

PRE_ADD_1	SEC	E390	F8	(CORRECTING LABEL NAME OCT/07/2022)
	LDA R0_3	E391	A5 13	EXPONENT PART OF R0
	AND #\$7F	E393	29 7F	REMOVE SIGN OF MANTISSA.
	STA TEMP_1	E395	85 0A	
	ASL	E397	0A	
	CLC	E398	18	
	BMI L03	E399	30 09	IF NEGATIVE (D6='1'), BRANCH.
	LDA TEMP_1	E39B	A5 0A	IF POSITIVE (D6='0'),
	ADC #\$60	E39D	69 60	ADD 60(BCD).
	STA TEMP_2	E39F	85 0B	
	CLC	E3A1	18	
	BCC L04	E3A2	90 06	

%

L03	LDA TEMP_1	E3A4	A5 0A	IN CASE OF NEGATIVE, ADD 80(BCD).
	ADC #\$80	E3A6	69 80	
	STA TEMP_2	E3A8	85 0B	
L04	LDA R1_3	E3AA	A5 17	EXPONENT PART OF R1.
	AND #\$7F	E3AC	29 7F	REMOVE SIGN OF MANTISSA.
	STA TEMP_0	E3AE	85 09	
	ASL	E3B0	0A	
	CLC	E3B1	18	
	BMI L05	E3B2	30 07	IF NEGATIVE (D6='1'), BRANCH.
	LDA TEMP_0	E3B2	A5 09	IF POSITIVE (D6='0'),
	ADC #\$60	E3B6	69 60	ADD 60(BCD).
	CLC	E3B8	18	
	BCC L06	E3B9	90 04	

%

L05	LDA TEMP_0	E3BB	A5 09	
	ADC #\$80	E3BD	69 80	IN CASE OF NEGATIVE, ADD 80(BCD).
L06	JMP PRE_ADD_3	E3BF	4C 35 E3	

%

%-----

% PATCH FOR PRE_ADD. (LIMIT THE SHIFT WIDTH TO 24 BITS.)

%-----

SHIFT_WIDTH	CMP #\$06	E3C2	C9 06
	BCC L01	E3C4	90 02
	LDA #\$06	E3C6	A9 06
L01	ASL	E3C8	0A
	ASL	E3C9	0A
	STA TEMP_3	E3CA	85 0C
	RTS	E3CC	60

%

%-----

% FLOATING POINT ADDITION.

%-----

.ORIGIN \$E3D0

%

ADD_FLOAT_1	JSR PRE_ADD_4	E3D0	20 F8 E3	ALIGN EXPONENT, CONVERT TO COMPLEMENT.
	LDX #\$FC	E3D3	A2 FC	32 BITS MANTISSA ADDITION,
	CLC	E3D5	18	
L01	LDA \$18,X	E3D6	B5 18	R0 = R1 + R0.

```

        ADC $14,X          E3D8 75 14
        STA $14,X          E3DA 95 14
        INX                E3DC E8
        NOP                E3DD EA
        NOP                E3DE EA
        BNE L01            E3DF D0 F5
L03      JSR COMP_2_ABS_1    E3E1 20 26 E4    CONVERT COMPLEMENT TO ABSOLUTE WITH SIGN.
        RTS                E3E4 60

%
%-----
% FLOATING POINT SUBTRACTION.
%-----
SUB_FLOAT_1 JSR PRE_ADD_4    E3E5 20 F8 E3    ALIGN EXPONENT, CONVERT TO COMPLEMENT.
        LDX #$FC            E3E8 A2 FC    32 BITS MANTISSA SUBTRACTION,
        SEC                E3EA 38
L02      LDA $18,X          E3EB B5 18    R0 = R1 - R0.
        SBC $14,X          E3ED F5 14
        STA $14,X          E3EF 95 14
        INX                E3F1 E8
        NOP                E3F2 EA
        NOP                E3F3 EA
        BNE L02            E3F4 D0 F5
        BEQ L03            E3F6 F0 E9

%
%-----
% PREPROCESSING OF ADDITION AND SUBTRACTION.
%-----
PRE_ADD_4   JSR PRE_ADD_1    E3F8 20 90 E3    ALIGN EXPONENT.
        LDA R0_3            E3FB A5 13
        AND #$7F            E3FD 29 7F    SAVE EXPONENT OF R0_3
        STA TEMP_1          E3FF 85 0A
        LDA #$FF            E401 A9 FF    SET R1 TO POINTER P0.
        STA P0+1            E403 85 41
        LDA #$18            E405 A9 18
        STA P0              E407 85 40
        JSR ABS_2_COMP_1     E409 20 14 E4    CONVERT R1 TO COMPLEMENT.
        LDA #$14            E40C A9 14
        STA P0              E40E 85 40
        JSR ABS_2_COMP_1     E410 20 14 E4    CONVERT R0 TO COMPLEMENT.
        RTS                E413 60

%
%-----
% CONVERT 24 BITS ABSOLUTE MANTISSA TO 32 BITS BCD COMPLEMENT.
%-----
ABS_2_COMP_1 LDY #$FF        E414 A0 FF
        LDA (P0),Y          E416 B1 40    EXTRACT SIGN BIT.
        AND #$80            E418 29 80
        STA (P0),Y          E41A 91 40
        BPL L01             E41C 10 07    IF IT'S POSITIVE, DO NOT CONVERT.
        LDA #$00            E41E A9 00
        STA (P0),Y          E420 91 40
        JSR COMP_2          E422 20 5A E4    COMPLIMENT CONVERSION.
        RTS                E425 60

%
%-----
% CONVERT 32 BITS BCD COMPLIMENT TO 24 BITS ABSOLUTE MANTISSA.
%-----
COMP_2_ABS_1 LDA #$00        E426 A9 00
        STA TEMP_7          E428 85 08
        LDA R0_3            E42A A5 13
        BPL L02             E42C 10 07    IF MANTISSA IS POSITIVE, DO NOT COMPLEMENT.
        JSR COMP_2          E42E 20 5A E4    WHEN MANTISSA IS NEGATIVE, COMPLEMENT.
        LDA #$80            E431 A9 80
        STA TEMP_7          E433 85 08    SET NEGATIVE TO MANTISSA SIGN FLAG.
L02      LSR R0_3            E435 46 13
        BCC L03             E437 90 1A    IF D0='1' OF R0_3, DO FOLLOWING PROCESS.
        LDX #$04            E439 A2 04
        LDY #$10            E43B A0 10
        LDA #$00            E43D A9 00
        JSR SHIFT_R_NBIT    E43F 20 6F E3    SHIFT RIGHT 4 BIT R0_3-R0_1.
        LDA #$10            E442 A9 10
        ORA R0_2            E444 05 12    SET '1' TO R0_2 UPPER 4 BITS.

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        STA R0_2          E446 85 12
        LDA TEMP_1        E448 A5 0A
        CLC               E44A 18
        ADC #$01          E44B 69 01      EXPONENT PART CORRECTION + 1
        AND #$7F          E44D 29 7F
        STA TEMP_1        E44F 85 0A
        NOP               E451 EA
        NOP               E452 EA
L03     LDA TEMP_1        E453 A5 0A
        ORA TEMP_7        E455 05 08      SYNTHESIS R0_3 AND SIGN OF MANTISSA.
        STA R0_3          E457 85 13
        RTS               E459 60

%
%-----
% COMPLEMENT CONVERSION CORE.
%-----
COMP_2   SEC             E45A 38
        LDY #$FC          E45B A0 FC
L04     LDA #$00          E45D A9 00
        SBC (P0),Y        E45F F1 40
        STA (P0),Y        E461 91 40
        INY               E463 C8
        BNE L04           E464 D0 F7
        RTS               E466 60

%
%-----
% DISPLAY ZERO. (V.1.1.0 AUG/27/2021)
%-----
DISP_ZERO LDA #$30        E467 A9 30
        STA OUT_BUF,Y     E469 99 80 02      OUTPUT '0' CODE.
        INY               E46C C8
        LDA #$20          E46D A9 20
L01     STA OUT_BUF,Y     E46F 99 80 02      OUTPUT 9 SPACES.
        INY               E472 C8
        CPY #$09          E473 C0 09
        BNE L01           E475 D0 F8
        LDA #$0D          E477 A9 0D
        STA OUT_BUF,Y     E479 99 80 02      OUTPUT 'CR' CODE.
        RTS               E47C 60

%
%-----
% FLOATING POINT MULTIPLICATION.
%-----
        .ORIGIN $E4A0
%
MUL_FLOAT_1 JSR PRE_MUL_2 E4A0 20 F3 E4      PREPROCESSING, EXPONENT ADDITION.
        LDX #$00          E4A3 A2 00
L01     LDA $10,X          E4A5 B5 10      MOVE MULTIPLIER R0_0-R0_2 TO DR0_0-DR0_2.
        STA $18,X          E4A7 95 18
        LDA $14,X          E4A9 B5 14      MOVE MULTIPLICAND R1_0-R1_2 TO DR1_0-DR1_2
        STA $20,X          E4AB 95 20
        INX               E4AD E8
        CPX #$03          E4AE E0 03
        BNE L01           E4B0 D0 F3
        JSR MUL_BCD_3      E4B2 20 C0 E4      MULTIPLICATION CORE.
        JSR AFTER_OPE_3    E4B5 20 82 E6      POST-PROCESSING.
        RTS               E4B8 60

%
%-----
% MULTIPLICATION CORE FOR MANTISSA. (RESULT, DR2 = MULTIPLICAND, DR1 * MULTIPLIER, DR0)
%-----
        .ORIGIN $E4C0
%
MUL_BCD_3 LDA #$06        E4C0 A9 06      INITIALIZE DIGIT COUNTER.
        STA COL_COUNT      E4C2 85 0A
L08     LDA DR0_0          E4C4 A5 18      EXTRACT LEAST SIGNIFICANT 4 BIT
        AND #$0F          E4C6 29 0F      OF MULTIPLIER 4 BIT.
        STA MUL_COUNT      E4C8 85 0B      IT BECOMES MULTIPLIER COUNTER VALUE.
        BEQ L01            E4CA F0 10      IF MULTIPLIER COUNTER=0, DO NOT ACCUMULATE
L03     LDX #$FA          E4CC A2 FA      INITIALIZE ACCUMULATION POINTER.
        CLC               E4CE 18
L02     LDA $2E,X          E4CF B5 2E      LOAD FROM RESULT REGISTER DR2.

```

	ADC \$26,X	E4D1	75 26	ACCUMULATE MULTIPLICAND DR1.
	STA \$2E,X	E4D3	95 2E	MOVE RESULT TO DR2.
	INX	E4D5	E8	ACCUMULATION POINTER + 1
	BNE L02	E4D6	D0 F7	REPEAT UNTIL MOST SIGNIFICANT DIGIT.
	DEC MUL_COUNT	E4D8	C6 0B	MULTIPLIER COUNTER - 1.
	BNE L03	E4DA	D0 F0	REPEAT UNTIL MULTIPLIER COUNTER = 0.
L01	LDX #\$04	E4DC	A2 04	
	LDY #\$18	E4DE	A0 18	
	LDA #\$00	E4E0	A9 00	
	JSR SHIFT_R_NBIT	E4E2	20 6F E3	SHIFIT 4 BIT RIGHT MULTIPLIER REGISTER DR0.
	LDX #\$04	E4E5	A2 04	
	LDY #\$26	E4E7	A0 26	
	LDA #\$FF	E4E9	A9 FF	
	JSR SHIFT_L_NBIT2	E4E9	20 1F E5	SHIFT 4 BIT LEFT MULTIPLICAND REGISTER DR1
	DEC COL_COUNT	E4EE	C6 0A	
	BNE L08	E4F0	D0 D2	
	RTS	E4F2	60	
%				
%-----				
% PREPROCESSING OF FLOATING POINT MULTIPLICATION				
%-----				
PRE_MUL_2	SED	E4F3	F8	IF THE MANTISSA SIGN OF R1 AND R0 ARE
	LDA R0_3	E4F4	A5 13	DIFFERENT, SET \$80 TO THE SIGN FLAG.
	EOR R1_3	E4F6	45 17	
	AND #\$80	E4F8	29 80	
	STA SIGN_FLAG	E4FA	85 08	
	JSR MUL_EXP_2	E4FC	20 61 E5	ADDITION OF 7 BIT EXPONENT PART.
	LDA R0_3	E4FF	A5 13	
	AND #\$7F	E501	29 7F	
	ORA SIGN_FLAG	E503	05 08	SYNTHESIS SIGN AND EXPONENT PART.
	STA R0_3	E505	85 13	
L02	LDX #\$00	E507	A2 00	CLEAR MULTIPLICAND DR1 UPPER AND
	LDA #\$00	E509	A9 00	CLEAR PRODUCT DR2.
	STA \$23,X	E50B	95 23	
	INX	E50D	E8	
	CPX #\$0B	E50E	E0 0B	
	BNE L02	E510	D0 F7	
	RTS	E512	60	
%				
%-----				
% POST-PROCESSING OF MULTIPLICATION.				
%-----				
AFTER_OPE_1	LDX #\$00	E513	A2 00	MOVE MANTISSA RESULT DR2 TO R0
L01	LDA \$2B,X	E515	B5 2B	
	STA \$10,X	E517	95 10	
	INX	E519	E8	
	CPX #\$03	E51A	E0 03	
	BNE L01	E51C	D0 F7	
	RTS	E51E	60	
%				
%-----				
% SHIFT LEFT WITH 6 BYTE SECTION.				
%-----				
SHIFT_L_NBIT2	STA P0+1	E51F	85 41	
	STY P0	E521	84 40	
L02	CLC	E523	18	
	LDY #\$FA	E524	A0 FA	
L01	LDA (P0),Y	E526	B1 40	
	ROL	E528	2A	
	STA (P0),Y	E529	91 40	
	INY	E52B	C8	
	BNE L01	E52C	D0 F8	
	DEX	E52E	CA	
	BNE L02	E52F	D0 F2	
	RTS	E531	60	
%				
%-----				
% ADDITION OF 7 BITS EXPONENT PART.				
%-----				
MUL_EXP_1	LDA R0_3	E532	A5 13	
	ASL	E534	0A	
	BPL L01	E535	10 09	IF R0_3 EXPONENT IS NEGATIVE, ADD 20(BCD)

	LDA R0_3	E537	A5 13	TO MAKE IT A COMPLEMENT TO 100(BCD).
	AND #\$7F	E539	29 7F	
	CLC	E53B	18	
	ADC #\$20	E53C	69 20	
	STA R0_3	E53E	85 13	
L01	LDA R1_3	E540	A5 17	IF R1_3 EXPONENT IS NEGATIVE, ADD 20(BCD)
	ASL	E542	0A	TO MAKE IT A COMPLEMENT TO 100(BCD).
	BPL L02	E543	10 09	
	LDA R1_3	E545	A5 17	
	AND #\$7F	E547	29 7F	
	CLC	E549	18	
	ADC #\$20	E54A	69 20	
	STA R1_3	E54C	85 17	
L02	LDA R0_3	E54E	A5 13	
	CLC	E550	18	
	ADC R1_3	E551	65 17	ADDITION (R1 EXPONENT + R0 EXPONENT)
	STA R0_3	E553	85 13	
	CMP #\$3F	E555	C9 3F	IF RESULT IS MORE THAN \$3F, IT'S NEGATIVE.
	BCC L03	E557	90 07	SUBTRACT 20(BCD)
	LDA R0_3	E559	A5 13	TO MAKE IT A COMPLEMENT TO 80(BCD).
	SEC	E55B	38	
	SBC	E55C	E9 20	
	STA R0_3	E55E	85 13	
L03	RTS	E560	60	
%				
%	-----			
%	% REMOVE SIGN OF MANTISSA FROM R0,R1 BEFORE ADD 7 BITS EXPONENT PART.			
%	-----			
MUL_EXP_2	LDA R0_3	E561	A5 13	
	AND #\$7F	E563	29 7F	
	STA R0_3	E565	85 13	
	LDA R1_3	E567	A5 17	
	AND #\$7F	E569	29 7F	
	STA R1_3	E56B	85 17	
	JMP MUL_EXP_1	E56D	4C 32 E5	
%				
%	-----			
%	% FLOATING POINT DIVISION.			
%	-----			
	.ORIGIN \$E570			
%				
DIV_FLOAT_1	JSR PRE_DIV_1	E570	20 89 E5	PREPROCESSING,EXPONENT SUBTRACTION.
	LDX #\$00	E573	A2 00	
L01	LDA \$10,X	E575	B5 10	MOVE R0 TO DR0 UPPER.
	STA \$1B,X	E577	95 1B	
	LDA \$14,X	E579	B5 14	MOVE R1 TO DR1 UPPER.
	STA \$23,X	E57B	95 23	
	INX	E57D	E8	
	CPX #\$03	E57E	E0 03	
	BNE L01	E580	D0 F3	
	JSR DIV_BCD_3	E582	20 DC E5	DIVISION CORE.
	JSR AFTER_OPE_2	E585	20 4D E6	POST-PROCESSING.
	RTS	E588	60	
%	-----			
%	% PREPROCESSING OF FLOATING POINT DIVISION			
%	-----			
PRE_DIV_1	SED	E589	F8	IF THE MANTISSA FLAG OF R1 AND R2 ARE
	LDA R0_3	E58A	A5 13	DIFFERENT, SET \$80 TO THE SIGN FLAG.
	EOR R1_3	E58C	45 17	
	AND #\$80	E58E	29 80	
	STA SIGN_FLAG	E590	85 08	
	JSR DIV_EXP_1	E592	20 A9 E5	SUBTRACTION OF 7 BIT EXPONENT PART.
	LDA R0_3	E595	A5 13	
	AND #\$7F	E597	29 7F	
	ORA SIGN_FLAG	E599	05 08	SYNTHESIS SIGN AND EXPONENT PART.
	STA R0_3	E59B	85 13	
	LDX #\$00	E59D	A2 00	CLEAR DR0,DR1,DR2
	LDA #\$00	E59F	A9 00	
L02	STA \$18,X	E5A1	95 18	
	INX	E5A3	E8	
	CPX #\$16	E5A4	E0 16	
	BNE L02	E5A6	D0 F9	

```

RTS                                E5A8  60
%
%-----
% SUBTRACTION OF 7 BIT EXPONENT PART.
%-----
DIV_EXP_1    LDA R1_3              E5A9  A5 17      REMOVE SIGN OF MANTISSA FROM R0_3,R1_3.
              AND #$7F             E5AB  29 7F
              STA R1_3             E5AD  85 17
              LDA R0_3             E5AF  A5 13
              AND #$7F             E5B1  29 7F
              STA R0_3             E5B3  85 13
              ASL                   E5B5  0A
              BPL L01              E5B6  10 07      IF R0_3 EXPONENT IS NEGATIVE, ADD 20(BCD)
              LDA R0_3             E5B8  A5 13      TO MAKE IT A COMPLEMENT TO 100(BCD).
              CLC                   E5BA  18
              ADC #$20             E5BB  69 20
              STA R0_3             E5BD  85 13
L01           LDA R1_3             E5BF  A5 17
              ASL                   E5C1  0A
              BPL L02              E5C2  10 07      IF R1_3 EXPONENT IS NEGATIVE, ADD 20(BCD)
              LDA R1_3             E5C4  A5 17      TO MAKE IT A COMPLEMENT TO 100(BCD).
              CLC                   E5C6  18
              ADC #$20             E5C7  69 20
              STA R1_3             E5C9  85 17
L02           LDA R1_3             E5CB  A5 17
              SEC                   E5CD  38
              SBC R0_3             E5CE  E5 13      SUBTRACTION (R1 EXPONENT - R0 EXPONENT)
              STA R0_3             E5D0  85 13
              CMP #$3F             E5D2  C9 3F      IF RESULT IS MORE THAN $3F, IT'S NEGATIVE.
              BCC L03              E5D4  90 05      SUBTRACT 20(BCD)
              SEC                   E5D6  38      TO MAKE IT A COMPLEMENT TO 80(BCD).
              SBC #$20             E5D7  E9 20
              STA R0_3             E5D9  85 13
L03           RTS                  E5DB  60
%
%-----
% DIVISION CORE FOR MANTISSA. (QUOTIENT,DR2 = DIVIDEND,DR1 / DIVISOR,DR0)
%-----
DIV_BCD_3    LDA #$00              E5DC  A9 00      INITIALIZE DIGIT COUNTER.
              STA COL_COUNT        E5DE  85 0A
L07           NOP                  E5E0  EA
              NOP                  E5E1  EA
              NOP                  E5E2  EA
              NOP                  E5E3  EA
              NOP                  E5E4  EA
              NOP                  E5E5  EA
              NOP                  E5E6  EA
              NOP                  E5E7  EA
              NOP                  E5E8  EA
L10           BEQ DET_ZERO_DR0     E5E9  F0 38
L09           LDA #$FF             E5EB  A9 FF
              STA QUO_COUNT        E5ED  85 0B      RESET QUOTIENT COUNTER.
L04           INC QUO_COUNT        E5EF  E6 0B      QUOTIENT COUNTER + 1.
              LDX #$FA             E5F1  A2 FA      12 DIGIT BCD SUBTRACTION
              SEC                   E5F3  38
L03           LDA $26,X            E5F4  B5 26      LOAD DIVIDEND TO DR1.
              SBC $1E,X            E5F6  F5 1E      SUBTRACT DIVISOR DR0.
              STA $26,X            E5F8  95 26      MOVE RESULT TO DR1.
              INX                   E5FA  E8      DIGIT POINTER + 1.
              BNE L03              E5FB  D0 F7
              BCS L04              E5FD  B0 F0
L08           LDX #$04             E5FF  A2 04      IF RESULT IS POSITIVE, REPEAT SUBTRACT.
              LDY #$2E             E601  A0 2E      IF RESULT IS NEGATIVE,
              LDA #$FF             E603  A9 FF      SHIFT LEFT 4 BITS QUOTIENT DR2.
              JSR SHIFT_L_NBIT2    E605  20 1F E5
              LDA DR2_0            E608  A5 28      SET QUOTIENT COUNTER VALUE TO LOWER 4 BIT
              ORA QUO_COUNT        E60A  05 0B      OF LEAST SIGNIFICANT BYTE OF QUOTIENT DR2.
              STA DR2_0            E60C  85 28
              LDX #$FA             E60E  A2 FA      RESTORING PROCESS.
              CLC                   E610  18
L06           LDA $26,X            E611  B5 26      DR1 = DR1 + DR0.
              ADC $1E,X            E613  75 1E

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        STA $26,X          E615 95 26
        INX                E617 E8
        BNE L06            E618 D0 F7
        INC COL_COUNT      E61A E6 0A      DIGIT COUNTER + 1
        LDA COL_COUNT      E61C A5 0A
        CMP #$07           E61E C9 07      FINISHED SHIFTING AND SUBTRACTING THE
        JMP DIV_PATCH_2    E620 4C 73 E6      DIVISOR FOR 6 DIGITS?

%-----
% JUDGEMENT OF DR0 IS ZERO.
%-----
DET_ZERO_DR0 LDX #$06      E623 A2 06      ADDRESS POINTER.
              LDY #$06      E625 A0 06      COUNTER OF ZERO BYTES.
L02          LDA $17,X      E627 B5 17
              BNE L01       E629 D0 01
              DEY           E62B 88
L01          DEX           E62C CA
              BNE L02       E62D D0 F8
              TYA           E62F 98
              BEQ L03       E630 F0 02
              BNE L09       E632 D0 B7      GO TO NON ZERO CASE PROCESS.
L03          LDA #$00       E634 A9 00      ZERO CASE PROCESS.
              STA QUO_COUNT E636 85 0B      RESET QUOTIENT COUNTER.
              BEQ L08       E638 F0 C5      GO TO SHIFT LEFT 4 BITS QUOTIENT.

%-----
% 6 BYTE REGISTER RIGHT SHIFT
% SHIFT BIT: IX, REGISTER HEAD ADDRESS LOWER: IY, REGISTER HEAD ADDRESS UPPER: ACC
%-----
SHIFT_R_NBIT2 STY P0       E63A 84 40
              STA P0+1      E63C 85 41
L67          CLC           E63E 18
              LDY #$05      E63F A0 05
L66          LDA (P0),Y     E641 B1 40
              ROR           E643 6A
              STA (P0),Y    E644 91 40
              DEY           E646 88
              BPL L66       E647 10 F8
              DEX           E649 CA
              BNE L67       E64A D0 F2
              RTS          E64C 60

%-----
% POST-PROCESSING OF DIVISION.
% SHIFTING QUOTIENT AND EXPONENT PART CORRECTION.
%-----
AFTER_OPE_2 LDA DR2_3      E64D A5 2B      IF THE BYTE ABOVE DECIMAL POINT
              BEQ L01       E64F F0 16      IN THE QUOTIENT REGISTER IS ZERO,
              LDX #$04      E651 A2 04      IT IS NOT SHIFTED.
              LDY #$28      E653 A0 28
              LDA #$00      E655 A9 00
              JSR SHIFT_R_NBIT2 E657 20 3A E6      SHIFT 4 BIT RIGHT QUOTIENT REGISTER.
              LDA R0_3      E65A A5 13
              AND #$7F      E65C 29 7F      REMOVE SIGN OF MANTISSA.
              CLC           E65E 18
              ADC #$01      E65F 69 01      EXPONENT + 1
              AND #$7F      E661 29 7F      REMOVE D7
              ORA SIGN_FLAG E663 05 08      SYNTHESIS SIGN AND CORRECTED EXPONENT.
              STA R0_3      E665 85 13
L01          LDX #$00       E667 A2 00      MOVE DR2_0-DR2_2 TO DR0_0-DR0_2
L02          LDA $28,X      E669 B5 28
              STA $10,X     E66B 95 10
              INX           E66D E8
              CPX #$03      E66E E0 03
              BNE L02       E670 D0 F7
              RTS          E672 60

%-----
% PATCH FOR SHIFTING RIGHT 4BIT DIVISOR DR0.
%-----
DIV_PATCH_2 BEQ L01        E673 F0 0C
              LDX #$04      E675 A2 04      SHIFTING RIGHT 4BIT DIVISOR DR0.

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LDY #$18          E677 A0 18
LDA #$00          E679 A9 00
JSR SHIFT_R_NBIT2 E67B 20 3A E6
JMP L10           E67E 4C E9 E5
L01 RTS           E681 60

%-----
% POST-PROCESSING OF MULTIPLICATION.
% SHIFTING RESULT AND EXPONENT PART CORRECTION.
%-----
AFTER_OPE_3 LDA DR2_5      E682 A5 2D      EXTRACT MOST SIGNIFICANT 2 DIGIT OF RESULT.
CMP #$10        E684 C9 10
BCS L01         E686 B0 16      IF IT'S 10 OR MORE, DO NOT SHIFT.
LDX #$04        E688 A2 04      SHIFT LEFT 4 BITS RESULT REGISTER
LDY #$2E        E68A A0 2E
LDA #$FF        E68C A9 FF
JSR SHIFT_L_NBIT2 E68E 20 1F E5
LDA R0_3        E691 A5 13      REMOVE SIGN OF MANTISSA FROM EXPONENT BYTE.
AND #$7F        E693 29 7F
JSR MUL_PATCH_4 E695 20 A3 E6    EXPONENT - 1
AND #$7F        E698 29 7F      REMOVE D7
ORA SIGN_FLAG   E69A 05 08      SYNTHESIS SIGN AND CORRECTED EXPONENT.
STA R0_3        E69A 85 13
L01 LDX #$00     E69E A2 00
JMP AFTER_OPE_1 E6A0 4C 13 E5

%-----
MUL_PATCH_4 SEC          E6A3 38
PHA          E6A4 48
PLA          E6A5 68
SUB #$01     E6A6 E9 01      PATCH FOR ERROR IN PROM MAKING (V1.2.1)
CMP #$99     E6A8 C9 99      PATCH FOR ERROR IN PROM MAKING (V1.2.1)
BNE L02      E6AA D0 02      IN THE CASE OF '00(BCD) - 01(BCD),
LDA #$79     E6AC A9 79      CONVERT RESULT '99(BCD) TO 79(BCD).
L02 RTS      E6AE 60

%-----
% PATCH FOR FOUR ARITHMETIC OPERATIONS UNIT TEST.
%-----
.ORIGIN $E6B0
%
GET_FLOAT_4 LDA LINE_HEAD,X E6B0 BD 00 02
CMP #$20     E6B3 C9 20      IS IT SPACE CODE?
BEQ G_FLOAT_4_L12 E6B5 F0 03
JMP L13      E6B7 4C FF E0    GO TO PROCESSING EXCEPT FOR SPACE CODE
G_FLOAT_4_L12 INX          E6BA E8      AND ARITHMETIC OPERATIONS.
LDA LINE_HEAD,X E6BB BD 00 02
CMP #$2B     E6EB C9 2B      IS THE '+' CODE NEXT TO THE SPACE CODE?
BNE L14      E6C0 D0 12
INX          E6C2 E8
LDA LINE_HEAD,X E6C3 BD 00 02
CMP #$0D     E6C6 C9 0D      IS THE 'CR' CODE NEXT TO THE SPACE CODE?
BNE L15      E6C8 D0 09
JSR CORRECT_EXP_1 E6CA 20 6B E1 EXPONENT CORRECTION.
JSR NORMALISE_1  E6CD 20 D0 E2 NORMALISE.
JSR ADD_FLOAT_1  E6D0 20 D0 E3 ADDITION.
L15 RTS      E6D3 60

%
L14 CMP #$2D     E6D4 C9 2D      IS IT '-' CODE?
BNE L16      E6D6 D0 12
INX          E6D8 E8
LDA LINE_HEAD,X E6D9 BD 00 02
CMP #$0D     E6DC C9 0D      IS THE 'CR' CODE NEXT TO THE '-' CODE?
BNE L17      E6DE D0 36
JSR CORRECT_EXP_1 E6E0 20 6B E1 EXPONENT CORRECTION.
JSR NORMALISE_1  E6E3 20 D0 E2 NORMALISE.
JSR SUB_FLOAT_1  E6E6 20 E5 E3 SUBTRACTION.
RTS          E6E9 60

%
L16 CMP #$2A     E6EA C9 2A      IS IT '*' CODE?
BNE L18      E6EC D0 12
INX          E6EE E8

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	LDA LINE_HEAD,X	E6EF	BD 00 02	
	CMP #\$0D	E6F2	C9 0D	IS THE 'CR' CODE NEXT TO THE '*' CODE?
	BNE L19	E6F4	D0 09	
	JSR CORRECT_EXP_1	E6F6	20 6B E1	EXPONENT CORRECTION.
	JSR NORMALISE_1	E6F9	20 D0 E2	NORMALISE.
	JSR MUL_FLOAT_1	E6FC	20 A0 E4	MULTIPLICATION.
L19	RTS	E6FF	60	
%				
L18	CMP #\$2F	E700	C9 2F	IS IT '/' CODE?
	BNE L20	E702	D0 16	
	INX	E704	E8	
	LDA LINE_HEAD,X	E705	BD 00 02	
	CMP #\$0D	E708	C9 0D	IS THE 'CR' CODE NEXT TO THE '/' CODE?
	BNE L21	E70A	D0 09	
	JSR CORRECT_EXP_1	E70C	20 6B E1	EXPONENT CORRECTION.
	JSR NORMALISE_1	E70F	20 D0 E2	NORMALISE.
	JSR DIV_FLOAT_1	E712	20 70 E5	DIVISION.
L21	RTS	E715	60	
%				
L17	DEX	E716	CA	RETURN THE POINTER TO SPACE CODE POSITION.
	NOP	E717	EA	
	NOP	E718	EA	
	NOP	E719	EA	
L20	DEX	E71A	CA	
	STX TEMP_5	E71B	86 0E	
	JSR CORRECT_EXP_1	E71D	20 6B E1	EXPONENT CORRECTION.
	JSR NORMALISE_1	E720	20 D0 E2	NORMALISE.
	LDA R0_0	E723	A5 10	MOVE R0 TO R1.
	STA R1_0	E725	85 14	
	LDA R0_1	E727	A5 11	
	STA R1_1	E729	85 15	
	LDA R0_2	E72B	A5 12	
	STA R1_2	E72D	85 16	
	LDA R0_3	E72F	A5 13	
	STA R1_3	E72F	85 17	
	JSR INIT_REG	E733	20 B3 E1	CLEAR R0.
	LDX TEMP_5	E736	A6 0E	
	INX	E738	E8	
	JMP GET_FLOAT_4	E739	4C 72 E4	RETURN TO ANALYZE ONE CHARACTER.
%				
%	-----			
%	-----			
%	-----			
%	-----			
%	-----			
%	-----			
	LINE EDITOR			
%	-----			
	.ORIGIN \$E740			
%				
LINE_EDITOR_1	LDA LINE_HEAD_L	E740	A9 00	
	STA P0	E742	85 40	
	LDA LINE_HEAD_H	E744	A9 02	
	STA P0+1	E746	85 41	
	JSR GET_LINE LENG	E748	20 C5 E7	GET THE LENGTH OF A NEW LINE.
	STY LINE_LENGTH_1	E74B	84 04	
	LDX #LR0_ADDRESS	E74D	A2 00	
	JSR GET_LINE_NUMB	E74F	20 3C E8	GET THE LINE NUMBER OF A NEW LINE.
	LDA #PROG_PO_1_L	E752	A9 00	
	STA P0	E754	85 40	
	LDA #PROG_PO_1_H	E756	A9 10	
	STA P0+1	E758	85 41	SET PROGRAM AREA HEAD ADDRESS TO P0.
L01	LDX #LR1_ADDRESS	E75A	A2 02	
	JSR GET_LINE_NUMB	E75C	20 3C E8	GET THE LINE NUMBER OF PROGRAM AREA.
	JSR CMP16_1	E75F	20 69 E8	COMPARE BOTH LINE NUMBERS.
	BEQ SWAP_1	E762	F0 0B	IF IT'S A SAME, EXCHANGE THE LINES.
	BCS SEARCH_NEXT	E764	B0 0F	IF LR1<LR0, SEARCH THE NEXT LINE NUMBER.
INSERT_LINE	LDY LINE_LENGTH_1	E766	A4 04	WHEN LR1>LR0, MOVE FORWARD THE NEXT LARGER
	JSR MOV_BLOCK_F1	E768	20 16 E8	LINE NUMBER AFTER THE NEW LINE.
	JMP LINE_EDITOR_2	E76B	4C F5 F0	INSERT NEW LINE.
	NOP	E76E	EA	
%				
SWAP_1	JSR DELETE_LINE	E76F	20 87 E7	DELETE THE LINE.
	CLC	E772	18	
	BCC INSERT_LINE	E773	90 F1	

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%
SEARCH_NEXT JSR SEARCH_NEXT_L E775 20 A3 E7 ADVANCE THE POINTER TO THE NEXT LINE NUMBER
            BCC L01 E778 90 E0
            JSR PUT_NEW_LINE E77A 20 92 E7
            JSR SEARCH_NEXT_L E77D 20 A3 E7
            LDA #$25 E780 A9 25
            LDY #$00 E782 A0 00
            STA (P0),Y E784 91 40
            RTS E786 60

%
%-----
% DELETE THE CURRENT LINE POINTED P0, AND PADDING THE PROGRAM BACK.
%-----
DELETE_LINE JSR GET_LINE LENG E787 20 C5 E7 GET THE LENGTH OF THE CURRENT LINE.
            STY LINE_LENGTH_2 E78A 84 05
            NOP E78C EA
            NOP E78D EA
            JSR MOV_BLOCK_B2 E78E 20 74 E8 PADDING THE PROGRAM BACK
            RTS E791 60 BY LENGTH OF CURRENT LINE.

%
%-----
% MOVE THE NEW LINE TO THE POSITION POINTED P0. IF THE LENGTH OF NEW LINE = 0, NOTHING.
%-----
PUT_NEW_LINE LDA LINE_LENGTH_1 E792 A5 04
            BEQ L02 E794 F0 0C
            LDY #$00 E796 A0 00 INITIALIZE POINTER.
L01 LDA LINE_HEAD,Y E798 B9 00 02 LOAD ONE CHARACTER FROM LINE BUFFER.
            STA (P0),Y E79B 91 40 STORE THE CHARACTER TO PROGRAM AREA.
            INY E79D C8
            CMP #$0D E79E C9 0D IF IT'S 'CR' CODE, EXIT.
            BNE L01 E7A0 D0 F6
L02 RTS E7A2 60

%
%-----
% ADVANCE THE POINTER P0,P0+1 TO THE HEAD OF THE NEXT LINE NUMBER.
% IF THE NEXT LINE NUMBER DOES NOT EXIST, SET CARRY FLAG. (V.1.5.0 MAR/11/2023)
%-----
SEARCH_NEXT_L LDA #$FF E7A3 A9 FF LIMIT LOWER 8BIT
            STA P1 E7A5 85 42
            LDA MEM_END_U E7A7 A5 82 LIMIT UPPER 8BIT (V.1.5.0 MAR/11/2023)
            STA P1+1 E7A9 85 43 THE END OF PROGRAM AREA.
            LDY #$00 E7AB A0 00
L03 LDA (P0),Y E7AD B1 40 LOAD ONE CHARACTER FROM THE PROGRAM.
            PHA E7AF 48 SAVE ACC.
            JSR INC_POINTER_1 E7B0 20 FC E7 ADVANCE THE POINTER.
            PLA E7B3 68
            CMP #$0D E7B4 C9 0D IF IT'S 'CR' CODE, EXIT.
            JMP PATCH_2 E7B6 4C 84 E8

%
SEARCH_N_L01 CMP #$25 E7B9 C9 25 IF IT'S '%' CODE, SET CARRY AND EXIT.
            BNE L02 E7BB D0 02
            SEC E7BD 38
            RTS E7BE 60

%
L02 JSR CMP_POINTER_1 E7BF 20 31 E8 IF IT'S END OF PROGRAM AREA, EXIT.
            BNE L03 E7C2 D0 E9
            RTS E7C4 60

%
%-----
% MEASURE THE LENGTH OF CURRENT POINTER POSITION BY P0,P0+1 TO THE NEXT 'CR' CODE.
% INPUT PARAMETER: P0,P0+1, OUTPUT PARAMETER: IY (LINE LENGTH)
%-----
GET_LINE LENG LDY #$00 E7C5 A0 00
L02 LDA (P0),Y E7C7 B1 40
            CMP #$0D E7C9 C9 0D
            BEQ L01 E7CB F0 03
            INY E7CD C8
            BNE L02 E7CE D0 F7
L01 DEY E7D0 88
            LDA (P0),Y E7D1 B1 40
            CMP #$3A E7D3 C9 3A
            BNE L03 E7D5 D0 03

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        LDY #$00          E7D7 A0 00
        RTS              E7D9 60
%
L03      INY              E7DA C8
        INY              E7DB C8
        RTS              E7DC 60
%
%-----
% BLOCK TRANSFER TO SMALLER MEMORY ADDRESS.
%   DESTINATION HEAD ADDRESS: P0,P0+1,  TRANSFER ADDRESS OFFSET: IY      (V.1.5.0 MAR/11/2023)
%-----
MOV_BLOCK_B1 LDA #$FF          E7DD A9 FF          LIMIT LOWER 8BIT
        STA P1              E7DF 85 42
        LDA MEM_END_U       E7E1 A5 82          LIMIT UPPER 8BIT (V.1.5.0 MAR/11/2023)
        STA P1+1            E7E3 85 43
        STY TEMP_0          E7E5 84 09          SAVE IY.
L03      LDY TEMP_0          E7E7 A4 09          RESTORE IY.
        LDA (P0),Y          E7E9 B1 40          LOAD FROM SOURCE POSITION.
        LDY #$00            E7EB A0 00
        STA (P0),Y          E7ED 91 40          STORE TO DESTINATION POSITION.
        CMP #$25            E7EF C9 25          IF IT'S '%' CODE, EXIT.
        BEQ L04             E7F1 F0 08
        JSR INC_POINTER_1    E7F3 20 FC E7
        JSR CMP_POINTER_1    E7F6 20 31 E8
        BNE L03             E7F9 D0 EC
L04      RTS              E7FB 60
%
%-----
% INCREMENT 16 BIT POINTER P0,P0+1.
%-----
INC_POINTER_1 CLD              E7FC D8
        CLC              E7FD 18
        LDA P0            E7FE A5 40
        ADC #$01          E800 69 01          LOWER 8 BIT +1
        STA P0            E802 85 40
        BCC L05           E804 90 02
        INC P0+1          E806 E6 41          IF CARRY EXIST LOWER 8 BIT, UPPER 8BIT +1.
L05      RTS              E808 60
%
%-----
% DECREMENT 16 BIT POINTER P1,P1+1.
%-----
DEC_POINTER_1 CLD              E809 D8
        SEC              E80A 38
        LDA P1            E80B A5 42
        SBC #$01          E80D E9 01          LOWER 8 BIT -1
        STA P1            E80F 85 42
        BCS L06           E811 B0 02          IF BORROW EXIST LOWER 8 BIT, UPPER 8BIT -1.
        DEC P1+1          E813 C6 43
L06      RTS              E815 60
%
%-----
% BLOCK TRANSFER TO LARGER MEMORY ADDRESS.
%   SOURCE HEAD ADDRESS: P0,P0+1,  TRANSFER ADDRESS OFFSET: IY      (V.1.5.0 MAR/11/2023)
%-----
MOV_BLOCK_F1 LDA #$00          E816 A9 00          AREA LIMIT ADDRESS - 255 BYTE
        STA P1              E818 85 42
        LDA MEM_END_U       E81A A5 82          LIMIT UPPER 8BIT (V.1.5.0 MAR/11/2023)
        STA P1+1            E81C 85 43
        STY TEMP_0          E81E 84 09
L07      LDY #$00            E820 A0 00
        LDA (P1),Y          E822 B1 42
        LDY TEMP_0          E824 A4 09
        STA (P1),Y          E826 91 42
        JSR DEC_POINTER_1    E828 20 09 E8
        JSR CMP_POINTER_1    E82B 20 31 E8
        BCS L07             E82E B0 F0
        RTS              E830 60
%
%-----
% COMPARE 16 BIT POINTER P1,P1+1 AND P0,P0+1.
%-----

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CMP_POINTER_1 LDA P1+1          E831 A5 43
                CMP P0+1        E833 C5 41      COMPARE UPPER 8 BIT
                BNE L01          E835 D0 04
                LDA P1           E837 A5 42
                CMP P0           E839 C5 40      COMPARE LOWER 8 BIT
L01             RTS             E83B 60
%
%-----
% CONVERT ASCII CODE LINE NUMBER TO 2 BYTE BCD VALUE.
% INPUT PARAMETER: P0,P0+1, OUTPUT PARAMETER: IY (LINE NUMBER REGISTER ADDRESS)
%-----
GET_LINE_NUMB LDA #$00          E83C A9 00
                STA $00,X        E83E 95 00
                STA $01,X        E840 95 01
                LDY #$00         E842 A0 00
L10             JMP PATCH_3      E844 4C B8 E8
                NOP              E847 EA
GET_LINE_L14   BEQ L10           E848 F0 10
                CMP #$20         E84A C9 20      IGNORE SPACE CODE.
                BEQ L13          E84C F0 09
                JSR SHIFT_L_NUM1 E84E 20 5B E8    4 BIT LEFT SHIFT LINE NUMBER REGISTER.
                AND #$0F         E851 29 0F      EXTRACT LOWER 4 BIT OF ASCII CODE.
                ORA $00,X        E853 15 00      SYNTHESIZE LINE NUMBER LOWER.
                STA $00,X        E855 95 00
L13             INY              E857 C8          ADVANCE LINE BUFFER POINTER.
                BNE L10          E858 D0 EA
                RTS              E85A 60
%
%-----
% 4 BIT LEFT SHIFT LINE NUMBER REGISTER.
%-----
SHIFT_L_NUM1   STY TEMP_0        E85B 84 09      SAVE IY.
                LDY #$04         E85D A0 04      SET 4 BIT SHIFT.
L11             ASL $00,X        E85F 16 00      LEFT SHIFT 2-BYTE SECTION.
                ROL $01,X        E861 36 01
                DEY              E863 88
                BNE L11          E864 D0 F9
                LDY TEMP_0       E866 A4 09      RESTORE IY.
                RTS              E868 60
%
%-----
% COMPARE LINE NUMBER REGISTERS
%-----
CMP16_1        LDA LR0_1         E869 A5 01      COMPARE UPPER 8 BIT.
                CMP LR1_1        E86B C5 03      IF LR1>LR0, SET BORROW (CLEAR CARRY)
                BNE L12          E86D D0 04
                LDA LR0_0        E86F A5 00      IF UPPER IS SAME, COMPARE LOWER.
                CMP LR1_0        E871 C5 02      IF LR1>LR0, SET BORROW (CLEAR CARRY)
L12             RTS              E873 60
%
%-----
% PATCH FOR MOVE_BLOCK_B1 TO SAVE P0,P0+1.
%-----
MOVE_BLOCK_B2 LDA P0            E874 A5 40
                PHA              E876 48
                LDA P0+1         E877 A5 41
                PHA              E879 48
                JSR MOVE_BLOCK_B1 E87A 20 DD E7
                PLA              E87D 68
                STA P0+1         E87E 85 41
                PLA              E880 68
                STA P0           E881 85 40
                RTS              E883 60
%
%-----
% PATCH FOR SEARCH_NEXT_L TO CLEAR CARRY WHEN 'CR' CODE IS DETECTED AND EXIT.
%-----
PATCH_2        BNE L01          E884 D0 02
                CLC              E886 18
                RTS              E887 60
L01             JMP SEARCH_N_L01 E888 4C B9 E7
%

```

```
%-----
% EDITOR UNIT TEST WITH SERIAL INTERFACE.
%-----
EDITOR_TEST_2 CLC                                E88B    18
                LDX  #$FF                        E88C    A2 FF
                TXS                               E88E    0A
L01             JSR  INIT_ACIA                    E88F    20 80 E0      INITIALIZE SERIAL INTERFACE
                JSR  IN_1LINE                     E892    20 C0 E0      INPUT ONE LINE.
                JSR  LINE_EDITOR_1               E895    20 40 E7      LINE EDITOR.
                JSR  DISP_PROGRAM1              E898    20 9E E8      DISPLAY PROGRAM.
                JMP  L01                         E89B    4C 92 E8
%
%-----
DISP_PROGRAM1 LDA  #PROG_PO_1_L                 E89E    A9 00
                STA  P0                          E8A0    85 40
                LDA  #PROG_PO_1_H               E8A2    A9 10
                STA  P0+1                       E8A4    85 41
L03             LDY  #$00                        E8A6    A0 00      SET PROGRAM AREA TO POINTER.
                LDA  (P0),Y                     E8A8    B1 40      LOAD ONE CHARACTER FROM PROGRAM AREA.
                CMP  #$25                       E8AA    C9 25      IF IT'S '%' CODE, EXIT.
                BEQ  L02                        E8AC    F0 09
                JSR  OUT_1CHA                    E8AE    20 9A E0      OUTPUT ONE CHARACTER TO SERIAL INTERFACE.
                JSR  INC_POINTER_1              E8B1    20 FC E7
                CLC                              E8B4    18
                BCC  L03                        E8B5    90 F1
L02             RTS                             E8B7    60
%
%-----
% PATCH FOR GET_LINE_NUMB
% WHEN THE END CODE IS DETECTED, RETURN THE VALUE 9999 TO LR.
% ENSURE THAT LINE NUMBERS WITH GREATER THAN CURRENT MAXIMUM LINE NUMBER ARE INSERTED CORRECTLY.
%-----
PATCH_3        LDA  (P0),Y                     E8B8    B1 40      LOAD ONE CHARACTER.
                CMP  #$25                       E8BA    C9 25      IS IT '%' CODE?
                BEQ  L03                        E8BC    F0 05
                CMP  #$3A                       E8BE    C9 3A      IS IT ':' CODE?
                JMP  GET_LINE_L14              E8C0    4C 48 E8      RETURN FROM THIS PATCH.
%
L03             LDA  #$99                       E8C3    A9 99      SET 9999 TO LR
                STA  $00,X                      E8C5    95 00
                STA  $01,X                      E8C7    95 01
                RTS                             E8C9    60
%
%-----
%----- ANALYSIS AND EXECUTION -----
%-----
% CI-2 MAIN PROGRAM
%-----
                .ORIGIN  $E8D0
%
CI-2_MAIN       LDX  #$FF                        E8D0    A2 FF      INITIALIZE STACK POINTER.
                TXS                               F8D2    9A
                JSR  INIT_ACIA                    E8D3    20 80 E0      INITIALIZE SERIAL INTERFACE.
                JSR  INIT_RUNFLAG                E8D6    20 0D ED      INITIALIZE RUN FLAG.
                JSR  GREETING                    E8D9    20 E0 F2      GREETING MESSAGE.
L01             JSR  IN_1LINE_2                  E8DC    20 B9 F0      ENTER A SINGLE LINE.
                JSR  ANA_1LINE                   E8DF    20 F0 E8      ANALYSIS & EXECUTE SINGLE LINE.
                JMP  L01                         E8E2    4C DC E8      REPEAT FROM PROMPT.
%
%-----
% MAIN LOOP OF ANALYSIS & EXECUTE SINGLE LINE.
%-----
                .ORIGIN  $E8F0
%
ANA_1LINE       JSR  SET_PO_LB                   E8F0    20 64 EA      SET POINTER TO LINE BUFFER BEGINNING.
                JSR  DET_LINE_NUM1              E8F3    20 14 ED      LINE NUMBER DETECTION.
                BCC  MAIN_LOOP_6                E8F6    90 03
                JMP  LINE_EDITOR_1              E8F8    4C 40 E7      IF A LINE NUMBER IS DETECTED, GO TO EDITOR.
MAIN_LOOP_6     JSR  INIT_REG_4                  E8FB    20 97 F0      CLEAR R0 ETC.
```

MAIN_LOOP_5	LDY #\$00	E8FE	A0 00	
MAIN_LOOP_1	JMP MAIN_LOOP_3	E900	4C FA EC	
MAIN_LOOP_4	BCS MAIN_LOOP_2	E903	B0 03	IGNORE THE LINE NUMBER
	JSR SET_P0_LB	E905	20 64 EA	
MAIN_LOOP_2	LDA (P0),Y	E908	B1 40	IF NO LINE NUMBER, ANALYSE SINLE CHARACTER.
	CMP #\$20	E90A	C9 20	
	BNE L03	E90C	D0 03	IF IT'S A SPACE CODE,
	JMP IN_NEW_VAR	E90E	4C 13 EA	START ENTERING A NEW VARIABLE.
L03	CMP #\$21	E911	C9 21	
	BNE L04	E913	D0 03	
	JMP RUN_CONT	E915	4C 95 EB	IF IT'S '!' CODE, GO TO EXECUTION.
L04	CMP #\$23	E918	C9 23	
	BNE L05	E91A	D0 03	
	JMP COMMENT	E91C	4C F9 ED	IF IT'S '#' CODE, GO TO COMMENT PROCESS,
L05	CMP #\$24	E91F	C9 24	
	BNE L06	E921	D0 03	
	JMP POINTER_VAR_1	E923	4C 86 EF	IF IT'S '\$' CODE, GO TO POINTER VARIABLES.
L06	CMP #\$29	E926	C9 29	
	JMP MAIN_LOOP_6	E928	4C DE F1	GO TO MAIN_LOOP_6
	NOP	E92B	EA	
	NOP	E92C	EA	
MAIN_LOOP_7	CMP #\$2B	E92D	C9 2B	RETURN FROM MAIN_LOOP_6
	BNE L08	E92F	D0 03	
	JMP ADD_1	E931	4C 26 EB	IF IT'S '+' CODE, GO TO ADDITION.
L08	CMP #\$2D	E934	C9 2D	
	BNE L09	E936	D0 03	
	JMP SUB_2	E938	4C A8 ED	IF IT'S '-' CODE, GO TO SUBTRACTION.
L09	CMP #\$2A	E93B	C9 2A	
	BNE L10	E93D	D0 03	
	JMP MUL_1	E93F	4C 54 EB	IF IT'S '*' CODE, GO TO MULTIPLICATION.
L10	CMP #\$2F	E942	C9 2F	
	BNE L11	E944	D0 03	
	JMP DIV_1	E946	4C 67 EB	IF IT'S '/' CODE, GO TO DIVISION.
L11	CMP #\$2E	E949	C9 2E	
	BNE L12	E94B	D0 03	
	JMP DEC_POINT	E94D	4C 0B EA	IF IT'S '.' CODE, GO TO DECIMAL POINT.
L12	CMP #\$45	E950	C9 45	
	BNE L13	E952	D0 03	
	JMP GET_EXP_4	E954	4C C7 E9	IF IT'S 'E' CODE, GO TO EXPONENT PROCESS.
L13	CMP #\$3B	E957	C9 3B	
	BNE L14	E959	D0 03	
	JMP DISP_CONT	E95B	4C A2 EA	IF IT'S ';' CODE, GO TO OUTPUT PROCESS.
L14	CMP #\$3D	E95E	C9 3D	
	BNE L15	E960	D0 03	
	JMP SUBSTITUTE_3	E962	4C 6D EA	IF IT'S '=' CODE, GO TO SUBSTITUTE BOOKING.
L15	CMP #\$3F	E965	C9 3F	
	BNE L16	E967	D0 03	
	JMP CONDITION_1	E969	4C 37 ED	IF IT'S '?' CODE, GO TO CONDITION PROCESS.
L16	CMP #\$40	E96C	C9 40	
	BNE L17	E96E	D0 03	
	JMP DISP_LIST_2	E970	4C F3 F0	IF IT'S '@' CODE, GO TO PROGRAM DUMP.
L17	CMP #\$41	E973	C9 41	
	BCC L18	E975	90 03	
	JMP VARIABLE	E977	4C CB EA	IF \$41 OR MORE, GO TO VARIABLE PROCESS.
L19	CMP #\$0D	E97A	C9 0D	
	BNE L20	E97C	D0 03	
	JMP ENDLINE_PROCL	E97E	4C B9 ED	IF IT'S 'CR' CODE, GO TO END LINE PROCESS.
L20	CMP #\$25	E981	C9 25	IF IT'S '%' CODE, TERMINATE EXECUTION.
	BNE L34	E983	D0 02	
	BEQ L36	E985	F0 0A	
L34	CMP #\$30	E987	C9 30	
	BCS L35	E989	B0 02	
	BCC L36	E98B	90 04	
L35	CMP #\$3A	E98D	C9 3A	
	BCC GET_FLOAT_5	E98F	90 03	IF \$30-\$39 CODE, GO TO NUMERIC INPUT.
L36	JMP STOP_RUNNING	E991	4C B1 EA	
%				
%-----				
GET_FLOAT_5	LDX TEMP_6	E994	A6 0F	
	BEQ L21	E996	F0 02	
	DEC TEMP_3	E998	C6 0C	
L21	STY TEMP_5	E99A	84 0E	

	STA TEMP_2	E99C	85 0B	
	LDX #\$04	E99E	A2 04	
	LDY #\$13	E9A0	A0 13	
	LDA #\$FF	E9A2	A9 FF	
	JSR SHIFT_L_NBIT1	E9A4	20 54 EC	
	LDY TEMP_5	E9A7	A4 0E	
	LDA TEMP_2	E9A9	A5 0B	
	AND #\$0F	E9AB	29 0F	
	ORA R0_0	E9AD	05 10	
	STA R0_0	E9AF	85 10	
GET_FLOAT_6	JSR INC_POINTER_1	E9B1	20 FC E7	
	LDA (P0),Y	E9B4	B1 40	
	JSR DET_CHR_1	E9B6	20 4E EA	
	BCS L22	E9B9	B0 03	
	JMP MAIN_LOOP_2	E9BB	4C 08 E9	
L22	JSR CORRECT_EXP_1	E9BE	20 6B E1	
	JRT NORMALISE_1	E9C1	20 D0 E2	
	JMP MAIN_LOOP_2	E9C4	4C 08 E9	
%				
%-----				
GET_EXP_4	JSR INC_POINTER_1	E9C7	20 FC E7	
L25	LDA (P0),Y	E9CA	B1 40	ANALYZE THE NEXT CHARACTER OF 'E'
	CMP #\$2D	E9CC	C9 2D	IS IT A '-' CODE?
	BEQ L23	E9CE	F0 33	
GET_EXP_2	STA TEMP_2	E9D0	85 0B	SAVE THE ACCUMULATOR VALUE.
	LDA R0_3	E9D2	A5 13	
	STA TEMP_0	E9D4	85 09	SAVE THE R0_3 VALUE.
	ASL	E9D6	0A	
	ASL	E9D7	0A	
	ASL	E9D8	0A	
	ASL	E9D9	0A	
	AND #\$30	E9DA	29 30	EXTRACT D5,D4.
	STA TEMP_1	E9DC	85 0A	
	LDA TEMP_0	E9DE	A5 09	
	AND #\$C0	E9E0	29 C0	EXTRACT D7,D6 OF R0_3.
	ORA TEMP_1	E9E2	05 0A	
	STA R0_3	E9E4	85 13	
	LDA TEMP_2	E9E6	A5 0B	THE NEW ASCII CHARACTER.
	AND #\$0F	E9E8	29 0F	EXTRACT LOWER 4BIT OF THE ASCII CODE.
	ORA R0_3	E9EA	05 13	
	STA R0_3	E9EC	85 13	
	JSR INC_POINTER_1	E9EE	20 FC E7	ADVANCE THE POINTER TO THE NEXT.
	LDA (P0),Y	E9F1	B1 40	
	JSR DET_CHR_2	E9F3	20 56 EA	
	BCS L24	E9F6	B0 02	
	BCC L25	E9F8	90 D0	
L24	JSR CORRECT_EXP_1	E9FA	20 6B E1	IF THE NEXT CHARACTER IS NOT A NUMBER,
	JSR NORMALISE_1	E9FD	20 D0 E2	DO EXPONENTIAL CORRECTION & NORMALIZATION
	JMP MAIN_LOOP_2	EA00	4C 08 E9	AND RETURN TO THE MAIN LOOP 2.
%				
%-----				
% PROCESS OF EXPONENT '- '.				
%-----				
L23	LDA TEMP_7	EA03	A5 08	
	ORA #\$40	EA05	09 40	
	STA TEMP_7	EA07	85 08	SET '1' TO SIGN FLAG D6.
	BNE GET_EXP_4	EA09	D0 BC	
%				
%-----				
% PROCESS OF DECIMAL POINT.				
%-----				
DEC_POINT	INC TEMP_6	EA0B	E6 0F	SET DECIMAL POINT FLAG
	JSR INC_POINTER_1	EA0D	20 FC E7	ADVANCE THE POINTER TO THE NEXT.
	JMP MAIN_LOOP_2	EA10	4C 08 E9	RETURN TO THE MAIN LOOP 2.
%				
%-----				
% PROCESS OF SPACE CODE.				
%-----				
IN_NEW_VAR	JSR PUSH_FP_REG	EA13	20 1F EA	PUSH THE ARITHMETIC STACK.
	JSR INIT_REG_2	EA16	20 FA EA	INITIALIZE R0,
	JSR INC_POINTER_1	EA19	20 FC E7	ALLOW THE NEXT NUMBER TO BE ENTERED.
	JMP MAIN_LOOP_2	EA1C	4C 08 E9	RETURN TO THE MAIN LOOP 2.


```

%-----
% PUSH THE ARITHMETIC REGISTER STACK.
%-----
PUSH_FP_REG  STY  TEMP_5          EA1F  84 0E          SAVE THE IY.
               LDX  #$30          EA21  A2 30
               LDY  #$34          EA23  A0 34
               JSR  MOV_FP_REG     EA25  20 39 EA        MOVE R1 TO R3.
               LDX  #$14          EA28  A2 14
               LDY  #$30          EA2A  A0 30          MOVE R1 TO T2.
               JSR  MOV_FP_REG     EA2C  20 39 EA
               LDX  #$10          EA2F  A2 10
               LDY  #$14          EA31  A0 14          MOVE R0 TO R1.
               JSR  MOV_FP_REG     EA33  20 39 EA
               LDY  TEMP_5        EA36  A4 0E
               RTS                EA38  60

%-----
% MOVE REGISTER. SOURCE HEAD ADDRESS: IX, DESTINATION HEAD ADDRESS: IY
%-----
MOV_FP_REG    LDA  $00,X          EA39  B5 00
               STA  $0000.Y       EA3B  99 00 00
               LDA  $01,X          EA3E  B5 01
               STA  $0001.Y       EA40  99 01 00
               LDA  $02,X          EA43  B5 02
               STA  $0002.Y       EA45  99 02 00
               LDA  $03,X          EA48  B5 03
               STA  $0003.Y       EA4A  99 03 00
               RTS                EA4D  60

%-----
% CHARACTER DETECTOR. (IF IT'S A NUMBER, '.', 'E', CLEAR CARRY, OTHERS SET CARRY.)
%-----
DET_CHR_1     CMP  #$2E          EA4E  C9 2E          '.' CODE?
               BEQ  L27          EA50  F0 10
               CMP  #$45          EA52  C9 45          'E' CODE?
               BEQ  L27          EA54  F0 0C
DET_CHR_2     CMP  #$30          EA56  C9 30          MORE THAN $30?
               BCS  L26          EA58  B0 02
               BCC  L28          EA5A  90 04
L26            CMP  #$3A          EA5C  C9 3A          UNDER $39?
               BCC  L27          EA5E  90 02
L28            SEC                EA60  38
               RTS                EA61  60
L27            CLC                EA62  18          IF IT'S MORE THAN $30 & UNDER $39,
               RTS                EA63  60          EXIT WITH CARRY CLEAR.

%-----
% SET HEAD POSITION OF LINE BUFFER TO P0,P0+1.
%-----
SET_P0_LB     LDA  #$00          EA64  A9 00
               STA  P0           EA66  85 40
               LDA  #$02          EA68  A9 02
               STA  $P0+1        EA6A  85 41
               RTS                EA6C  60

%-----
% SUBSTITUTE PATCH (INITIALIZE R0 TO MAKE IT POSSIBLE TO ENTER THE FOLLOWING NUMBERS.)
%-----
SUBSTITUTE_3   JSR  INIT_REG_2    EA6D  20 FA EA
               LDA  VAR_0         EA70  A5 52
               STA  VAR_1         EA72  85 53          SET NORMAL VARIABLE OFFSET TO VAR_1.
               JSR  INC_POINTER_1  EA74  20 FC E7          ADVANCE THE POINTER.
               JMP  MAIN_LOOP_2    EA77  4C 08 E9          RETURN TO MAIN LOOP 2.

%-----
               .ORIGIN  $EAA2
%-----
DISP_CONT     INC  DISP_FLAG      EAA2  E6 51
               JMP  VAR_RET_1     EAA4  4C E6 EA
%-----

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%-----
% SET HEAD POSITION OF PROGRAM AREA TO P0,P0+1.
%-----
                .ORIGIN $EAA8
%
SET_P0_PR      LDA  PROG_P0_1_L      EAA8  A9 00
                STA  P0               EAAA  85 40
                LDA  PROG_P0_1_H      EAAC  A9 10
                STA  P0+1             EAAE  85 41
                RTS                   EAB0  60

%
%-----
% TERMINATE THE EXECUTION.
%-----
STOP_RUNNING   LDA  #$00             EAB1  A9 00
                STA  RUN_FLAG         EAB3  85 50
                RTS                   EAB5  50

%
%-----
% NORMAL VARIABLE PROCESS.
%      SHIFT THE LOWER 6 BITS OF THE VARIABLE CHARACTER BY 2 BIT
%      TO MAKE IT AN ADDRESS OFFSET, AND LOAD THE VARIABLE VALUE INTO R0.
%-----
                .ORIGIN $EACB
%
VARIABLE       AND  #$3F             EACB  29 3F      EXTRACT LOWER 6 BITS OF ASCII CODE.
                ASL                   EACD  0A          SHIFT LEFT BY 2 BIT.
                ASL                   EACE  0A
                STA  VAR_0            EACF  85 52      SAVE THE DETECTED ADDRESS OFFSET.
                TAX                   EAD1  AA          MAKE THE IY THE ADDRESS OFFSET.
                LDA  VAR_HEAD,X       EAD2  BD 00 03    SUBSTITUTE VARIABLE VALUE TO R0.
                STA  R0_0             EAD5  85 10
                LDA  VAR_HEAD+1,X     EAD7  BD 01 03
                STA  R0_1             EADA  85 11
                LDA  VAR_HEAD+2,X     EADC  BD 02 03
                STA  R0_2             EADF  85 12
                JMP  VAR_PATCH_1      EAE1  4C A2 F2
                NOP                   EAE4  EA
                NOP                   EAE5  EA
VAR_RET_1      JSR  INC_POINTER_1     EAE6  20 FC E7    ADVANCE POINTER TO THE NEXT.
                JMP  MAIN_LOOP_2      EAE9  4C 08 E9    RETURN TO THE MAIN LOOP 2.

%
%-----
% INITIALIZE REGISTERS.
%-----
                .ORIGIN $EAE6
%
INIT_REG_3     LDA  #$5C             EAE6  A9 5C      INITIALIZE MEMORY WRITE POINTER.
                STA  P3               EAF0  85 46
                LDA  #$00             EAF2  A9 00
                STA  P3+1             EAF4  85 47
INIT_REG_1     LDA  #$FC             EAF6  A9 FC      INITIALIZE SUBSTITUTE BOOKING ADDRESS.
                STA  VAR_1            EAF8  85 53
INIT_REG_2     LDA  #$06             EAF9  A9 06
                STA  TEMP_3           EAFB  85 0C      INITIALIZE DECIMAL POSITION COUNTER.
                LDA  #$00             EAFE  A9 00
                STA  R0_0             EB00  85 10      CLEAR R0.
                STA  R0_1             EB02  85 11
                STA  R0_2             EB04  85 12
                STA  R0_3             EB06  85 13
                STA  TEMP_6           EB08  85 0F      CLEAR DECIMAL FLAG.
                STA  TEMP_7           EB0A  85 08      CLEAR SIGN FLAG OF MANTISSA & EXPONENT.
                STA  DISP_FLAG        EB0C  85 51
                RTS                   EB0E  60

%
%-----
% ADDITION.      (R0 = R1 + R0)
%-----
                .ORIGIN $EB26
%
ADD_1          STY  TEMP_10          EB26  84 54      SAVE IY.
                JSR  ADD_FLOAT_2     EB28  20 C5 EC    FLOATING POINT ADDITION.

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        JSR NORMALISE_1      EB2B  20 D0 E2    NORMALISE.
        JSR PULL_FP_REG      EB2E  20 82 EB    PULL THE ARITHMETIC STACK.
        LDY TEMP_10          EB31  A4 54
        JSR INC_POINTER_1    EB33  20 FC E7    ADVANCE THE POINTER TO THE NEXT.
        JMP MAIN_LOOP_2      EB36  4C 08 E9    RETURN TO THE MAIN LOOP 2.
%
%-----
% SUBTRACTION.      (R0 = R1 - R0)
%-----
SUB_1      INY              EB39  C8              ADVANCE THE POINTER TO THE NEXT.
          LDA (P0),Y        EB3A  B1 40
          CMP #$30          EB3C  C9 30          THE NEXT CHARACTER IS MORE THAN $30
          BCS MANT_SIGN     EB3E  B0 3A          VARIABLE,VALUE, '-' IS DETERMINED SIGN.
SUB1_1     DEY              EB40  88
          STY TEMP_10       EB41  84 54
          JSR SUB_FLOAT_2   EB43  20 CF EC    FLOATING POINT SUBTRACTION.
          JSR NORMALISE_1   EB46  20 D0 E2    NORMALISE.
          JSR PULL_FP_REG   EB49  20 82 EB    PULL THE ARITHMETIC STACK.
          LDY TEMP_10       EB4C  A4 54
          JSR INC_POINTER_1 EB4E  20 FC E7    ADVANCE THE POINTER TO THE NEXT.
          JMP MAIN_LOOP_2   EB51  4C 08 E9    RETURN TO THE MAIN LOOP 2.
%
%-----
% MULTIPLICATION.  (R0 = R1 * R0)
%-----
MUL_1      STY TEMP_10      EB54  84 54          SAVE IY.
          JSR MUL_FLOAT_2   EB56  20 D9 EC    FLOATING POINT MULTIPLICATION.
          JSR NORMALISE_1   EB59  20 D0 E2    NORMALISE.
          JSR PULL_FP_REG   EB5C  20 82 EB    PULL THE ARITHMETIC STACK.
          LDY TEMP_10       EB5F  A4 54
          JSR INC_POINTER_1 EB61  20 FC E7    ADVANCE THE POINTER TO THE NEXT.
          JMP MAIN_LOOP_2   EB64  4C 08 E9    RETURN TO THE MAIN LOOP 2.
%
%-----
% DIVISION.        (R0 = R1 / R0)
%-----
DIV_1      STY TEMP_10      EB67  84 54          SAVE IY.
          JSR DIV_FLOAT_1   EB69  20 E3 EC    FLOATING POINT DIVISION.
          JSR NORMALISE_1   EB6C  20 D0 E2    NORMALISE.
          JSR PULL_FP_REG   EB6F  20 82 EB    PULL THE ARITHMETIC STACK.
          LDY TEMP_10       EB72  A4 54
          JSR INC_POINTER_1 EB74  20 FC E7    ADVANCE THE POINTER TO THE NEXT.
          JMP MAIN_LOOP_2   EB77  4C 08 E9    RETURN TO THE MAIN LOOP 2.
%
%-----
% SIGN PROCESS OF MANTISSA.
%-----
MANT_SIGN  DEY              EB7A  88              MOVE BACK THE POINTER
          LDA #$80          EB7B  A9 80          SET '1' TO SIGN FLAG.
          STA TEMP_7        EB7D  85 08
          JMP GET_FLOAT_6    EB7F  4C B1 E9    RETURN TO THE NUMBER INPUT
%
%-----
% PULL THE ARITHMETIC REGISTER STACK.
%-----
PULL_FP_REG STY TEMP_5      EB82  84 0E          SAVE IY.
          LDX #$30          EB84  A2 30
          LDY #$14          EB86  A0 14
          JSR MOV_FP_REG    EB88  20 39 EA    MOVE R2 TO R1
          LDX #$34          EB8B  A2 34
          LDY #$30          EB8D  A0 30
          JSR MOV_FP_REG    EB8F  20 39 EA    MOVE R3 TO R2
          LDY TEMP_5        EB92  A4 0E
          RTS              EB94  60
%
%-----
% EXECUTION OF EACH LINE.
%-----
RUN_CONT   LDA RUN_FLAG     EB95  A5 50
          BNE L01           EB97  D0 08
          INC RUN_FLAG      EB99  E6 50          IF IT IS NOT RUN STATE,
          JSR SET_P0_PR     EB9B  20 A8 EA    SET POINTER TO HEAD OF PROGRAM

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L01      JMP MAIN_LOOP_5      EB9E  4C FE E8      AND SET RUN FLAG AS '1'.
JSR SET_LINE_NUM      EBA1  20 B9 EB      IF IT IS RUN STATE,
JSR SET_P0_PR      EBA4  20 A8 EA      SET INTEGER PART OF R0 TO LR0
L03      LDX LR1_ADDRESS      EBA7  A2 02      GET LINE NUMBER OF PROGRAM
JSR GET_LINE_NUMB      EBA9  20 3C E8
JSR CMP16_1      EBAC  20 69 E8      COMPARE LINE NUMBERS
BEQ L02      EBAF  F0 05
JSR SEARCH_NEXT_L      EBB1  20 A3 E7      IF IT IS NOT SAME, MOVE NEXT LINE.
BCC L03      EBB4  90 F1
L02      JMP MAIN_LOOP_5      EBB6  4C FE E8      EXECUTE FROM THE DETECTED LINE
%
%-----
% CONVERT R0 TO INTEGER 4 DIGIT, AND SUBSTITUTE IT TO LR0
%-----
SET_LINE_NUM LDX #$00      EBB9  A2 00
LDA R0_1      EBBB  A5 11      MOVE R0_1 TO LR0_0
STA LR0_0      EBBD  85 00
LDA R0_2      EBBF  A5 12      MOVE R0_2 TO LR0_1
STA LR0_1      EBC1  85 01
LDA R0_3      EBC3  A5 13      LOAD EXPONENT OF R0
CMP #$01      EBC5  C9 01      IS THE EXPONENT IS 1?
BEQ L04      EBC7  F0 0F
CMP #$02      EBC9  C9 02      IS THE EXPONENT IS 2?
BEQ L05      EBCB  F0 0E
CMP #$03      EBCD  C9 03      IS THE EXPONENT IS 3?
BEQ L06      EBCF  F0 0D
CMP #$04      EBD1  C9 04      IS THE EXPONENT IS 4?
BEQ L07      EBD3  F0 0C
JMP STOP_RUNNING      EBD5  4C B1 EA      IF IT IS OUT OF RANGE, TERMINATE EXEC.
L04      JSR SHIFT_R_NUM_1      EBD8  20 E2 EB      SHIFT LR0 BY 4 BIT TO THE RIGHT
L05      JSR SHIFT_R_NUM_1      EBD8  20 E2 EB
L06      JSR SHIFT_R_NUM_1      EBDE  20 E2 EB
L07      RTS      EBE1  60
%
%-----
% SHIFT LINE NUMBER REGISTER LR0 BY 4 BIT TO THE RIGHT.
%-----
SHIFT_R_NUM_1 STY TEMP_5      EBE2  84 0E      SAVE IY.
LDY #$04      EBE4  A0 04      SET SHIFT TO 4BIT.
L08      LSR $01,X      EBE6  56 01      SHIFT RIGHT 2 BYTE WIDTH.
ROR $00,X      EBE8  76 00
DEY      EBEA  88
BNE L08      EBEB  D0 F9
LDY TEMP_5      EBED  A4 0E
RTS      EBEF  60
%
%-----
% CONDITION PROCESS. (=, >, <, >=, <=)
%-----
CONDITION STY TEMP_10      EBF0  84 54      SAVE IY.
JSR SUB_FLOAT_2      EBF2  20 CF EC      R1 - R0.
JSR NORMALISE_1      EBF5  20 D0 E2      NORMALISE.
JSR INC_POINTER_1      EBF8  20 FC E7      ADVANCE POINTER.
CONDITION_2 LDA (P0),Y      EBF8  B1 40      ANALYZE THE NEXT OF '?' CODE.
CMP #$3E      EBF8  C9 3E      IS IT '>'?
BEQ L09      EBF8  F0 0B
CMP #$3C      EC01  C9 3C      IS IT '<'?
BEQ L10      EC03  F0 22
CMP #$3D      EC05  C9 3D      IS IT '='?
BEQ L11      EC07  F0 37
JMP MAIN_LOOP_2      EC09  4C 08 E9
L09      JSR INC_POINTER_1      EC0C  20 FC E7
LDA (P0),Y      EC0F  B1 40      ANALYZE MORE NEXT CHARACTER.
CMP #$3D      EC11  C9 3D      IS IT '='?
BEQ L12      EC13  F0 0C      GO TO '>=' PRCESS.
LDA R0_3      EC15  A5 13      '>' PROCESS.
BPL L13      EC17  10 02      IS COMPARISON RESULT PLUS?
BMI L15      EC19  30 29
L13      LDA R0_2      EC1B  A5 12      IS MANTISSA IS ZERO?
BNE L17      EC1D  D0 30      IS THE SIGN IS PULS AND NOT ZERO?
BEQ L15      EC1F  F0 23      IF SIGN IS PULS AND ZERO, GO THAT LINE PROC.
L12      LDA R0_3      EC21  A5 13

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        BPL L14          EC23 10 27      IF THE SIGN IS PULS, GO THAT LINE PROCESS.
        BMI L15          EC25 30 1D      ELSE GO TO NEXT LINE.

%
L10      JSR INC_POINTER_1 EC27 20 FC E7
        LDA (P0),Y      EC2A B1 40
        CMP #$3D        EC2C C9 3D      ANALYZE MORE NEXT CHARACTER.
        BEQ L16          EC2E F0 06      IS IT '='?
        LDA R0_3        EC30 A5 13      GO TO '<=' PRCESS.
        BMI L17          EC32 30 1B      '<' PROCESS.
        BPL L15          EC34 10 0E      IF SIGN IS MINUS, GO THAT LINE PROC.
L16      LDA R0_3        EC36 A5 13      ELSE GO TO NEXT LINE.
        BMI L14          EC38 30 12      IF SIGN IS MINUS, GO THAT LINE PROC.
        LDA R0_2        EC3A A5 12
        BEQ L14          EC3C F0 0E      IF RESULT IS ZERO, GO THAT LINE PROC.
        BNE L15          EC3E D0 04      ELSE GO TO NEXT LINE.

%
L11      LDA R0_2        EC40 A5 12
        BEQ L14          EC42 F0 08      IF RESULT IS ZERO, GO THAT LINE PROC.
L15      JSR SEARCH_NEXT_L EC44 20 A3 E7      ELSE GO TO NEXT LINE.
        LDY TEMP_10     EC47 A4 54
        JMP MAIN_LOOP_5 EC49 4C FE E8

%
L14      JSR INC_POINTER_1 EC4C 20 FC E7
L17      LDY TEMP_10     EC4F A4 54
        JMP MAIN_LOOP_2 EC51 4C 08 E9      RETURN TO THE MAIN LOOP 2.

%
%-----
% SHIFT LEFT 3 BYTE WIDTH. (SAVING P0,P0+1)
%-----
SHIFT_L_NBIT1 STA TEMP_13 EC54 85 57      SAVE ACCUMULATOR.
        LDA P0          EC56 A5 40      SAVE P0.
        PHA            EC58 48
        LDA P0+1        EC59 A5 41      SAVE P0+1.
        PHA            EC5B 48
        LDA TEMP_13     EC5C A5 57
        JSR SHIFT_L_NBIT EC5E 20 A0 E1      SHIFT LEFT 3 BYTE WIDTH.
        PLA            EC61 68
        STA P0+1        EC62 85 41      RETURN P0+1.
        PLA            EC64 68
        STA P0          EC65 85 40      RETURN P0.
        RTS            EC67 60

%
%-----
% CONVERT FLOATING POINT VALUE TO BINARY
%-----
FLOAT_TO_INT8 JSR SHIFT_INT_1 EC68 20 A0 EE      BOTTOMING R0.
        JSR FLOAT_2_INT16 EC6B 20 3B EE      CONVERT R0 VALUE TO 16 BIT BINARY.
        LDX VAR_1        EC6E A6 53      RESTORE THE BROKEN R0.
        LDA VAR_HEAD,X   EC70 BD 00 03
        STA R0_0         EC73 85 10
        LDA VAR_HEAD+1,X EC75 BD 01 03
        STA R0_1         EC78 85 11
        LDA VAR_HEAD+2,X EC7A BD 02 03
        STA R0_2         EC7D 85 12
        LDA VAR_HEAD+3,X EC7F BD 03 03
        STA R0_3         EC82 85 13
        RTS            EC84 60

%
%-----
% SAVE POINTER P0,P0+1
%-----
        .ORIGIN $EC86

%
SAVE_P0      STA TEMP_13 EC86 85 57
        LDA P0          EC88 A5 40
        STA TEMP_11     EC8A 85 55
        LDA P0+1        EC8C A5 41
        STA TEMP_12     EC8E 85 56
        LDA TEMP_13     EC90 A5 57
        RTS            EC92 60

%
%-----

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```

% RESTORE POINTER P0,P0+1
%-----
LOAD_P0      LDA  TEMP_11      EC93  A5 55
              STA  P0          EC95  85 40
              LDA  TEMP_12      EC97  A5 56
              STA  P0+1        EC99  85 41
              RTS              EC9B  60

%
%-----
              .ORIGIN  $ECBF

%
TEST_2       STA  TEMP_14      ECBF  85 58      R0_3 MONITOR
              SED              ECC1  F8          SET DECIMAL MODE
              JMP  OUT_EXP_5    ECC2  4C 9F E2

%
%-----
% FLOATING POINT ADDITION.
%-----
ADD_FLOAT_2  JSR  SAVE_P0      ECC5  20 86 EC
              JSR  ADD_FLOAT_1  ECC8  20 D0 E3
              JSR  LOAD_P0      ECCB  20 93 EC
              RTS              ECCE  60

%
%-----
% FLOATING POINT SUBTRACTION.
%-----
SUB_FLOAT_2  JSR  SAVE_P0      ECCF  20 86 EC
              JSR  SUB_FLOAT_1  ECD2  20 E5 E3
              JSR  LOAD_P0      ECD5  20 93 EC
              RTS              ECD8  60

%
%-----
% FLOATING POINT MULTIPLICATION.
%-----
MUL_FLOAT_2  JSR  SAVE_P0      ECD9  20 86 EC
              JSR  MUL_FLOAT_1  ECDC  20 A0 E4
              JSR  LOAD_P0      ECDF  20 93 EC
              RTS              ECE2  60

%
%-----
% FLOATING POINT DIVISION.
%-----
DIV_FLOAT_2  JSR  SAVE_P0      ECE3  20 86 EC
              JSR  DIV_FLOAT_1  ECE6  20 70 E5
              JSR  LOAD_P0      ECE9  20 93 EC
              RTS              ECEC  60

%
%-----
% PATCH OF MAIN LOOP.
%-----
              .ORIGIN  $ECFA

%
MAIN_LOOP_3  LDA  (P0),Y      ECFA  B1 40      ANALYZE ONE CHARACTER
              STA  MONI_1      ECFC  85 58      CHARACTER MONITOR
              CMP  #$25        ECFE  C9 25
              BEQ  L01         ED00  F0 06      IF IT'S '%'CODE, SET RUN FLAG TO ZERO.
              JSR  DET_LINE_NUM_1 ED02  20 14 ED  DETECT LINE NUMBER.
              JMP  MAIN_LOOP_4  ED05  4C 03 E9  RETURN TO MAIN LOOP.
L01          LDA  #$00         ED08  A9 00
              STA  RUN_FLAG    ED0A  85 50
              RTS              ED0C  60

%
%-----
% INITIALIZE RUN FLAG AT START UP.
%-----
INIT_RUNFLAG SED              ED0D  F8
              CLC              ED0E  18
              LDA  #$00        ED0F  A9 00
              STA  RUN_FLAG    ED11  85 50
              RTS              ED13  60

%
%-----

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```

% DETECT LINE NUMBER.
%      ':' IS DETECTED, SET CARRY. P0 POINTS THE NEXT CHARACTER OF ':'.
%      ':' IS NOT DETECTED, CLEAR CARRY. P0 POINTS THE POSITION BEFORE EXECUTION THE ROUTINE.
%-----
DET_LIN_NUM_1 JSR SAVE_P0          ED14  20 86 EC
               LDX #$05           ED17  A2 05      DOES THE ':' EXIST BY THE FOURTH LETTER?
               LDY #$00           ED19  A0 00
L29            LDA (P0),Y          ED1B  B1 40
               PHA                ED1D  48
               JSR INC_POINTER_1  ED1E  20 FC E7
               PLA                ED21  68
               CMP #$3A           ED22  C9 3A
               BEQ L30            ED24  F0 08
               DEX                ED26  CA
               BNE L29            ED27  D0 F2
               CLC                ED29  18
               JSR LOAD_P0        ED2A  20 93 EC
               RTS               ED2D  60

%
L30            SEC                ED2E  38
               RTS               ED2F  60

%
%-----
% PATCH OF CONDITION PROCESS.
%-----
               .ORIGIN $ED37

%
CONDITION_1   STY TEMP_10        ED37  84 54      SAVE IY.
               JSR SUB_FLOAT_2    ED39  20 CF EC      R1 - R0
               JSR NORMALISE_1    ED3C  20 D0 E2      NORMALIZE
               JSR INC_POINTER_1  ED3F  20 FC E7      ADVANCE THE POINTER
               LDY TEMP_10        ED42  A4 54      RETURN IY
               JMP CONDITION_2    ED44  4C FB EB      GO TO CONDITION PROCESS

%
%-----
% DISPLAY PROGRAM LIST
%-----
DISP_LIST_1   LDA P0             ED47  A5 40      DOES ANY CHARACTER EXIST BEFORE '@'?
               CMP #$01          ED49  C9 00
               BNE L01           ED4B  D0 2F
               JSR SET_P0_PR      ED4D  20 A8 EA      SET POINTER TO THE HEAD OF PROGRAM AREA.
L10            LDY #$00           ED50  A0 00
L03            LDA (P0),Y          ED52  B1 40      GET ONE CHARACTER.
               CMP #$0D          ED54  C9 0D      'CR' CODE?
               BEQ L02           ED56  F0 0D
               CMP #$25          ED58  C9 25      PROGRAM END '%' CODE?
               BEQ L04           ED5A  F0 1F
L09            JSR OUT_1CHA        ED5C  20 9A E0      OUT ONE CHARACTER TO SERIAL INTERFACE.
               JSR INC_POINTER_1  ED5F  20 FC E7      ADVANCE THE POINTER.
               CLC                ED62  18
               BCC L03           ED63  90 ED      REPEAT.
L02            JMP L11            ED65  4C 97 ED      WAIT TO PUSH A KEY

%
               NOP              ED68  EA
               NOP              ED69  EA
               NOP              ED6A  EA
               NOP              ED6B  EA

%
L05            LDA (P0),Y          ED6C  B1 40      IF 'CR' IS PUSHED, DISPLAY TO THE END.
               CMP #$25          ED6E  C9 25
               BEQ L04           ED70  F0 09
               JSR OUT_1CHA        ED72  20 9A E0
               JSR INC_POINTER_1  ED75  20 FC E7
               CLC                ED78  18
               BCC L05           ED79  90 F1
L04            RTS               ED7B  60

%
L01            JSR SET_LINE_NUM    ED7C  20 B9 EB      CASE OF ENTERING BEFORE '@'.
               JSR SET_P0_PR      ED7F  20 A8 EA      SET THE HEAD OF PROGRAM AREA TO P0.
L07            LDX LR1_ADDRESS    ED82  A2 02
               JSR GET_LINE_NUMB  ED84  20 3C E8      GET LINE NUMBER OF PROGRAM AREA.
               JSR CMP16_1        ED87  20 69 E8      COMPARE TWO LINE NUMBERS.

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        BEQ L10          ED8A F0 C4
        JSR SEARCH_NEXT_L ED8C 20 A3 E7    IF IT IS NOT THE SAME, GO TO NEXT LINE.
        BCC L07          ED8F 90 F1
        BCS L03          ED91 B0 BF
L08      LDA #$0D          ED93 A9 0D    OUTPUT 'CR' CODE.
        BNE L09          ED95 D0 C5
L11      JSR IN_1CHA      ED97 20 90 E0
        CMP #$0D          ED9A C9 0D    IF 'CR' IS PUSHED, DISPLAY TO THE END.
        BEQ L05          ED9C F0 CE
        CMP #$0A          ED9E C9 0A    IF 'LF' IS PUSHED, EXIT.
        BNE L08          EDA0 D0 F1
        LDA #$0D          EDA2 A9 0D
        JSR OUT_1CHA      EDA4 20 9A E0
        RTS              EDA7 60

%
%-----
% PROCESS '-' CODE.
%-----
SUB_2      INY              EDA8 C8          ADVANCE THE POINTER
        LDA (P0),Y          EDA9 B1 40
        CMP #$30          EDAB C9 30
        BCS L01          EDAD B0 03    IS THE NEXT CHARACTER OF '-'
        JMP SUB_1_1          EDAF 4C 40 EB    MORE THAN $30? (VALUE, ':', VARIABLE)
L02      CMP #$3B          EDB2 C9 3B    IF LESS THAN $2F, GO TO SUBTRACTION.
L01      BEQ L02          EDB4 F0 F9
        JMP MANT_SIGN      EDB6 4C 7A EB    IF IT'S ';' GO TO SUBTRACTION.
        ELSE GO TO SIGN PROCESS OF VALUE & VARIABLE.

%
%-----
% END LINE PROCESS      (';' NO OUTPUT, ';;' OUTPUT WITH NO NEW LINE)
%-----
ENDLINE_PROC1 JSR SUBSTITUTE_5 EDB9 20 62 F0
        LDA DISP_FLAG      EDBC A5 51
        CMP #$01          EDBE C9 01
        BEQ ENDLINE_PROC3 EDC0 F0 0F    IF DISP_FLAG=1, NO DISPLAY
        CMP #$02          EDC2 C9 02
        BEQ L02          EDC4 F0 15
        JMP ENDLINE_PROC2 EDC6 4C 17 EE    IF DISP_FLAG=2, DISPLAY R0 & NO NEW LINE.
ENDLINE_PROC4 JSR DISP_BUFFER_2 EDC9 20 E6 ED    IF DISP_FLAG=0, DISPLAY R0 & NEW LINE.
        LDA #$0D          EDCC A9 0D    DISPLAY UNTIL BEFORE THE 'CR' CODE.
L04      JSR OUT_1CHA      EDCE 20 9A E0    NEW LINE
ENDLINE_PROC3 JMP ENDLINE_PROC5 EDD1 4C AB F0

%
        .ORIGIN $EDDC
%
L02      JSR DISP_FLOAT      EDDC 20 E0 E1    IF DISP_FLAG=2, DISPLAY R0 & NO NEW LINE.
ENDLINE_PROC5 JSR DISP_BUFFER_2 EDDF 20 E6 ED
        LDA #$20          EDE2 A9 20
        BNE L04          EDE4 D0 E8
        OUTPUT SPACE CODE

%
%-----
% OUTPUT ASCII CODES IN THE DISPLAY BUFFER TO SERIAL INTERFACE
%-----
DISP_BUFFER_2 LDY #$00      EDE6 A0 00
L07      LDA OUT_BUF,Y      EDE8 B9 80 02
        INY              EDEB C8
        BEQ L05          EDEC F0 0A
        CMP #$0D          EDEE C9 0D    OUTPUT UNTIL BEFORE THE 'CR' CODE.
        BEQ L05          EDF0 F0 06
        JSR OUT_1CHA      EDF2 20 9A E0
        CLC              EDF5 18
        BCC L07          EDF6 90 F0
L05      RTS              EDF8 60

%
%-----
% COMMENT PROCESS      (AFTER '#' CODE IN A LINE, RECOGNIZE CHARACTERS AS COMMENTS.)
%-----
COMMENT      LDX #$00      EDF9 A2 00
        LDY #$00      EDFB A0 00
L02      JSR INC_POINTER_1 EDFD 20 FC E7    ADVANCE THE POINTER.
        LDA (P0),Y      EE00 B1 40    GET A ONE CHARACTER.
        CMP #$3B      EE02 C9 3B
        BEQ L01      EE04 F0 0A    IF IT'S ';', EXIT

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	CMP #\$0D	EE06	C9 0D	IF IT'S 'CR', EXIT
	BEQ L01	EE08	F0 06	
	STA OUT_BUF,X	EE0A	9D 80 02	WRITE TEXT TO DISPLAY BUFFER.
	INX	EE0D	E8	ADVANCE THE DISPLAY BUFFER POINTER.
	BNE L02	EE0E	D0 ED	
L01	LDA #\$04	EE10	A9 04	
	STA DISP_FLAG	EE12	85 51	
	JMP COMMENT_1	EE14	4C 33 EE	
%				

ENDLINE_PROC2	CMP #\$00	EE17	C9 00	IF DISP_FLAG=0, DISPLAY R0 & NEW LINE.
	BEQ L03	EE19	F0 0C	
	CMP #\$04	EE1B	C9 04	IF DISP_FLAG=4, DISPLAY COMMENT & NEW LINE.
	BEQ L04	EE1D	F0 0B	
	CMP #\$05	EE1F	C9 05	IF DISP_FLAG=5, DO NOT DISPLAY COMMENT.
	BEQ L05	EE21	F0 0A	
	CMP #\$06	EE23	C9 06	IF DISP_FLAG=6, DISP COMMENT & NO NEW LINE.
	BEQ L06	EE25	F0 09	
L03	JSR DISP_FLOAT	EE27	20 E0 E1	PUT ASCII CODE CONVERTED FROM R0 TO BUFFER.
L04	JMP ENDLINE_PROC4	EE2A	4C C9 ED	GO TO OUTPUT BUFFER & NEW LINE PROCESS
L05	JMP ENDLINE_PROC3	EE2D	4C D1 ED	GO TO WITHOUT OUTPUT PROCESS
L06	JMP PATCH_ELP_5	EE30	4C 5D E0	PATCH TO PREVENT SPACE CODE IN ;; (V.1.3.1)
%				
COMMENT_1	LDA #\$0D	EE33	A9 0D	PUT 'CR' CODE ON THE DISPLAY BUFFER END.
	STA OUT_BUF,X	EE45	9D 80 02	
	JMP MAIN_LOOP_2	EE38	4C 03 E9	RETURN TO MAIN LOOP 2.
%				

% CONVERT BOTTOMING R0 VALUE TO 16 BIT BINARY AND SET P1,P1+1 TO IT.				
%				

FLOAT_2_INT16	LDA #\$00	EE3B	A9 00	
	STA P1	EE3D	85 42	CLEAR P1,P1+1.
	STA P1+1	EEDF	85 43	
	STA P2+1	EE41	85 45	
	LDA #\$01	EE43	A9 01	
	STA P2	EE45	85 44	SET \$0001 TO P2,P2+1.
	LDA R0_0	EE47	A5 10	
	JSR LOWER_INTEG_1	EE49	20 79 EE	ACCUMULATE WEIGHT OF 10^0.
	LDA #\$0A	EE4C	A9 0A	
	STA P2	EE4E	85 44	SET \$000A TO P2,P2+1.
	LDA R0_0	EE50	A5 10	
	JSR UPPER_INTEG_1	EE52	20 80 EE	ACCUMULATE WEIGHT OF 10^1.
	LDA #\$64	EE55	A9 64	
	STA P2	EE57	85 44	SET \$0064 TO P2,P2+1.
	LDA R0_1	EE59	A5 11	
	JSR LOWER_INTEG_1	EE5B	20 79 EE	ACCUMULATE WEIGHT OF 10^2.
	LDA #\$03	EE5E	A9 03	
	STA P2+1	EE60	85 45	
	LDA #\$E8	EE62	A9 E8	
	STA P2	EE64	85 44	SET \$03E8 TO P2,P2+1.
	LDA R0_1	EE66	A5 11	
	JSR UPPER_INTEG_1	EE68	20 80 EE	ACCUMULATE WEIGHT OF 10^3.
	LDA #\$27	EE6B	A9 27	
	STA P2+1	EE6D	85 45	
	LDA #\$10	EE6F	A9 10	
	STA P2	EE71	85 44	SET \$2710 TO P2,P2+1.
	LDA R0_2	EE73	A5 12	
	JSR LOWER_INTEG_1	EE75	20 79 EE	ACCUMULATE WEIGHT OF 10^4.
	RTS	EE78	60	
%				

% ACCUMULATE THE COUNT OF LOWER 4 BIT OF ACC				
%				

LOWER_INTEG_1	AND #\$0F	EE79	29 0F	EXTRACT LOWER 4 BIT.
	TAX	EE7B	AA	
	JSR INTEG16_1	EE7C	20 54 EF	16 BIT ACCUMULATION.
	RTS	EE7F	60	
%				

% ACCUMULATE THE COUNT OF UPPER 4 BIT OF ACC				
%				

UPPER_INTEG_1	LSR	EE80	4A	4 BIT SHIFT RIGHT.

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        LSR          EE81  4A
        LSR          EE82  4A
        LSR          EE83  4A
        TAX          EE84  AA
        JSR  INTEG16_1  EE85  20 54 EF      16 BIT ACCUMULATION.
        RTS          EE88  60

%-----
% BOTTOMING R0 MANTISSA VALUE
%-----
        .ORIGIN  $EEA0

%
SHIFT_INT_1  JSR  SAVE_P0      EEA0  20 86 EC
              LDA  R0_3        EEA3  A5 13
              AND  #$07        EEA5  29 07      EXTRACT 3 BIT OF EXPONENT.
              STA  TEMP_2      EEA7  85 0B
              CLD
              SEC              EEA9  D8
              LDA  #$06        EEAB  A9 06      CALC RIGHT SHIFT BIT (6 - EXPONENT) * 4.
              SBC  TEMP_2      EEAD  E5 0B
              ASL              EEAF  0A
              ASL              EEB0  0A
              STA  MONI_1      EEB1  85 58      SHIFT BIT MONITOR.
              TAX              EEB3  AA          SET SHIFT BIT TO IX.
              LDY  #$10        EEB4  A0 10
              LDA  #$00        EEB6  A9 00
              JSR  SHIFT_R_NBIT EEB8  20 6F E3      3 BYTE SHIFT RIGHT
              JSR  LOAD_P0     EEBB  20 93 EC
              RTS              EEBE  60

%-----
% CONVERT 8 BIT BINARY OF ACC TO BCD INTEGER, AND SET R0 TO IT.
%-----
INT8_TO_FLOAT SED          EEBF  F8
              STA  MEM_VAL     EEC0  85 5A
              LDA  #$00        EEC2  A9 00      CLEAR R0,R0+1.
              STA  R0_0        EEC4  85 10
              STA  R0_1        EEC6  85 11
              STA  R0_2        EEC8  85 12
              STA  R1_0        EECA  85 14
              STA  R1_1        EECC  85 15
              STA  R1_2        EECE  85 16
              ASL  MEM_VAL     EED0  06 5A      EXTRACT D7 OF MEM_VAL TO CARRY BIT.
              BCC  L01         EED2  90 0F      IF D7=0, DO NOT ADD WEIGHT.
              LDA  #$28        EED4  A9 28      SET 128(DEC) TO R1.
              STA  R1_0        EED6  85 14
              LDA  #$01        EED8  A9 01
              STA  R1_1        EEDA  85 15
              LDA  #$00        EEDC  A9 00
              STA  R1_2        EEDE  85 16
              JSR  ADD_ABS_BCD_1 EEE0  20 6A EF
L01          ASL  MEM_VAL     EEE3  06 5A      EXTRACT D6 OF MEM_VAL TO CARRY BIT.
              BCC  L02         EEE5  90 0B
              LDA  #$64        EEE7  A9 64      SET 64(DEC) TO R1.
              STA  R1_0        EEE9  85 14
              LDA  #$00        EEEB  A9 00
              STA  R1_1        EEED  85 15
              JSR  ADD_ABS_BCD_1 EEEF  20 6A EF
L02          LDA  #$00        EFF2  A9 00
              STA  R1_1        EFF4  85 15      CLEAR R1_1
              ASL  MEM_VAL     EFF6  06 5A      EXTRACT D5 OF MEM_VAL TO CARRY BIT.
              BCC  L03         EFF8  90 07
              LDA  #$32        EEFA  A9 32      SET 32(DEC) TO R1.
              STA  R1_0        EEFC  85 14
              JSR  ADD_ABS_BCD_1 EEFE  20 6A EF
L03          ASL  MEM_VAL     EF01  06 5A      EXTRACT D4 OF MEM_VAL TO CARRY BIT.
              BCC  L04         EF03  90 07
              LDA  #$16        EF05  A9 16      SET 16(DEC) TO R1.
              STA  R1_0        EF07  85 14
              JSR  ADD_ABS_BCD_1 EF09  20 6A EF
L04          ASL  MEM_VAL     EF0C  06 5A      EXTRACT D3 OF MEM_VAL TO CARRY BIT.
              BCC  L05         EF0E  90 0B

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L05      LDA #$08      EF10 A9 08      SET 8(DEC) TO R1.
          STA R1_1      EF12 85 14
          LDA #$00      EF14 A9 00
          STA R1_1      EF16 85 15
          JSR ADD_ABS_BCD_1 EF18 20 6A EF
          ASL MEM_VAL    EF1B 06 5A      EXTRACT D2 OF MEM_VAL TO CARRY BIT.
          BCC L06        EF1D 90 07
          LDA #$04      EF1F A9 04      SET 4(DEC) TO R1.
          STA R1_0      EF21 85 14
          JSR ADD_ABS_BCD_1 EF23 20 6A EF
L06      ASL MEM_VAL    EF26 06 5A      EXTRACT D1 OF MEM_VAL TO CARRY BIT.
          BCC L07        EF28 90 07
          LDA #$02      EF2A A9 02      SET 2(DEC) TO R1.
          STA R1_0      EF2C 85 14
          JSR ADD_ABS_BCD_1 EF2E 20 6A EF
L07      ASL MEM_VAL    EF31 06 5A      EXTRACT D0 OF MEM_VAL TO CARRY BIT.
          BCC L08        EF33 90 07
          LDA #$01      EF35 A9 01      SET 1(DEC) TO R1.
          STA R1_0      EF37 85 14
          JSR ADD_ABS_BCD_1 EF39 20 6A EF
L08      RTS           EF3C 60
%
%-----
% ACCUMULATE P1,PI+1 BY 16 BIT VALUE P2,P2+1. (ACCUMULATION COUNT: IX)
%-----
          .ORIGIN $EF54
%
INTEG16_1 CLD           EF54 D8
          CPX #$00      EF55 E0 00      IF IX=0, DO NOT ACCUMULATE
          BEQ L01        EF57 F0 10
L02      CLC           EF59 18          CARRY CLEAR
          LDA P1         EF5A A5 42
          ADC P2         EF5C 65 44      ACCUMULATE LOWER 8BIT
          STA P1         EF5E 85 42
          LDA P1+1       EF60 A5 43
          ADC P2+1       EF62 65 45      ACCUMULATE UPPER 8BIT
          STA P1+1       EF64 85 43
          DEX           EF66 CA          COUNTER -1
          BNE L02        EF67 D0 F0      REPEAT UNTIL COUNTER=0
L01      RTS           EF69 60
%
%-----
% ADDITION OF MANTISSA 24 BIT ABSOLUTE BCD.
%-----
          .ORIGIN $EF6A
%
ADD_ABS_BCD_1 SED      EF6A F8
          CLC           EF6B 18
          LDA R0_0      EF6C A5 10
          ADC R1_0      EF6E 65 14
          STA R0_0      EF70 85 10
          LDA R0_1      EF72 A5 11
          ADC R1_1      EF74 65 15
          STA R0_1      EF76 85 11
          LDA R0_2      EF78 A5 12
          ADC R1_2      EF7A 65 16
          STA R0_2      EF7C 85 12
          RTS           EF7E 60
%
%-----
% POINTER VARIABLE. (8BIT MEMORY VALUE ADDRESSED R0 IS LOADED TO R0)
%-----
          .ORIGIN $EF86
%
POINTER_VAR_1 JSR SHIFT_INT_1 EF86 20 A0 EE      ALIGN THE DECIMAL POINT OF R0.
          JSR FLOAT_2_INT16 EF89 20 3B EE      CONVERT R0 VALUE TO 16 BIT BINARY.
          LDY %$01      EF8C A0 01
          LDA (P0),Y    EF8E B1 40
          CMP %$3D      EF90 C9 3D      IF THE NEXT CHARACTER IS '=',
          BEQ L01        EF92 F0 19      DO NOT READ MEMORY
          DEY           EF94 88
          LDA (P0),Y    EF95 B1 42      READ MEMORY POINTED BY R0
          STA MEM_VAL    EF97 85 5A

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	STA MONI_2	EF99	85 5B	MONITOR FOR READ VALUE
	JSR INT8_TO_FLOAT	EF9B	20 BF EE	CONVERT BYNARY TO FLOATING, AND PUT TO R0.
	LDA #\$05	EF9E	A9 06	CORRECT EXPONENT AS AN INTEGER.
	STA R0_3	EFA0	85 13	
	JSR NORMALISE_1	EFA2	20 D0 E2	NORMALISE.
L02	JSR INC_POINTER_1	EFA5	20 FC E7	ADVANCE THE POINTER.
	LDY #\$00	EFA8	A0 00	
	JMP MAIN_LOOP_2	EFAA	4C 08 E9	RETURN TO MAIN LOOP 2.
%				
L01	LDA #\$FC	EFAD	A9 FC	IF THE NEXT CHARACTER IS '=',
	STA VAR_1	EFAF	85 53	RESET THE NORMAL VARIABLE POINTER.
	LDA P1	EFB1	A5 42	SET MEMORY WRITE POINTER.
	STA P3	EFB3	85 46	
	LDA P1+1	EFB5	A5 43	
	STA P3+1	EFB7	85 47	
	JSR INC_POINTER_1	EFB9	20 FC E7	
	JSR INIT_REG_2	EFBC	20 FA EA	INITIALIZE R0,
	CLC	EFBF	18	ALLOW THE FOLLOWING VALUES TO BE ENTERED.
	BCC L02	EFC0	90 E3	
%				
%	-----			
%	INPUT STATE. (PAUSE THE EXECUTION AND ENTER THE ONE-LINE INPUT STATE)			
%	-----			
INPUT_STATE	LDA #\$00	EFC2	A9 00	
	STA RUN_FLAG	EFC4	85 50	PAUSE THE EXECUTION.
	LDA P0	EFC6	A5 40	SAVE THE POINTER P0 TO P4.
	STA P4	EFC8	85 48	
	LDA P0+1	EFCA	A5 41	
	STA P4+1	EFCC	85 49	
	JSR IN_1LINE_1	EFCE	20 B6 E0	INPUT ONE-LINE.
	JSR ANA_1LINE	EFD1	20 F0 E8	ANALYZE ONE-LINE.
	LDA P4	EFD4	A5 48	RESTORE THE POINTER P0.
	STA P0	EFD6	85 40	
	LDA P4+1	EFD8	A5 49	
	STA P0+1	EFDA	85 41	
	JSR SEARCH_NEXT_L	Efdc	20 A3 E7	ADVANCE THE POINTER TO THE NEXT LINE.
	LDA #\$01	EFDf	A9 01	RETURN TO THE EXECUTION.
	STA RUN_FLAG	EFE1	85 50	
	LDY #\$00	EFE3	A0 00	
	JMP MAIN_LOOP_5	EFE5	4C FE E8	RETURN TO MAIN LOOP 5
%				
%	-----			
%	ARRAY VARIABLE.			
%	LOAD VALUE OF ARRAY VARIABLE 'X, Y, Z' POINTED BY R0(0-255) TO R0			
%	-----			
	.ORIGIN \$F00C			
%				
VECTOR_1	STA TEMP_0	F00C	85 09	SAVE ASCII CODE.
	JSR SHIFT_INT_1	F00E	20 A0 EE	ALIGN DECIMAL POSITION OF R0.
	JSR FLOAT_2_INT16	F011	20 3B EE	CONVERT R0 TO BINARY, AND PUT IT ONTO P1.
	ASL P1	F014	06 42	2 BIT SHIFT LEFT P1,P1+1
	ROL P1+1	F016	26 43	
	ASL P1	F018	06 42	
	ROL P1+1	F01A	26 43	
	LDA TEMP_0	F01C	A5 09	RESTORE ASCII CODE
	AND #\$03	F01E	29 03	EXTRACT LOWER 2 BIT
	EOR #\$03	F020	49 03	INVERT LOWER 2 BIT
	ASL	F022	0A	2 BIT SHIFT LEFT
	ASL	F023	0A	
	ORA P1+1	F024	05 43	SYNTHESIZE WHTH P1+1
	ORA #\$00	F026	09 00	SET '0000' TO UPPER 4 BIT.
	JMP VECTOR_PATCH1	F028	4C A2 F0	IF THE NEXT CHARACTER IS '=',
	NOP	F02B	EA	DO NOT READ ARRAY VARIABLE.
VECTOR_PATCH2	CMP #\$3D	F02C	C9 3D	
	BEQ L01	F02E	F0 1D	
	LDY #\$00	F030	A0 00	
	LDA (P1),Y	F032	B1 42	READ ARRAY VARIABLE AND PUT ONTO R0.
	STA R0_0	F034	85 10	
	INY	F036	C8	
	LDA (P1),Y	F037	B1 42	
	STA R0_1	F039	85 11	
	INY	F03B	C8	

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LDA (P1),Y      F03C B1 42
STA R0_2        F03E 85 12
INY            F040 C8
LDA (P1),Y      F041 B1 42
STA R0_3        F043 85 13
L04 JSR INC_POINTER_1 F045 20 FC E7 ADVANCE THE POINTER.
LDY #$00        F048 A0 00
JMP MAIN_LOOP_2 F04A 4C 08 E9 RETURN TO MAIN LOOP 2.

%
L01 LDA #$FC      F04D A9 FC IF THE NEXT CHARACTER IS '=',
STA VAR_1        F04F 85 53 RESET THE NORMAL VARIABLE POINTER.
LDA P1           F051 A5 42
STA P5           F053 85 4A SET VALUE TO MEMORY WRITE POINTER P5.
LDA P1+1         F055 A5 43
STA P5+1         F057 85 4B
JSR INC_POINTER_1 F059 20 FC E7
JSR INIT_REG_2   F05C 20 FA EA INITIALIZE R0,
CLC              F05F 18 ALLOW THE FOLLOWING VALUES TO BE ENTERED.
BCC L04          F060 90 E3

%
%-----
% SUBSTITUTION PROCESS FOR NORMAL VARIABLES.
%-----
SUBSTITUTE_5 LDX VAR_1      F062 A6 53 SET VARIABLE OFFSET TO IX
LDA R0_0        F064 A5 10 MOVE R0 TO NORMAL VARIABLE.
STA VAR_HEAD,X  F066 9D 00 03
LDA R0_1        F069 A5 11
STA VAR_HEAD+1,X F06B 9D 01 03
LDA R0_2        F06E A5 12
STA VAR_HEAD+2,X F070 9D 02 03
LDA R0_3        F073 A5 13
STA VAR_HEAD+3,X F075 9D 03 03

%
JSR FLOAT_TO_INT8 F078 20 68 EC CONVERT R0 TO BINARY, AND PUT IT TO P1.
LDA P1           F07B A5 42 LOAD A BINARY VALUE TO ACC.
LDY #$00        F07D A0 00
STA (P3),Y       F07F 91 46 WRITE ACC VALUE TO MEMORY POINTED BY P3.

%
LDA R0_0        F081 A5 10 SUBSTITUTE TO ARRAY VARIABLE POINTED BY P5.
STA (P5),Y       F083 91 4A
INY             F085 C8
LDA R0_1        F086 A5 11
STA (P5),Y       F088 91 4A
INY             F08A C8
LDA R0_2        F08B A5 12
STA (P5),Y       F08D 91 4A
INY             F08F C8
LDA R0_3        F090 A5 13
STA (P5),Y       F092 91 4A
LDY #$00        F094 A0 00
RTS             F096 60

%
%-----
% PATCH FOR INITIALIZE REGISTERS.
%-----
INIT_REG_4 LDA #$5C      F097 A9 5C INITIALIZE ARRAY WRITE POINTER.
STA P5        F099 85 4A
LDA #$00      F09B A9 00
STA P5+1      F09D 85 4B
JMP INIT_REG_3 F09F 4C EE EA

%
%-----
VECTOR_PATCH1 STA P1+1      F0A2 85 43
LDY #$01      F0A4 A0 01
LDA (P0),Y     F0A6 B1 40
JMP VECTOR_PATCH2 F0A8 4C 2C F0

%
%-----
% PATCH FOR CALCULATOR LIKE OPERATION.
%-----
ENDLINE_PROC5 LDA RUN_FLAG F0AB A5 50 IF RUN_FLAG='0', PUSH ARITHMETIC STACK.
BNE L03        F0AD D0 04

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        JSR PUSH_FP_REG      F0AF 20 1F EA
        RTS                  F0B2 60
L03      JSR INC_POINTER_1    F0B3 20 FC E7      IF RUN_FLAG='1', ADVANCE THE POINTER.
        JMP MAIN_LOOP_6      F0B6 4C FB E8      RETURN TO MAIN LOOP 6.
%
%-----
% DISPLAY PROMPT '>' CODE.
%-----
IN_1LINE_2 LDA #$3E          F0B9 A9 3E          PROMPT '>' CODE.
        JSR OUT_1CHA         F0BB 20 9A E0      OUTPUT ONE CHARACTER.
        JMP IN_1LINE_1       F0BE 4C B6 E0      GO TO INPUT ONE LINE.
%
%-----
% CHECK FOR PROGRAM.
% IF THE NEXT CHARACTER OF 'CR' IS NOT '%' OR NUMERAL, REMOVE ILLEGAL GAPS.
%-----
CHECK_PROG_1 LDA #$00        F0C1 A9 00
        STA P0               F0C3 85 40
        LDA #$10            F0C5 A9 10
        STA P0+1            F0C7 85 41
L04      JSR SEARCH_NEXT_L    F0C9 20 A3 E7      ADVANCE THE POINTER TO THE NEXT OF 'CR'.
        LDA (P0),Y           F0CC B1 40      INPUT ONE CHARACTER.
        CMP #$25             F0CE C9 25      IF IT'S '%' CODE, NORMAL TERMINATION.
        BEQ L01              F0D0 F0 0C
        CMP #$30             F0D2 C9 30
        BCS L02              F0D4 B0 02      IF IT'S MORE THAN $30, BRANCH.
        BCC L03              F0D6 90 07      IF IT'S LESS THAN $30, GO TO CORRECTION.
L02      CMP #$3A            F0D8 C9 3A
        BCS L03              F0DA B0 03      IF IT'S MORE THAN $30, GO TO CORRECTION.
        BCC L04              F0DC 90 EB      ELSE ADVANCE THE POINTER TO THE NEXT 'CR'.
L01      RTS                  F0DE 60
%
L03      INY                  F0DF C8          FOLLOWING IS CORRECTION PROCESS.
        LDA (P0),Y           F0E0 B1 40
        CMP #$25             F0E2 C9 25      MEASURE LENGTH UNTIL '%' CODE DETECTION.
        BEQ L05              F0E4 F0 07
        CMP #$0D             F0E6 C9 0D      DOES 'CR' CODE DETECT?
        BEQ L06              F0E8 F0 02
        BNE L03              F0EA D0 F3
L06      INY                  F0EC C8          POINT OF THE NEXT OF 'CR' IS OFFSET TO MOVE.
L05      STY #$58            F0ED 84 58
        JSR MOV_BLOCK_B1     F0EF 20 DD E7      BLOCK TRANSFER OF WIDTH INDICATED BY IY.
        RTS                  F0F2 60
%
%-----
%
%-----
DISP_LIST_2 JSR SAVE_P0       F0F3 20 86 EC
        JSR CHECK_PROG_1     F0F6 20 C1 F0      EXECUTE THE PROGRAM CHECK
        JSR LOAD_P0          F0F9 20 93 EC      BEFORE DISPLAY PROGRAM LIST.
        JMP DISP_LIST_1      F0FC 4C 47 ED
%
%-----
%-----
%-----
%-----
%-----
%-----
%-----
%-----
%-----
% SQUARE ROOT BY NEWTON'S METHOD. Y = (Y + X / Y) * 0.5 (V.1.2.0 APR/09/2022)
%-----
SQR_1      LDA R0_0           F0FF A5 10
        BNE L04              F101 D0 09
        LDA R0_1             F103 A5 11
        BNE L04              F105 D0 05
        LDA R0_2             F107 A5 12
        BEQ L06              F109 F0 0E      IF MANTISSA IS ZERO QUIT THE FUNCTION.
        NOP                  F10B EA
L04      LDA R0_3             F10C A5 13
        BPL L05              F10E 10 03      IF MANTISSA IS NEGATIVE,
        JMP ERROR_PROC       F110 4C 10 F1      GO TO ERROR PROCESS.
L05      JSR INIT_VAL_3       F113 20 21 F1      GENERATE INITIAL VALUE OF NEWTON METHOD.
        JSR NEWTON_METHD_1    F116 20 70 F1      NEWTON'S METHOD.

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```

L06          RTS          F119  60
%
%-----
% GENERATE INITIAL VALUE OF NEWTON'S METHOD.
%-----
          .ORIGIN $F121
%
INIT_VAL_3   LDX  #$10          F121  A2 10          STORE ARGUMENT R0 TO R4
              LDY  #$60          F123  A0 60
              JSR  MOV_FP_REG    F125  20 39 EA
              LDA  R4_3          F128  A5 63          EXPONENT OF THE ARGUMENT
              ASL                     F12A  0A
              BMI  L02          F12B  30 0C          IF EXPONENT IS NEGATIVE, BRANCH.
              LDA  R4_3          F12D  A5 63
              JSR  INIT_VAL_4    F12F  20 50 F1          SET THE HALF EXPONENT OF ARGUMENT.
L06          STA  R5_3          F132  85 67
              LDA  #$10          F134  A9 10
              STA  R5_2          F136  85 66
              RTS          F138  60
%
L02          LDA  R4_3          F139  A5 63
              STA  TEMP_13       F13B  85 57
              LDA  #$80          F13D  A9 80
              SED                     F13F  F8
              SEC                     F140  38
              SBC  TEMP_13       F141  E5 57          CONVERT TO ABSOLUTE, 80(BCD) - EXPONENT.
              JSR  INIT_VAL_4    F143  20 50 F1
              BEQ  L03          F146  F0 05          IF INITIAL VALUE IS ZERO, DO NOT COMPLEMENT
              LDA  #$80          F148  A9 80
              SEC                     F14A  38
              SBC  R0_2          F14B  E5 12
L03          CLC                     F14D  18
              BCC  L06          F14E  90 E2
%
%-----
% R0 = 0.5 * (EXPONENT OF ARGUMENT).
%-----
INIT_VAL_4   STA  R1_2          F150  85 16
              LDA  #$05          F152  A9 05
              STA  R0_2          F154  85 12
              LDA  #$01          F156  A9 01
              STA  R1_3          F158  85 17
              STA  R0_3          F15A  85 13
              LDA  #$00          F15C  A9 00
              STA  R5_0          F15E  85 64
              STA  R1_0          F160  85 14
              STA  R0_0          F162  85 10
              STA  R5_1          F164  85 65
              STA  R1_1          F166  85 15
              STA  R0_1          F168  85 11
              JSR  MUL_FLOAT_2    F16A  20 D9 EC
              LDA  R0_2          F16D  A5 12
              RTS          F16F  60
%
%-----
% NEWTON'S METHOD.
%-----
NEWTON_METD_1 LDA  #$08          F170  A9 08          SET 8 TO LOOP COUNTER.
              STA  LOOP_COUNTER_2 F172  85 70
L01          LDX  #$60          F174  A2 60
              LDY  #$14          F176  A0 14
              JSR  MOV_FP_REG    F178  20 39 EA          MOVE ARGUMENT R4 TO R1.
              LDX  #$64          F17B  A2 64
              LDY  #$10          F17D  A0 10
              JSR  MOV_FP_REG    F17F  20 39 EA          MOVE PROVISIONAL VALUE Y,R5 TO R0.
              JSR  DIV_FLOAT_1    F182  20 E3 EC          R0 = R1 / R0.
              JSR  NORMALISE_1    F185  20 D0 E2
              LDX  #$64          F188  A2 64
              LDY  #$14          F18A  A0 14
              JSR  MOV_FP_REG    F18C  20 39 EA          MOVE Y,R5 TO R1
              JSR  ADD_FLOAT_2    F18F  20 C5 EC          R0 = Y + X / Y
              JSR  NORMALISE_1    F192  20 D0 E2          NORMALISE

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LDA #$00          F195  A9 00          SET 0.5 TO R1
STA R1_0          F197  85 14
STA R1_1          F199  85 15
STA R1_3          F19B  85 17
LDA #$50          F19D  A9 50
STA R1_2          F19F  85 16
JSR MUL_FLOAT_2   F1A1  20 D9 EC      R0 = 0.5 * (Y + X /Y)
JSR NORMALISE_1   F1A4  20 D0 E2
LDX #$10          F1A7  A2 10
LDY #$64          F1A9  A0 64
JSR MOV_FP_REG    F1AB  20 39 EA      MOVE R0 TO R5, UPDATE PROVISIONAL VALUE.
DEC LOOP_COUNTER_2 F1AE  C6 70
BNE L01           F1B0  D0 C2
RTS               F1B2  60

%
%-----
% LOAD TABLE VALUES FOR FUNCTIONS.
% TABLE HEAD ADDRESS: P6,P6+1, TABLE INDEX: ACC, DESTINATION HEAD ADDRESS: IX
%-----
.ORIGIN $F1C7
%
LOAD_TABLE_1 ASL          F1C7  0A          2 BIT LEFT SHIFT TABLE INDEX.
              ASL          F1C8  0A
              TAY          F1C9  A8          SET INDEX TO IY.
              LDA (P6),Y    F1CA  B1 80
              STA $00,X     F1CC  95 00      LOAD FLOATING VALUES FROM TABLE
              INY           F1CE  C8
              LDA (P6),Y    F1CF  B1 80
              STA $01,X     F1D1  95 01
              INY           F1D3  C8
              LDA (P6),Y    F1D4  B1 80
              STA $02,X     F1D6  95 02
              INY           F1D8  C8
              LDA (P6),Y    F1D9  B1 80
              STA $03,X     F1DB  95 03
              RTS           F1DD  60

%
%-----
% PATCH FOR MAIN LOOP (ADDED '' COMMAND. V.2.0.0 APR/20/2023)
%-----
MAIN_LOOP_6 BNE L07        F1DE  D0 03
              JMP SUB_LOOP_2 F1E0  4C FB F1  IF IT'S ')' CODE, GO TO SUB LOOP.
L07          CMP #$26       F1E0  C9 26
              BNE L25       F1E5  D0 03
              JMP INPUT_STATE F1F7  4C C2 EF  IF IT'S '&' CODE, GO TO INPUT PROCESS.
L25          CMP #$22       F1EA  C9 22
              BNE L26       F1EC  D0 03
              JMP LOAD_PROGRAM F1EE  4C 01 F3  IF IT'S ''' CODE, GO TO LOAD PROGRAM.
L26          CMP #$27       F1F1  C9 27
              BNE L27       F1F3  D0 03
              JMP LOAD_PROG_PI F1F5  4C 28 F3  IF IT'S ''' CODE, GO TO LOAD PROG PI.
L27          JMP MAIN_LOOP_7 F1F8  4C 2D E9  RETURN TO MAIN_LOOP.

%
%-----
% SUB LOOP
%-----
SUB_LOOP_2 JSR INC_POINTER_1 F1FB  20 FC E7  ADVANCE THE POINTER TO THE NEXT OF ')'.
              LDA (P0),Y     F1FE  B1 40
              CMP #$58       F200  C9 58
              BCC L01        F202  90 07      IF IT'S $57 OR LESS, BRANCH
              CMP #$5B       F204  C9 5B
              BCS L01        F206  B0 03      IF IT'S $57 OR MORE, BRANCH
              JMP VECTOR_1    F208  4C 0C F0  GO TO ARRAY VARIABLE PROCESS.
L01          CMP #$51       F20B  C9 51
              BNE L02        F20D  D0 03
              JMP FUNCTION_SQRT F20F  4C DE FB  IF IT'S 'Q' CODE, GO TO SQUARE ROOT FUNC.
L02          CMP #$53       F212  C9 53
              BNE L03        F214  D0 03
              JMP FUNCTION_SIN2 F216  4C 4B F4  IF IT'S 'S' CODE, GO TO SINE FUNCTION.
L03          CMP #$43       F219  C9 43
              BNE L04        F21B  D0 03
              JMP FUNCTION_COS F21D  4C DA F5  IF IT'S 'C' CODE, GO TO COSINE FUNCTION.

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L04      CMP  #$54          F220  C9 54
        BNE  L05          F222  D0 03
        JMP  FUNCTION_TAN  F224  4C E6 F5      IF IT'S 'T' CODE, GO TO TANGENT FUNCTION.
L05      CMP  #$4D          F227  C9 4D
        BNE  L06          F229  D0 03
        JMP  FUNCTION_ASIN F22B  4C 92 F6      IF IT'S 'M' CODE, GO TO ARCSINE FUNCTION.
L06      CMP  #$4E          F22E  C9 4E
        BNE  L07          F230  D0 03
        JMP  FUNCTION_ACOS F232  4C 47 F7      IF IT'S 'N' CODE, GO TO ARCCOSINE FUNCTION.
L07      CMP  #$4F          F235  C9 4F
        BNE  L08          F237  D0 03
        JMP  FUNCTION_ATAN F239  4C F2 F5      IF IT'S 'O' CODE, GO TO ARCTANGENT FUNC.
L08      CMP  #$45          F23C  C9 45
        BNE  L09          F23E  D0 03
        JMP  FUNCTION_EXP1 F240  4C 64 F7      IF IT'S 'E' CODE, GO TO EXPONENTIAL FUNC.
L09      CMP  #$4C          F243  C9 4C
        BNE  L10          F245  D0 03
        JMP  FUNCTION_LN1  F247  4C 75 F8      IF IT'S 'L' CODE, GO TO NATURAL LOG. FUNC.
L10      CMP  #$50          F24A  C9 50
        BNE  L11          F24C  D0 03
        JMP  FUNCTION_PWR1 F24E  4C B4 FA      IF IT'S 'P' CODE, GO TO EXPONENTIATION.
L11      CMP  #$55          F251  C9 55
        BNE  L12          F253  D0 03
        JMP  FUNCTION_HSin F255  4C D4 FA      IF IT'S 'U' CODE, GO TO HYPERBOLIC SINE.
L12      CMP  #$56          F258  C9 56
        BNE  L13          F25A  D0 03
        JMP  FUNCTION_HCos F25C  4C 21 FB      IF IT'S 'V' CODE, GO TO HYPERBOLIC COSINE.
L13      CMP  #$57          F25F  C9 57
        BNE  L14          F261  D0 03
        JMP  FUNCTION_HTan F263  4C 6E FB      IF IT'S 'W' CODE, GO TO HYPERBOLIC TANGENT.
L14      CMP  #$41          F266  C9 41
        BNE  L15          F268  C0 03
        JMP  FUNCTION_ABS  F26A  4C EA FB      IF IT'S 'A' CODE, GO TO ABSOLUTE FUNCTION.
L15      CMP  #$49          F26D  C9 49
        BNE  L16          F26F  C0 03
        JMP  FUNCTION_INT  F271  4C FD FB      IF IT'S 'I' CODE, GO TO INTEGER COSINE.
L16      CMP  #$52          F274  C9 52
        BNE  L17          F276  D0 03
        JMP  FUNCTION_RND  F278  4C 7B F2      IF IT'S 'R' CODE, GO TO RANDOM NUMBER FUNC.
L17      JSR  INC_POINTER_1 F27B  20 FC E7
        JMP  MAIN_LOOP_2   F27E  4C 08 E9      RETURN TO MAIN LOOP 2.

%
%-----
% PATCH FOR FORMULA OF MINUS SUBSTITUTION 'A=-B'
%-----
        .ORIGIN  $F2A2
%
VAR_PATCH_1 LDA  VAR_HEAD+3,X  F2A2  BD 03 03
        STA  R0_3             F2A5  85 13
        LDA  TEMP_7           F2A7  A5 08      LOAD SIGN FLAG.
        BPL  L01              F2A9  10 06
        LDA  R0_3             F2AB  A5 13      IF SIGN FLAG IS NEGATIVE,
        EOR  #$80             F2AD  49 80      INVERT SIGN OF MANTISSA OF R0_3.
        STA  R0_3             F2AF  85 13
L01      JMP  VAR_RET_1        F2B1  4C E6 EA
%
%-----
%----- GREETING MESSAGE TEXT (V.2.0.0 APR/20/2023) -----
%-----
        .ORIGIN  $F2B4
%
        F2B4  0D 43 49 2D      'CR'  'C'  'I'  '-'
        F2B8  32 20 56 32      '2'  ' '  'V'  '2'
        F2BC  2E 30 20 4D      '.'  '0'  ' '  'M'
        F2C0  2E 59 41 4D      '.'  'Y'  'A'  'M'
        F2C4  41 44 41 20      'A'  'D'  'A'  ' '
        F2C8  32 30 32 33      '2'  '0'  '2'  '3'
        F2CC  0D 22           'CR'  ""

%
%-----
% DISPLAY GREETING MESSAGE.
%-----

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```

.ORIGIN $F2E0

%
GREETING JSR SET_P0 F2E0 20 E7 F2
          JSR OUT_TEXT F2E3 20 F0 F2
          RTS F2E6 60

%
%-----
SET_P0 LDA #$B0 F2E7 A9 B4
        STA P0 F2E9 85 40
        LDA #$F2 F2EB A2 F2
        STA P0+1 F2ED 85 41
        RTS F2EF 60

%
%-----
OUT_TEXT LDY #$00 F2F0 A0 00
L01 LDA (P0),Y F2F2 B1 40
     CMP #$22 F2F4 C9 22
     BEQ L02 F2F6 F0 08 IF IT'S '"' CODE, TERMINATE DISPLAYING.
     JSR OUT_1CHA F2F8 20 9A E0 OUTPUT ONE CHARACTER.
     JSR INC_POINTER_1 F2FB 20 FC E7 ADVANCE THE POINTER.
     BCC L01 F2FE 90 F2
L02 RTS F300 60

%
%-----
% LOAD PROGRAM FROM SERIAL INTERFACE.
% WHEN RECEIVING IS COMPLETE, PRESS 'CR' KEY ON THE TERMINAL TO EXIT.
% THE END CODE '%' IS PLACED AT THE END OF THE PROGRAM.
%-----
LOAD_PROGRAM LDA #$00 F301 A9 00
            STA P0 F303 85 40
            LDA #$10 F305 A9 10
            STA P0+1 F307 85 41 SET PROGRAM AREA HEAD $1000 TO P0.
            LDY #$00 F309 A0 00
            LDX #$00 F30B A2 00 INITIALIZE CHARACTER COUNTER.
L03 JSR IN_1CHA F300 20 90 E0 INPUT ONE CHARACTER FROM SERIAL INTERFACE.
     CMP #$0D F310 C9 0D
     BNE L01 F312 D0 06
     CPX #$01 F314 E0 01 IF IT'S 'CR' CODE AND CHARACTER COUNTER=1,
     BEQ L02 F316 F0 0B EXIT.
     LDX #$00 F318 A2 00 OTHERWISE RESET CHARACTER COUNTER.
L01 INX F31A E8
     STA (P0),Y F31B 91 40 PUT RECEIVED CHARACTER TO MEMORY.
     JSR INC_POINTER_1 F31D 20 FC E7 ADVANCE THE POINTER.
     CLC F320 18
     BCC L03 F321 90 EA REPEAT.
L02 LDA #$25 F323 A9 25
     STA (P0),Y F325 91 40 PUT THE END CODE '%' AT THE PROGRAM END.
     RTS F327 60

%
%-----
% LOAD PROGRAM FROM EXTROM-2 CONNECTED PARALLEL INTERFACE. (V.2.0.0 APR/20/2023)
% RESET EXTROM-2 UPPER ADDRESS COUNTER BEFORE READING THE PROM.
% EXIT WHEN THE END CODE '%' IS DETECTED OR PROG AREA LIMIT $2000 IS REACHED.
%-----
.ORIGIN $F328

%
LOAD_PROG_PI LDA #$00 F328 A9 00
            STA P0 F32A 85 40
            LDA #$10 F32C A9 10
            STA P0+1 F32E 85 41 SET PROGRAM AREA HEAD $1000 TO P0.
            LDY #$00 F330 A0 00
            LDA #$00 F332 A9 00
            STA PARALLEL_PORT F334 8D 00 40 RESET PARALLEL PORT.
            LDA #$80 F337 A9 80
            STA PARALLEL_PORT F339 8D 00 40 RESET EXTROM-2 UPPER ADDRESS COUNTER.
            LDA #$00 F33C A9 00
            STA PARALLEL_PORT F33E 8D 00 40
L01 LDA P0 F341 A5 40 EXTRACT POINTER LOWER 8BIT.
     AND #$7F F343 29 7F EXTRACT 7BIT.
     STA PARALLEL_PORT F345 8D 00 40 SET PROM ADDRESS LOWER 7BIT.
     LDA PARALLEL_PORT F348 AD 00 40 LOAD PROM DATA 8BIT.
     STA (P0),Y F34B 91 40 PUT THE DATA TO USER PROGRAM AREA.

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TAX F34D AA
JSR INC_POINTER_1 F34E 20 FC E7 ADVANCE THE POINTER.
LDA P0+1 F351 A5 41
CMP #$20 F353 C9 20 EXIT WHEN PROG AREA LIMIT $2000 IS REACHED.
BEQ L02 F355 F0 04
CPX #$25 F357 E0 25 EXIT WHEN '%' CODE IS DETECTED.
BNE L01 F359 D0 E6 REPEAT.
L02 RTS F35B 60
%
%-----
% POSTPROCESSING OF FUNCTIONS
%-----
.ORIGIN $F38E
%
FUNC_2 LDX #$74 F38E A2 74 RESTORE R1
LDY #$14 F390 A0 14
JSR MOV_FP_REG F392 20 39 EA
RTS F395 60
%
%-----
% PREPROCESSING OF FUNCTIONS (V.1.4.0 DEC/09/2022)
%-----
.ORIGIN $F396
%
FUNC_1 LDA RUN_FLAG F396 A5 50 DOES NOT PULL CALCULATION STACK
BNE L01 F398 D0 0D IN RUN MODE. (V.1.4.0 DEC/09/2022)
LDA P0 F39A A5 40
CMP #$01 F39C C9 01 DOES NOT EXIST VARIABLES NOR NUMBERS?
BNE L01 F39E D0 07
LDX #$14 F3A0 A2 14
LDY #$10 F3A2 A0 10 MOVE R1 TO R0
JSR MOV_FP_REG F3A4 20 39 EA TO MAKE IT POSSIBLE TO EXECUTE.
L01 LDX #$14 F3A7 A2 14
LDY #$74 F3A9 A0 74
JSR MOV_FP_REG F3AB 20 39 EA SAVE R1 TO R9
RTS F3AE 60
%
%-----
% SINE FUNCTION MACLAURIN SERIES.
% Y = X * (K4 - X^2 * (K3 - X^2 * (K2 - X^2 * (K1 - K0 * X^2))))
%-----
.ORIGIN $F3B2
%
MACLAURIN_1 LDX #$78 F3B2 A2 78
LDY #$14 F3B6 A0 14
JSR MOV_FP_REG F3B6 20 39 EA MOVE ARGUMENT X,R10 TO R1.
LDX #$78 F3B9 A2 78
LDY #$10 F3BB A0 10
JSR MOV_FP_REG F3BD 20 39 EA MOVE R10 TO R0.
JSR MUL_FLOAT_2 F3C0 20 D9 EC R0 = X * X.
JSR NORMALISE_1 F3C3 20 D0 E2 NORMALISE.
LDX #$10 F3C6 A2 10
LDY #$7C F3C8 A0 7C
JSR MOV_FP_REG F3CA 20 39 EA MOVE X^2 TO R11.
NOP F3CD EA
NOP F3CE EA
NOP F3CF EA
NOP F3D0 EA
NOP F3D1 EA
NOP F3D2 EA
NOP F3D3 EA
NOP F3D4 EA
LDA #$00 F3D5 A9 00 SET ZERO TO TABLE INDEX.
LDX #$14 F3D7 A2 14
JSR LOAD_TABLE_1 F3D9 20 C7 F1 LOAD COEFFICIENT K0 TO R1.
JSR MUL_FLOAT_2 F3DC 20 D9 EC R0 = K0 * X^2.
JSR NORMALISE_1 F3DF 20 D0 E2
LDA #$01 F3E2 A9 01
LDX #$14 F3E4 A2 14
JSR LOAD_TABLE_1 F3E6 20 C7 F1 LOAD K1 TO R1.
JSR SUB_FLOAT_2 F3E9 20 CF EC R0 = K1 - R0.
JSR NORMALISE_1 F3EC 20 D0 E2

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	LDD	#\$7C	F3EF	A2 7C	
	LDY	#\$14	F3F1	A0 14	
	JSR	MOV_FP_REG	F3F3	20 39 EA	MOVE X^2 TO R1.
	JSR	MUL_FLOAT_2	F3F6	20 D9 EC	R0 = X^2 * R0.
	JSR	NORMALISE_1	F3F9	20 D0 E2	
	LDA	#\$02	F3FC	A9 02	
	LDD	#\$14	F3FE	A2 14	
	JSR	LOAD_TABLE_1	F400	20 C7 F1	LOAD K2 TO R1.
	JSR	SUB_FLOAT_2	F403	20 CF EC	R0 = K2 - R0.
	JSR	NORMALISE_1	F406	20 D0 E2	
	LDD	#\$7C	F409	A2 7C	
	LDY	#\$14	F40B	A0 14	
	JSR	MOV_FP_REG	F40D	20 39 EA	MOVE X^2 TO R1.
	JSR	MUL_FLOAT_2	F410	20 D9 EC	R0 = X^2 * R0.
	JSR	NORMALISE_1	F413	20 D0 E2	
	LDA	#\$03	F416	A9 03	
	LDD	#\$14	F418	A2 14	
	JSR	LOAD_TABLE_1	F41A	20 C7 F1	LOAD K3 TO R1.
	JSR	SUB_FLOAT_2	F41D	20 CF EC	R0 = K3 - R0.
	JSR	NORMALISE_1	F420	20 D0 E2	
	LDD	#\$7C	F423	A2 7C	
	LDY	#\$14	F425	A0 14	
	JSR	MOV_FP_REG	F427	20 39 EA	MOVE X^2 TO R1.
	JSR	MUL_FLOAT_2	F42A	20 D9 EC	R0 = X^2 * R0.
	JSR	NORMALISE_1	F42D	20 D0 E2	
	LDA	#\$04	F430	A9 04	
	LDD	#\$14	F432	A2 14	
	JSR	LOAD_TABLE_1	F434	20 C7 F1	LOAD K4 TO R1.
	JSR	SUB_FLOAT_2	F437	20 CF EC	R0 = K4 - R0.
	JSR	NORMALISE_1	F43A	20 D0 E2	
	LDD	#\$78	F43D	A2 78	
	LDY	#\$14	F43F	A0 14	
	JSR	MOV_FP_REG	F441	20 39 EA	MOVE X TO R1.
	JSR	MUL_FLOAT_2	F444	20 D9 EC	R0 = X * R0.
	JSR	NORMALISE_1	F447	20 D0 E2	
	RTS		F44A	60	
%					

% SINE FUNCTION					

FUNC_SIN_2	JSR	FUNC_1	F44B	20 96 F3	INDIVIDUAL EXECUTION PROCESS, SAVE R1.
	JSR	SIN_1	F44E	20 5F F4	SINE FUNCTION WITH ARGUMENTS INTERVAL.
	JSR	FUNC_2	F451	20 8E F3	RESTORE R1
	NOP		F454	EA	
	NOP		F455	EA	
	NOP		F456	EA	
FUNC_RETURN_1	JSR	INC_POINTER_1	F457	20 FC E7	ADVANCE THE POINTER.
	LDY	#\$00	F45A	A0 00	
	JMP	MAIN_LOOP_2	F45C	4C 08 E9	RETURN TO MAIN LOOP 2
%					

% SINE FUNCTION WITH CONVERSION OF ARGUMENTS PER PI/2 INTERVAL.					
% ARGUMENTS ARE CONVERTED TO $0 \leq X < \pi/2$, AND RESULTS ARE CONVERTED.					

SIN_1	LDA	#\$00	F45F	A9 00	
	STA	FUNC_SGN_FLAG	F461	85 91	INITIALIZE SIGN FLAG.
	LDA	R0_3	F461	A5 13	
	BPL	L01	F465	10 06	IF SIGN IS PLUS, BRANCH
	EOR	#\$80	F467	49 80	IF SIGN IS MINUS, CONVERT TO ABSOLUTE.
	INC	FUNC_SGN_FLAG	F469	E6 91	SET 1 TO SIGN FLAG
	STA	R0_3	F46B	85 13	
L01	LDD	#\$10	F46D	A2 10	
	LDY	#\$78	F46F	A0 78	
	JSR	MOV_FP_REG	F471	20 39 EA	MOVE ARGUMENT X,R0 TO R10.
L03	LDD	#\$78	F474	A2 78	
	LDY	#\$14	F476	A0 14	
	JSR	MOV_FP_REG	F478	20 39 EA	MOVE ARGUMENT X,R10 TO R1.
	LDA	#\$80	F47B	A9 80	
	STA	P6	F47D	85 80	SET HEAD ADDRESS OF TABLE \$FF80 TO P6
	LDA	#\$FF	F47F	A9 FF	
	STA	P6+1	F481	85 81	
	LDA	#\$05	F483	A9 05	

Label	Instruction	Address	Op	Op2	Op3	Comment
	LDX #\$10	F485	A2	10		
	JSR LOAD_TABLE_1	F487	20	C7	F1	LOAD 2*PI TO R0.
	JSR SUB_FLOAT_2	F48A	20	CF	EC	R0 = X - 2*PI.
	JSR NORMALISE_1	F48D	20	D0	E2	
	LDA R0_3	F490	A5	13		
	BMI L02	F492	30	0A		THE RESULT IS MINUS, DO NOT SUBTRACT.
	LDX #\$10	F494	A2	10		
	LDY #\$78	F496	A0	78		
	JSR MOV_FP_REG	F498	20	39	EA	THE RESULT IS PLUS, RESTORE RESULT TO R10.
	CLC	F49B	18			
	BCC L03	F49C	90	D6		REPEAT TO COMPARE X AND 2*PI.
	LDX #\$78	F49E	A2	78		
	LDY #\$14	F4A0	A0	14		
	JSR MOV_FP_REG	F4A2	20	39	EA	MOVE X,R10 TO R1.
	LDA #\$08	F4A5	A9	08		
	LDX #\$10	F4A7	A2	10		
	JSR LOAD_TABLE_1	F4A9	20	C7	F1	LOAD 0.5*PI TO R0.
	JSR SUB_FLOAT_2	F4AC	20	CF	EC	R0 = X - 0.5*PI.
	LDA R0_3	F4AF	A5	13		
	BPL L04	F4B1	10	06		IF NOT (X < 0.5*PI),BRANCH
	JSR MACLIN_SIN	F4B3	20	CE	F5	CALCULATION SINE BY MACLAURIN SERIES.
	JMP L05	F4B6	4C	4F	F5	
% L02	LDX #\$78	F4B9	A2	78		
	LDY #\$14	F4BB	A0	14		
	JSR MOV_FP_REG	F4BD	20	39	EA	MOVE X,R10 TO R1.
	LDA #\$07	F4C0	A9	07		
	LDX #\$10	F4C2	A2	10		
	JSR LOAD_TABLE_1	F4C4	20	C7	F1	LOAD PI TO R0.
	JSR SUB_FLOAT_2	F4C7	20	CF	EC	X - PI
	LDA R0_3	F4CA	A5	13		
	BPL L06	F4CC	10	21		IF NOT (X < PI), BRANCH
	LDA #\$07	F4CE	A9	07		
	LDX #\$14	F4D0	A2	14		
	JSR LOAD_TABLE_1	F4D2	20	C7	F1	LOAD PI TO R1.
	LDX #\$78	F4D5	A2	78		
	LDY #\$10	F4D7	A0	10		
	JSR MOV_FP_REG	F4D9	20	39	EA	MOVE X,R10 TO R0.
	JSR SUB_FLOAT_2	F4DC	20	CF	EC	R0 = PI - X.
	JSR NORMALISE_1	F4DF	20	D0	E2	
	LDX #\$10	F4E2	A2	10		
	LDY #\$78	F4E4	A0	78		
	JSR MOV_FP_REG	F4E6	20	39	EA	MOVE R0 TO R10
	JSR MACLN_SIN	F4E9	20	CE	F5	CALCULATION SINE BY MACLAURIN SERIES.
	JMP L05	F4EC	4C	4F	F5	
% L04	LDX #\$78	F4EE	A2	78		
	LDY #\$14	F4F1	A0	14		
	JSR MOV_FP_REG	F4F3	20	39	EA	MOVE X,R10 TO R1.
	LDA #\$06	F4F6	A9	06		
	LDX #\$10	F4F8	A2	10		
	JSR LOAD_TABLE_1	F4FA	20	C7	F1	LOAD 1.5*PI TO R0.
	JSR SUB_FLOAT_2	F4FD	20	CF	EC	X - 1.5*PI
	LDA R0_3	F500	A5	13		
	BPL L07	F502	10	27		IF NOT (X < 1.5*PI), BRANCH
	LDX #\$78	F504	A2	78		
	LDY #\$14	F506	A0	14		
	JSR MOV_FP_REG	F508	20	39	EA	MOVE X,R10 TO R1.
	LDA #\$07	F50B	A9	07		
	LDX #\$10	F50D	A2	10		
	JSR LOAD_TABLE_1	F51F	20	C7	F1	LOAD PI TO R0.
	JSR SUB_FLOAT_2	F512	20	CF	EC	R0= X - PI
	JSR NORMALISE_1	F515	20	D0	E2	
	LDX #\$10	F518	A2	10		
	LDY #\$78	F51A	A0	78		
	JSR MOV_FP_REG	F51C	20	39	EA	MOVE R0 TO R10.
	JSR MACLN_SIN	F51F	20	CE	F	

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L07      LDA #$05          F52B A9 05
        LDX #$14          F52D A2 14
        JSR LOAD_TABLE_1  F52F 20 C7 F1    LOAD 2*PI TO R1.
        LDX #$78          F532 A2 78
        LDY #$10          F534 A0 10
        JSR MOV_FP_REG     F536 20 39 EA    MOVE X,R10 TO R0.
        JSR SUB_FLOAT_2    F539 20 CF EC    R0 = 2*PI - X.
        JSR NORMALISE_1    F53C 20 D0 E2
        LDX #$10          F53F A2 10
        LDY #$78          F541 A0 78
        JSR MOV_FP_REG     F543 20 39 EA    MOVE R0 TO R10.
        JSR MACLN_SIN      F546 20 CE F5    CALCULATION SINE BY MACLAURIN SERIES.
        LDA R0_3           F549 A5 13
        EOR #$80           F54B 49 80      INVERT SIGN OF THE RESULT.
        STA R0_3           F54D 85 13
L05      LDA FUNC_SGN_FLAG F54F A5 91      SING FLAG OF THE ARGUMENT.
        BEQ L08            F551 F0 06
        LDA R0_3           F553 A5 13
        EOR #$80           F555 49 80      IF IT'S MINUS, INVERT THE RESULT SIGN.
        STA R0_3           F557 85 13
L08      RTS              F559 60
%
%-----
% COSINE FUNCTION.  COS(X) = SIN(X + PI/2)
%-----
        .ORIGIN $F55D
%
COS_1    LDA #$80          F55D A9 80      INDIVIDUAL EXECUTION PROCESS, SAVE R1.
        STA P6             F55F 85 80
        LDA #$FF           F561 A9 FF
        STA P6+1           F563 85 81
        LDA #$08           F565 A9 08
        LDX #$14           F567 A2 14
        JSR LOAD_TABLE_1  F569 20 C7 F1    LOAD 0.5*PI TO R1.
        JSR ADD_FLOAT_2    F56C 20 C5 EC    R0 = 0.5*PI + X.
        JSR NORMALISE_1    F56F 20 D0 E2
        JSR SIN_1          F572 20 5F F4    CALCULATION SINE.
        RTS              F575 60
%
%-----
% TANGENT FUNCTION.  TAN(X) = SIN(X)/COS(X)
%-----
        .ORIGIN $F57E
%
TAN_1    JMP TAN_PATCH_1   F57E 4C B3 F5
%
        .ORIGIN $F588
%
TAN_PATCH_2 LDA #$80      F588 A9 80
        STA P6            F58A 85 80
        LDA #$FF          F58C A9 FF
        STA P6+1          F58E 85 81
        LDA #$08          F590 A9 08
        LDX #$14          F592 A2 14
        JSR LOAD_TABLE_1  F594 20 C7 F1
        JSR ADD_FLOAT_2    F597 20 C5 EC    R0 = 0.5*PI + X.
        JSR NORMALISE_1    F59A 20 D0 E2
        JSR SIN_2          F59D 20 5F F4    R0 = COS(X).
        LDX #$70          F5A0 A2 70
        LDY #$14          F5A2 A0 14
        JSR MOV_FP_REG     F5A4 20 39 EA    MOVE SIN(X),R8 TO R1.
        JSR DIV_FLOAT_1    F5A7 20 E3 EC    R0 = SIN(X) / COS(X).
        JSR NORMALISE_1    F5AA 20 D0 E2
        RTS              F5AD 60
%
%-----
        .ORIGIN $F5B3
%
TAN_PATCH_1 LDX #$10      F5B3 A2 10
        LDY #$6C          F5B5 A0 6C
        JSR MOV_FP_REG     F5B7 20 39 EA    MOVE ARGUMENT,R0 TO R7.
        JSR SIN_2          F5BA 20 5F F4    R0 = SIN(X).
        LDX #$10          F5BD A2 10

```

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        LDY #\$70          F5BF  A0 70
        JSR MOV_FP_REG     F5C1  20 39 EA      MOVE SIN(X),R0 TO R8.
        LDX #\$6C          F5C4  A2 6C
        LDY #\$10          F5C6  A0 10
        JSR MOV_FP_REG     F5C8  20 39 EA      MOVE ARGUMENT,R7 TO R0.
        JMP TAN_PATCH_2    F5CB  4C 88 F5

%
%-----
% SINE FUNCTION
%-----
MACLIN_SIN LDA #\$80          F5CE  A9 80          SET TABLE HEAD ADDRESS \$FF80 TO P6
           STA P6            F5D0  85 80
           LDA #\$FF          F5D2  A9 FF
           STA P6+1          F5D4  85 81
           JSR MACLAURIN_1    F5D6  20 B2 F3      MACLAURIN SERIES.
           RTS              F5D9  60

%
%-----
% COSINE FUNCTION
%-----
FUNCTION_COS JSR FUNC_1       F5DA  20 96 F3
           JSR COS_1         F5DD  20 5D F5
           JSR FUNC_2       F5E0  20 8E F3
           JMP FUNC_RETURN   F5E3  4C 57 F4

%
%-----
% TANGENT FUNCTION
%-----
FUNCTION_TAN JSR FUNC_1       F5E6  20 96 F3
           JSR TAN_1         F5E9  20 7E F5
           JSR FUNC_2       F5EC  20 8E F3
           JMP FUNC_RETURN   F5EF  4C 57 F4

%
%-----
% ARCTANGENT FUNCTION.
%      BISECTION METHOD (IF X < TAN(Y), Y = Y - PI/2^N, ELSE Y = Y + PI/2^N)
%-----
FUNCTION_ATAN JSR FUNC_1       F5F2  20 96 F3
           JSR ATAN_1        F5F5  20 FE F5
           JSR FUNC_2       F5F8  20 8E F3
           JMP FUNC_RETURN   F5FB  4C 57 F4

%
ATAN_1      LDA #\$00          F5FE  A9 00
           STA FUNC_SGN_FLG2 F600  85 92
           LDA R0_3          F602  A5 13
           BPL L01           F604  10 06
           EOR #\$80          F606  49 80
           INC FUNC_SGN_FLG2 F608  E6 92
           STA R0_3          F60A  85 13
L01        LDX #\$10          F60C  A2 10          MOVE ARGUMENT,R0 TO R3
           LDY #\$34          F60E  A0 34
           JSR MOV_FP_REG     F610  20 39 EA
           LDA #\$00          F613  A9 00
           STA P6            F615  85 80
           LDA #\$FF          F617  A9 FF
           STA P6+1          F619  85 81          SET TABLE HEAD ADDRESS \$FF00 TO P6.
           LDA #\$00          F61B  A9 00
           LDX #\$68          F61D  A2 68
           JSR LOAD_TABLE_1   F61F  20 C7 F1      LOAD PROVISIONAL PI/4 TO R6.
           LDA #\$01          F622  A9 01
           STA LOOP_CONTER    F624  85 90          INITIALIZE LOOP COUNTER.
L04        LDX #\$68          F626  A2 68
           LDY #\$10          F628  A0 10
           JSR MOV_FP_REG     F62A  20 39 EA      MOVE Y,R6 TO R0.
           JSR TAN_1          F62D  20 7E F5      R0 = TAN(Y).
           LDX #\$34          F630  A2 34
           LDY #\$14          F632  A0 14
           JSR MOV_FP_REG     F634  20 39 EA      MOVE X,R3 TO R1.
           JSR SUB_FLOAT_2    F637  20 CF EC      X - TAN(Y).
           LDA R0_3          F63A  A5 13
           BPL L02           F63C  10 22

```

	LDX #\$68	F63E	A2 68	
	LDY #\$14	F640	A0 14	
	JSR MOV_FP_REG	F642	20 39 EA	MOVE Y,R6 TO R1.
	LDA #\$00	F645	A9 00	
	STA P6	F647	85 80	
	LDA LOOP_COUNTER	F649	A5 90	
	LDX #\$10	F64B	A2 10	
	JSR LOAD_TABLE_1	F64D	20 C7 F1	LOAD K(L00P_COUNTER) TO R0.
	JSR SUB_FLOAT_2	F650	20 CF EC	R0 = Y - K(L00P_COUNTER).
	JSR NORMALISE_1	F653	20 D0 E2	
	LDX #\$10	F656	A2 10	
	LDY #\$68	F656	A0 68	
	JSR MOV_FP_REG	F65A	20 39 EA	MOVE R0 TO R1.
	CLC	F65D	18	
	BCC L03	F65E	90 1F	
%				
L02	LDX #\$68	F660	A2 68	
	LDY #\$14	F662	A0 14	
	JSR MOV_FP_REG	F664	20 39 EA	MOVE Y,R6 TO R0.
	LDA #\$00	F667	A9 00	
	STA P6	F669	85 80	
	LDA LOOP_COUNTER	F66B	A5 90	
	LDX #\$10	F66D	A2 10	
	JSR LOAD_TABLE_1	F66F	20 C7 F1	LOAD K(L00P_COUNTER) TO R0.
	JSR ADD_FLOAT_2	F672	20 C5 EC	R0 = Y + K(L00P_COUNTER).
	JSR NORMALISE_1	F675	20 D0 E2	
	LDX #\$10	F678	A2 10	
	LDY #\$68	F67A	A0 68	
	JSR MOV_FP_REG	F67C	20 39 EA	MOVE R0 TO R1.
L03	INC LOOP_COUNTER	F67F	E6 90	
	LDA LOOP_COUNTER	F681	A5 90	
	CMP #\$10	F683	C9 10	
	BNE L04	F685	D0 9F	REPEAT UNTIL LOOP_COUNTER=15
	LDA FUNC_SGN_FLG2	F687	A5 92	
	BEQ L05	F689	F0 06	
	LDA R0_3	F68B	A5 13	
	EOR #\$80	F68D	49 80	IF ARGUMENT IS MINUS, INVERT SIGN.
	STA R0_3	F68F	85 13	
L05	RTS	F691	60	
%				
%-----				
%	ARCSINE FUNCTION			
%-----				
FUNCTION_ASIN	JSR FUNC_1	F692	20 96 F3	
	JSR ASIN_1	F695	20 9E F6	
	JSR FUNC_2	F698	20 8E F3	
	JMP FUNC_RETURN	F69B	4C 57 F4	
%				
%-----				
%	ARCSINE FUNCTION			
%	BISECTION METHOD (IF X < SIN(Y), Y = Y - PI/2^N, ELSE Y = Y + PI/2^N)			
%-----				
ASIN_1	LDA #\$00	F69E	A9 00	
	STA FUNC_SGN_FLG2	F6A0	85 92	INITIALIZE SIGN FLAG
	LDA R0_3	F6A2	A5 13	
	BPL L01	F6A4	10 06	
	EOR #\$80	F6A6	49 80	IF ARGUMENT IS MINUS,
	INC FUNC_SGN_FLG2	F6A8	E6 92	INVERT SIGN OF MANTISSA
	STA R0_3	F6AA	85 13	
L01	LDX #\$10	F6AC	A2 10	
	LDY #\$34	F6AE	A0 34	
	JSR MOV_FP_REG	F6B0	20 39 EA	MOVE ARGUMENT X,R0 TO R3
	LDA #\$00	F6B3	A9 00	
	STA P6	F6B5	85 80	
	LDA #\$FF	F6B7	A9 FF	
	STA P6+1	F6B9	85 81	SET TABLE HEAD ADDRESS \$FF00 TO P6.
	JSR ASIN_ERR	F6BB	20 35 F7	ERROR JUDGEMENT IF X IS OVER 1.
	LDA #\$00	F6BE	A9 00	
	LDX #\$68	F6C0	A2 68	
	JSR LOAD_TABLE_1	F6C2	20 C7 F1	LOAD PROVISIONAL PI/4 TO R6.
	LDA #\$01	F6C5	A9 01	
	STA LOOP_COUNTER	F6C7	85 90	INITIALIZE LOOP COUNTER.

L04	LDX #\$68	F6C9	A2 68	
	LDY #\$10	F6CB	A0 10	
	JSR MOV_FP_REG	F6CD	20 39 EA	MOVE Y,R6 TO R0.
	JSR SIN_1	F6D0	20 5F F4	R0 = SIN(Y).
	LDX #\$34	F6D3	A2 34	
	LDY #\$14	F6D5	A0 14	
	JSR MOV_FP_REG	F6D7	20 39 EA	MOVE Y,R3 TO R1.
	JSR SUB_FLOAT_2	F6DA	20 CF EC	X - SIN(Y).
	LDA R0_3	F6DD	A5 13	
	BPL L02	F6DF	10 22	
	LDX #\$68	F6E1	A2 68	
	LDY #\$14	F6E3	A0 14	
	JSR MOV_FP_REG	F6E5	20 39 EA	MOVE Y,R6 TO R1.
	LDA #\$00	F6E8	A9 00	
	STA P6	F6EA	85 80	
	LDA LOOP_COUNTER	F6EC	A5 90	
	LDX #\$10	F6EE	A2 10	
	JSR LOAD_TABLE_1	F6F0	20 C7 F1	LOAD K(L00P_COUNTER) TO R0.
	JSR SUB_FLOAT_2	F6F3	20 CF EC	R0 = Y - K(L00P_COUNTER).
	JSR NORMALISE_1	F6F6	20 D0 E2	
	LDX #\$10	F6F9	A2 10	
	LDY #\$68	F6FB	A0 68	
	JSR MOV_FP_REG	F6FD	20 39 EA	MOVE R0 TO R1.
	CLC	F700	18	
	BCC L03	F701	90 1F	
%				
L02	LDX #\$68	F703	A2 68	
	LDY #\$14	F705	A0 14	
	JSR MOV_FP_REG	F707	20 39 EA	MOVE Y,R6 TO R0.
	LDA #\$00	F70A	A9 00	
	STA P6	F70C	85 80	
	LDA LOOP_COUNTER	F70E	A5 90	
	LDX #\$10	F710	A2 10	
	JSR LOAD_TABLE_1	F712	20 C7 F1	LOAD K(L00P_COUNTER) TO R0.
	JSR ADD_FLOAT_2	F715	20 C5 EC	R0 = Y + K(L00P_COUNTER).
	JSR NORMALISE_1	F718	20 D0 E2	
	LDX #\$10	F71B	A2 10	
	LDY #\$68	F71D	A0 68	
	JSR MOV_FP_REG	F71F	20 39 EA	MOVE R0 TO R1.
L03	INC LOOP_COUNTER	F722	E6 90	
	LDA LOOP_COUNTER	F724	A5 90	
	CMP #\$10	F726	C9 10	
	BNE L04	F728	D0 9F	REPEAT UNTIL LOOP_COUNTER=15
	LDA FUNC_SGN_FLG2	F72A	A5 92	
	BEQ L05	F72C	F0 06	
	LDA R0_3	F72E	A5 13	
	EOR #\$80	F730	49 80	IF ARGUMENT IS MINUS, INVERT SIGN.
	STA R0_3	F732	85 13	
L05	RTS	F734	60	
%				
%-----				
% ERROR JUDGEMENT IF X IS OVER 1.				
%-----				
%				
ASIN_ERR	LDA #\$1F	F735	A9 1F	TABLE INDEX = 31
	LDX #\$14	F737	A2 14	
	JSR LOAD_TABLE_1	F739	20 C7 F1	LOAD 1.0 TO R1
	JSR SUB_FLOAT_2	F73C	20 CF EC	1.0 - X
	LDA R0_3	F73F	A5 13	
	BPL L06	F741	10 03	
	JMP ERROR_PROC	F743	4C 43 F7	IF X > 1.0, GO TO ERROR PROCESS.
L06	RTS	F746	60	
%				
%-----				
% ARCCOSINE FUNCTION.				
%-----				
FUNCTION_ACOS	JSR FUNC_1	F747	20 96 F3	
	JSR ACOS_1	F74A	20 53 F7	
	JSR FUNC_2	F74D	20 8E F3	
	JMP FUNC_RETURN	F750	4C 57 F4	
%				
%-----				

% ARCCOSINE FUNCTION. $\text{ARCCOS}(X) = \text{PI}/2 - \text{ARCSIN}(X)$

```

%-----
ACOS_1      JSR  ASIN_1          F753  20 9E F6      ARCSIN(X)
             LDA  #$1E          F756  A9 1E
             LDX  #$14          F758  A2 14
             JSR  LOAD_TABLE_1  F75A  20 C7 F1      LOAD 0.5*PI TO R1
             JSR  SUB_FLOAT_2    F75D  20 CF EC      R0 = 0.5*PI - ARCSIN(X)
             JSR  NORMALISE_1    F760  20 D0 E2
             RTS                 F763  60
%

```

% EXPONENTIAL FUNCTION.

```

%-----
FUNCTION_EXP1 JSR  FUNC_1        F764  20 96 F3
              JSR  EXP_1         F767  20 70 F7
              JSR  FUNC_2        F76A  20 8E F3
              JMP  FUNC_RETURN    F76D  4C 57 F4
%

```

```

%-----
EXP_1        JSR  SECT_EXP       F770  20 D1 F7
             NOP                 F773  EA
             NOP                 F774  EA
             NOP                 F775  EA
             NOP                 F776  EA
             NOP                 F777  EA
             NOP                 F778  EA
             RTS                 F779  60
%

```

% EXPONENTIAL FUNCTION BY MACLAURIN SERIES.

% $Y = 1 + X * (K8 + X * (K7 + X * (K6 + X * (K5 + X * (K4 + X * (K3 + X * (K2 + X * (K1 + X * K0))))))))).$

```

%-----
MACLN_2      LDX  #$10          F77A  A2 10
             LDY  #$78          F77C  A0 78
             JSR  MOV_FP_REG     F77E  20 39 EA      MOVE ARGUMENT X,R0 TO R10
             LDA  #$A4          F781  A9 A4
             STA  P6            F783  85 80
             LDA  #$FF          F785  A9 FF
             STA  P6+1          F787  85 81      SET TABLE HEAD ADDRESS $FFA4 TO P6.
             LDA  #$00          F789  A9 00
             LDX  #$14          F78B  A2 14
             JSR  LOAD_TABLE_1  F78D  20 C7 F1      LOAD K(0) TO R1.
             LDX  #$78          F790  A2 78
             LDY  #$10          F792  A0 10
             JSR  MOV_FP_REG     F794  20 39 EA      MOVE X,R10 TO R0.
             JSR  MUL_FLOAT_2    F797  20 D9 EC      R0 = K(0) * X.
             JSR  NORMALISE_1    F79A  20 D0 E2
             LDA  #$01          F79D  A9 01
             STA  LOOP_COUNTER   F79F  85 90      INITIALIZE LOOP COUNTER.
L01          LDA  LOOP_COUNTER   F7A1  A5 90
             LDX  #$14          F7A3  A2 14
             JSR  LOAD_TABLE_1  F7A5  20 C7 F1      LOAD K(L01) TO R1.
             JSR  ADD_FLOAT_2    F7A8  20 C5 EC      R0 = K(L01) + R0.
             JSR  NORMALISE_1    F7AB  20 D0 E2
             LDX  #$78          F7AE  A2 78
             LDY  #$14          F7B0  A0 14
             JSR  MOV_FP_REG     F7B2  20 39 EA      MOVE X,R10 TO R1.
             JSR  MUL_FLOAT_2    F7B5  20 D9 EC      R0 = X * (K(L01) + R0).
             JSR  NORMALISE_1    F7B8  20 D0 E2
             INC  LOOP_COUNTER   F7BB  E6 90
             LDA  LOOP_COUNTER   F7BD  A5 90
             CMP  #$09          F7BF  C9 09      REPEAT UNTIL LOOP_COUNTER=9
             BNE  L01           F7C1  D0 DE
             LDA  #$08          F7C3  A9 08
             LDX  #$14          F7C5  A2 14
             JSR  LOAD_TABLE_1  F7C7  20 C7 F1      LOAD K(8) TO R1
             JSR  ADD_FLOAT_2    F7CA  20 C5 EC      R0 = 1 + R0
             JSR  NORMALISE_1    F7CD  20 D0 E2
             RTS                 F7D0  60
%

```

% DECOMPOSITION PROCESS OF EXPONENTIAL FUNCTION

```

%-----
SECT_EXP      LDX  #$10          F7D1  A2 10
               LDY  #$70          F7D3  A0 70
               JSR  MOV_FP_REG    F7D5  20 39 EA      MOVE ARGUMENT,R0 TO R8
               LDA  #$C8          F7D8  A9 C8
               STA  P6            F7DA  85 80
               LDA  #$FF          F7DC  A9 FF
               STA  P6+1          F7DE  85 81      SET TABLE HEAD ADDRESS $FFC8 TO P6.
               LDA  #$00          F7E0  A9 00      TABLE INDEX = 0
               LDX  #$14          F7E2  A2 14
               JSR  LOAD_TABLE_1   F7E4  20 C7 F1      LOAD OVERFLOW JUDGEMENT VALUE TO R1.
               JSR  SUB_FLOAT_2    F7E7  20 CF EC
               LDA  R0_3          F7EA  A5 13
               JMP  EXP_PATCH_2    F7EC  4C B2 FB      PATCH FOR ERROR PROCESS.

%
               NOP                F7EF  EA
               NOP                F7F0  EA
EXP_PATCH_2R   LDA  R8_3          F7F1  A5 73
               AND  #$7F          F7F3  29 7F      REMOVE SIGN OF MANTISSA.
               CMP  #$02          F7F5  C9 02
               BEQ  L02           F7F7  F0 50      IF EXPONENT=2, BRANCH.
               CMP  #$01          F7F9  C9 01
               BEQ  L03           F7FB  F0 0F      IF EXPONENT=1, BRANCH.
               LDX  #$70          F7FD  A2 70
               LDY  #$10          F7FF  A0 10
               JSR  MOV_FP_REG    F801  20 39 EA      MOVE X,R8 TO R0
               LDA  #$A4          F804  A9 A4
               STA  P6            F806  85 80      SET TABLE HEAD ADDRESS $FFA4 TO P6.
               JSR  MACLN_2       F808  20 7A F7      R0 = EXP(X).
               RTS                F80B  60

%
L03            LDX  #$70          F80C  A2 70      WHEN THE INTEGER PART IS ONE DIGIT.
               LDY  #$10          F80E  A0 10
               JSR  MOV_FP_REG    F810  20 39 EA      MOVE X,R8 TO R0.
               LDA  R0_2          F813  A5 12
               AND  #$0F          F815  29 0F      EXTRACT DECIMAL FRACTION OF ARGUMENT.
               STA  R0_2          F817  85 12
               JSR  NORMALISE_1   F819  20 D0 E2
               LDA  #$A4          F81C  A9 A4
               STA  P6            F81E  85 80      SET TABLE HEAD ADDRESS $FFA4 TO P6.
               JSR  MACLN_2       F81E  20 7A F7      R0 = EXP(X).
               LDA  R8_2          F823  A5 72      EXTRACT INTEGER PART OF ARGUMENT.
               LSR                F825  4A          4 BIT RIGHT SHIFT.
               LSR                F826  4A
               LSR                F827  4A
               LSR                F828  4A
               STA  P1            F829  85 42
L06            JMP  EXP_PATCH_1    F82B  4C A3 FB

%
EXP_PATCH_1R   NOP                F82E  EA
               LDA  #$07          F82F  A9 07
               STA  LOOP_COUNTER  F831  85 90      INITIALIZE LOOP COUNTER.
L05            LSR  P1            F833  46 42
               BCC  L04           F835  90 0D
               LDA  LOOP_COUNTER  F837  A5 90
               LDX  #$14          F839  A2 14
               JSR  LOAD_TABLE_1   F83B  20 C7 F1      LOAD CONSTANT TO R1.
               JSR  MUL_FLOAT_2    F83E  20 D9 EC      R0 = R1 * R0.
               JSR  NORMALISE_1   F841  20 D0 E2
L04            DEC  LOOP_COUNTER  F844  C6 90
               BNE  L05           F846  D0 EB
               RTS                F848  60

%
L02            LDX  #$70          F849  A2 70      WHEN THE INTEGER PART IS TWO DIGIT.
               LDY  #$10          F84B  A0 10
               JSR  MOV_FP_REG    F84D  20 39 EA      MOVE X,R8 TO R0.
               LDA  R0_2          F850  A5 12
               STA  R0_0          F852  85 10      MOVE INTEGER PART TO R0 LOWER
               LDA  #$00          F854  A9 00
               STA  R0_1          F856  85 11
               STA  R0_2          F858  85 12      CLEAR R0 UPPER
               JSR  FLOAT_2_INT16  F85A  20 3B EE      CONVERT BCD TO BINARY, PUT IT TO P1.

```

```

        LDX #$70          F85D A2 70
        LDY #$10          F85F A0 10
        JSR MOV_FP_REG    F861 20 39 EA    MOVE X,R8 TO R0.
        LDA #$00          F864 A9 00
        STA R0_2          F866 85 12      EXTRACT DECIMAL FRACTION OF ARGUMENT.
        JSR NORMALISE_1   F868 20 D0 E2
        LDA #$A4          F86B A9 A4
        STA P6            F86D 85 80      SET TABLE HEAD ADDRESS $FFA4 TO P6.
        JSR MACLN_2       F86F 20 7A F7    R0 = EXP(X).
        JMP L06           F872 4C 2B F8

%
%-----
% NATURAL LOGARITHM FUNCTION
%-----
FUNCTION_LN1 JSR FUNC_1      F875 20 96 F3
              JSR LN_1       F878 20 81 F8
              JSR FUNC_2     F87B 20 8E F3
              JMP FUNC_RETURN F87E 4C 57 F4

%
%-----
LN_1         JSR PRE_LN_1    F881 20 50 F9
              NOP           F884 EA
              NOP           F885 EA
              NOP           F886 EA
              RTS           F887 60

%
%-----
% NATURAL LOGARITHM FUNCTION BY MACLAURIN SERIES.
%      Z = X*(K4+X^2*(K3+X^2*(K2+X^2*(K1+K0*X^2))))).
%-----
        .ORIGIN $F88B

%
MACLN_3      LDX #$10          F88B A2 10
              LDY #$78          F88D A0 78
              JSR MOV_FP_REG    F88F 20 39 EA    MOVE ARGUMENT X,R0 TO R10.
              LDX #$10          F892 A2 10
              LDY #$14          F894 A0 14
              JSR MOV_FP_REG    F896 20 39 EA    MOVE X,R0 TP R1.
              JSR MUL_FLOAT_2   F899 20 D9 EC    R0 = X * X.
              JSR NORMALISE_1   F89C 20 D0 E2
              LDX #$10          F89F A2 10
              LDY #$70          F8A1 A0 70
              JSR MOV_FP_REG    F8A3 20 39 EA    MOVE X^2 TO R8
MACLN_4      LDA #$80          F8A6 A9 80
              STA P6            F8A8 85 80
              LDA #$FE          F8AA A9 FE
              STA P6+1          F8AC 85 81      SET TABLE HEAD ADDRESS $FE80 TO P6.
              LDA #$00          F8AE A9 00      TABLE INDEX = 0
              LDX #$14          F8B0 A2 14
              JSR LOAD_TABLE_1   F8B2 20 C7 F1    LOAD K0 TO R1
              LDX #$70          F8B5 A2 70
              LDY #$10          F8B7 A0 10
              JSR MOV_FP_REG    F8B9 20 39 EA    MOVE X^2,R8 TO R0
              JSR MUL_FLOAT_2   F8BC 20 D9 EC    R0 = K0 * X^2.
              JSR NORMALISE_1   F8BF 20 D0 E2
              LDA #$01          F8C2 A9 01
              STA LOOP_COUNTER  F8C4 85 90      INITIALIZE LOOP COUNTER.
L01          LDA LOOP_COUNTER  F8C6 A5 90
              LDX #$14          F8C8 A2 14
              JSR LOAD_TABLE_1   F8CA 20 C7 F1    LOAD K(L01) TO R1.
              JSR ADD_FLOAT_2   F8CD 20 C5 EC    R0 = K(L01) + R0.
              JSR NORMALISE_1   F8D0 20 D0 E2
              LDX #$70          F8D3 A2 70
              LDY #$14          F8D5 A0 14
              JSR MOV_FP_REG    F8D7 20 39 EA    MOVE X^2,R8 TO R1.
              JSR MUL_FLOAT_2   F8DA 20 D9 EC    R0 = X^2 * (K(L01) + R0).
              JSR NORMALISE_1   F8DD 20 D0 E2
              INC LOOP_COUNTER  F8E0 E6 90
              LDA LOOP_COUNTER  F8E2 A5 90
              CMP #$04          F8E4 C9 04      REPEAT UNTIL LOOP_COUNTER=4
              BNE L01           F8E6 D0 DE
              LDX #$14          F8E8 A2 14

```

```

JSR LOAD_TABLE_1      F8EA 20 C7 F1      LOAD 2.0 TO R1
JSR ADD_FLOAT_2       F8ED 20 C5 EC      R0 = 2.0 + R0.
JSR NORMALISE_1       F8F0 20 D0 E2
LDX #$78              F8F3 A2 78
LDY #$14              F8F5 A0 14
JSR MOV_FP_REG        F8F7 20 39 EA      MOVE X,R10 TO R1.
JSR MUL_FLOAT_2       F8FA 20 D9 EC      R0 = X * R0.
JSR NORMALISE_1       F8FD 20 D0 E2
RTS                   F900 60

%
%-----
% CONVERT Y TO X FOR NATURAL LOGARITHM FUNCTION BY MACLAURIN SERIES.
%      X = (Y - 1) / (Y + 1).
%-----
PRE_LIN_2
LDX #$10              F901 A2 10
LDY #$7C              F903 A0 7C
JSR MOV_FP_REG        F905 20 39 EA      MOVE ARGUMENT,R0 TO R11.
LDA #$80              F908 A9 80
STA P6                F90A 85 80
LDA #$FE              F90C A9 FE
STA P6+1              F90E 85 81      SET TABLE HEAD ADDRESS $FE80 TO P6.
LDA #$05              F910 A9 05      TABLE INDEX = 5.
LDX #$10              F912 A2 10
JSR LOAD_TABLE_1      F914 20 C7 F1      LOAD 1.0 TO R1.
LDX #$7C              F917 A2 7C
LDY #$14              F919 A0 14
JSR MOV_FP_REG        F91B 20 39 EA      MOVE Y,R11 TO R1.
JSR SUB_FLOAT_2       F91E 20 CF EC      R0 = Y - 1.
JSR NORMALISE_1       F921 20 D0 E2
LDX #$10              F924 A2 10
LDY #$A0              F926 A0 A0
JSR MOV_FP_REG        F928 20 39 EA      MOVE R0 TO R12.
LDA #$05              F92B A9 05      TABLE INDEX = 5.
LDX #$10              F92D A2 10
JSR LOAD_TABLE_1      F92F 20 C7 F1      LOAD 1.0 TO R0.
LDX #$7C              F932 A2 7C
LDY #$14              F934 A0 14
JSR MOV_FP_REG        F936 20 39 EA      MOVE Y,R11 TO R1.
JSR ADD_FLOAT_2       F939 20 C5 EC      R0 = Y + 1.
JSR NORMALISE_1       F93C 20 D0 E2
LDX #$A0              F93F A2 A0
LDY #$14              F941 A0 14
JSR MOV_FP_REG        F943 20 39 EA      MOVE R12 TO R1.
JSR DIV_FLOAT_1       F946 20 E3 EC      R0 = (Y - 1) / (Y + 1)
JSR NORMALISE_1       F949 20 D0 E2
RTS                   F94C 60

%
%-----
% DECOMPOSITION PROCESS OF NATURAL LOGARITHM FUNCTION
%-----
.ORIGIN $F950
%
PRE_LN_1
LDX #$10              F950 A2 10
LDY #$60              F952 A0 60
JSR MOV_FP_REG        F952 20 39 EA      MOVE ARGUMENT Y,R0 TO R4.
LDA #$80              F957 A9 80
STA P6                F959 85 80
LDA #$FE              F95B A9 FE
STA P6+1              F95D 85 81      SET TABLE HEAD ADDRESS $FE80 TO P6.
LDA R0_2              F95F A5 12
BNE L01              F961 D0 03
JMP ERROR_PROC        F963 4C 63 F9      IF ARGUMENT=0, GO TO ERROR PROCESS.
L01 LDA R0_3          F966 A5 13
BPL L07              F968 10 03
JMP ERROR_PROC        F96A 4C 6A F9      IF ARGUMENT<0, GO TO ERROR PROCESS.
L07 SED              F96D F8      SET DECIMAL MODE.
SEC                  F96E 38
SBC #$01             F96F E9 01      EXPONENT - 1
JMP LN_PATCH_1       F971 4C 5B FA      SET THE EXPONENT PART TO MANTISSA OF R0.
%
L06 LDA #$00          F974 A9 00

```

	STA R0_0	F976	85 10	
	STA R0_1	F978	85 11	
	LDA #\$06	F97A	A9 06	
	LDX #\$14	F97C	A2 14	
	JSR LOAD_TABLE_1	F97E	20 C7 F1	LOAD LN(10) TO R1.
	JSR MUL_FLOAT_2	F981	20 D9 EC	R0 = R1 * R0.
	JSR NORMALISE_1	F984	20 D0 E2	
	LDX #\$10	F987	A2 10	
	LDY #\$6C	F989	A0 6C	
	JSR MOV_FP_REG	F98B	20 39 EA	MOVE R0 TO R7.
	LDA R4_2	F98E	A5 62	UPPER 2 DIGIT OF MANTISSA OF ARGUMENT.
	AND #\$F0	F990	29 F0	
	CMP #\$10	F992	C9 10	
	BNE L02	F994	D0 15	
	LDA #\$07	F996	A9 07	
	LDX #\$68	F998	A2 68	WHEN UPPER DIGIT OF MANTISSA = 1,
	JSR LOAD_TABLE_1	F99A	20 C7 F1	MOVE K(7) TO R6.
	LDX #\$60	F99D	A2 60	
	LDY #\$64	F99F	A0 64	
	JSR MOV_FP_REG	F9A1	20 39 EA	MOVE ARGUMENT Y,R4 TO R5.
	LDA #\$01	F9A4	A9 01	
	STA R5_3	F9A6	85 67	SET 1 TO EXPONENT PART OF Y.
	JMP L03	F9A8	4C 33 FA	
% L02	LDA R4_2	F9AB	A5 62	
	AND #\$F0	F9AB	29 F0	
	CMP #\$40	F9AF	C9 40	IF UPPER DIGIT OF MATISSA >= 4, BRANCH.
	BPL L04	F9B1	10 29	
	LDA #\$08	F9B3	A9 08	WHEN UPPER DIGIT OF MATISSA = 2 OR 3,
	LDX #\$68	F9B5	A2 68	LOAD K(8) TO R6.
	JSR LOAD_TABLE_1	F9B7	20 C7 F1	
	LDX #\$60	F9BA	A2 60	
	LDY #\$14	F9BC	A0 14	
	JSR MOV_FP_REG	F9BE	20 39 EA	MOVE ARGUMENT Y,R4 TO R1.
	LDA #\$01	F9C1	A9 01	
	STA R1_3	F9C3	85 17	SET 1 TO EXPONENT PART OF R1.
	LDA #\$0B	F9C5	A9 0B	
	LDX #\$10	F9C7	A2 10	
	JSR LOAD_TABLE_1	F9C9	20 C7 F1	LOAD K(11) TO R0.
	JSR MUL_FLOAT_2	F9CC	20 D9 EC	R0 = R1 * R0.
	JSR NORMALISE_1	F9CF	20 D0 E2	
	LDX #\$10	F9D2	A2 10	
	LDY #\$64	F9D4	A0 64	
	JSR MOV_FP_REG	F9D6	20 39 EA	MOVE R0 TO R5.
	CLC	F9D9	18	
	BCC L03	F9DA	90 57	
% L04	LDA R4_2	F9DC	A5 62	
	AND #\$F0	F9DE	29 F0	
	CMP #\$80	F9E0	C9 80	IF UPPER DIGIT OF MANTISSA >= 8, BRANCH.
	BPL L05	F9E2	10 29	
	LDA #\$09	F9E4	A9 09	WHEN UPPER DIGIT OF MANTISSA = 4,5,6,7,
	LDX #\$68	F9E6	A2 68	LOAD K(9) TO R6.
	JSR LOAD_TABLE_1	F9E8	20 C7 F1	
	LDX #\$60	F9EB	A2 60	
	LDY #\$14	F9ED	A0 14	
	JSR MOV_FP_REG	F9EF	20 39 EA	MOVE ARGUMENT Y,R4 TO R1.
	LDA #\$01	F9F2	A9 01	
	STA R1_3	F9F4	85 17	SET 1 TO EXPONENT PART OF R1.
	LDA #\$0C	F9F6	A9 0C	
	LDX #\$10	F9F8	A2 10	
	JSR LOAD_TABLE_1	F9FA	20 C7 F1	LOAD K(12) TO R0.
	JSR MUL_FLOAT_2	F9FD	20 D9 EC	R0 = R1 * R0.
	JSR NORMALISE_1	FA00	20 D0 E2	
	LDX #\$10	FA03	A2 10	
	LDY #\$64	FA05	A0 64	
	JSR MOV_FP_REG	FA07	20 39 EA	MOVE R0 TO R5.
	CLC	FA0A	18	
	BCC L03	FA0B	90 26	
% L05	LDA #\$0A	FA0D	A9 0A	WHEN UPPER DIGIT OF MANTISSA = 8 OR 9.
	LDX #\$68	FA0F	A2 68	

	JSR LOAD_TABLE_1	FA11	20 C7 F1	LOAD K(10) TO R6.
	LDX #\$60	FA14	A2 60	
	LDY #\$14	FA16	A0 14	
	JSR MOV_FP_REG	FA18	20 39 EA	MOVE ARGUMENT Y,R4 TO R1.
	LDA #\$01	FA1B	A9 01	
	STA R1_3	FA1D	85 17	SET 1 TO EXPONENT PART OF R1.
	LDA #\$0D	FA1F	A9 0D	
	LDX #\$10	FA21	A2 10	
	JSR LOAD_TABLE_1	FA23	20 C7 F1	LOAD K(13) TO R0.
	JSR MUL_FLOAT_2	FA26	20 D9 EC	R0 = R1 * R0.
	JSR NORMALISE_1	FA29	20 D0 E2	
	LDX #\$10	FA2C	A2 10	
	LDY #\$64	FA2E	A0 64	
L03	JSR MOV_FP_REG	FA30	20 39 EA	MOVE R0 TO R5.
	LDX #\$64	FA33	A2 64	
	LDY #\$10	FA35	A0 10	
	JSR MOV_FP_REG	FA37	20 39 EA	MOVE R5 TO R0.
	JSR PRE_LN_2	FA3A	20 01 F9	CONVERT Y TO X.
	JSR MACLN_3	FA3D	20 8B F8	MACLAURIN SERIES OF NATURAL LOG.
	LDX #\$68	FA40	A2 68	
	LDY #\$14	FA42	A0 14	
	JSR MOV_FP_REG	FA44	20 39 EA	MOVE R6 TO R1.
	JSR ADD_FLOAT_2	FA47	20 C5 EC	R0 = R1 + R0.
	JSR NORMALISE_1	FA4A	20 D0 E2	
	LDX #\$6C	FA4D	A2 6C	
	LDY #\$14	FA4F	A0 14	
	JSR MOV_FP_REG	FA51	20 39 EA	MOVE R7 TO R1.
	JSR ADD_FLOAT_2	FA54	20 C5 EC	R0 = R1 + R0.
	JSR NORMALISE_1	FA57	20 D0 E2	
	RTS	FA5A	60	
%				
%	-----			
%	PATCH OF NATURAL LOGARITHM FUNCTION.			
%	-----			
LN_PATCH_1	STA TEMP_13	FA5B	85 56	
	CMP #\$40	FA5D	C9 40	
	BCC L08	FA5F	90 37	IF EXPONENT PART IS PLUS, BRANCH
	CMP #\$99	FA61	C9 99	
	BNE L09	FA63	D0 11	
	LDA #\$00	FA65	A9 00	IF EXPONENT IS 99(BCD), SET -1 TO R0.
	STA R0_0	FA67	85 10	
	STA R0_1	FA69	85 11	
	LDA #\$10	FA6B	A9 10	
	STA R0_2	FA6D	85 12	
	LDA #\$81	FA6F	A9 81	
	STA R0_3	FA71	85 13	
	JMP L06	FA73	4C 74 F9	
L09	SED	FA76	F8	
	SEC	FA77	38	
	LDA #\$80	FA78	A9 80	CONVERT TO ABSOLUTE VALUE BY(80 - EXPONENT)
	SBC TEMP_13	FA7A	E5 56	
	STA R0_2	FA7C	85 12	
	CMP #\$10	FA7E	C9 10	IS EXPONENT PART IS 2 DIGIT?
	BCS L10	FA80	B0 0F	SET ABSOLUTE EXPONENT R0 TO MANTISSA UPPER.
	ASL R0_2	FA82	06 12	IF EXPONENT PART IS 1 DIGIT, SHIFT 4 BIT
	ASL R0_2	FA84	06 12	
	ASL R0_2	FA86	06 12	
	ASL R0_2	FA88	06 12	
	LDX #\$81	FA8A	A2 81	MANTISSA IS MINUS, EXPONENT IS 1 DIGIT.
	STX R0_3	FA8C	86 13	
	JMP L06	FA8E	4C 74 F9	
%				
L10	LDX #\$82	FA91	A2 82	MANTISSA IS MINUS, EXPONENT IS 2 DIGITS.
	STX R0_3	FA93	86 13	
	JMP L06	FA95	4C 74 F9	
%				
L08	STA R0_2	FA98	85 12	WHEN EXPONENT PART IS PLUS,
	CMP #\$10	FA9A	C9 10	
	BCS L11	FA9C	B0 0F	
	ASL R0_2	FA9E	06 12	
	ASL R0_2	FAA0	06 12	
	ASL R0_2	FAA2	06 12	

```

        ASL R0_2          FAA4 06 12
        LDX #$01          FAA6 A2 01      MANTISSA IS PLUS, EXPONENT IS 1 DIGIT.
        STX R0_3          FAA8 86 13
        JMP L06           FAAA 4C 74 F9

%
L11      LDX #$02          FAAD A2 02      MANTISSA IS PLUS, EXPONENT IS 2 DIGITS.
        STX R0_3          FAAF 86 13
        JMP L06           FAB1 4C 74 F9

%
%-----
% EXPONENTIATION FUNCTION.      R0 = R0 ^ R1 = EXP(R1 * LN(R0))
%-----
FUNCTION_PWR1 JSR FUNC_1      FAB4 20 96 F3
        JSR PWR_1           FAB7 20 C0 FA
        JSR FUNC_2          FABA 20 8E F3
        JMP FUNC_RETURN     FABD 4C 57 F4

%
%-----
PWR_1      JSR LN_1          FAC0 20 81 F8      R0 = LN(R0).
        LDX #$74           FAC3 A2 74
        LDY #$14           FAC5 A0 14
        JSR MOV_FP_REG      FAC7 20 39 EA      MOVE R9 TO R1.
        JSR MUL_FLOAT_1     FACA 20 D9 EC      R0 = R1 * R0.
        JSR NORMALISE_1     FACD 20 D0 E2
        JSR EXP_1           FAD0 20 70 F7      R0 = EXP(R1 * LN(R0)).
        RTS                FAD3 60

%
%-----
% HYPERBOLIC SINE FUNCTION.      SINH(X) = 0.5 * (EXP(X) - EXP(-X)).
%-----
FUNCTION_HSIN JSR FUNC_1      FAD4 20 96 F3
        JSR HSIN_1          FAD7 20 E0 FA
        JSR FUNC_2          FADA 20 8E F3
        JMP FUNC_RETRUN     FADD 4C 57 F4

%
%-----
HSIN_1      LDX #$10          FAE0 A2 10
        LDY #$6C           FAE2 A0 6C
        JSR MOV_FP_REG      FAE4 20 39 EA      MOVE ARGUMENT X,R0 TO R7.
        JSR EXP_1           FAE7 20 70 F7      R0 = EXP(X).
        LDX #$10           FAEA A2 10
        LDY #$68           FAEC A0 68
        JSR MOV_FP_REG      FAEE 20 39 EA      MOVE R0 TO R6.
        LDX #$6C           FAF1 A2 6C
        LDY #$10           FAF3 A0 10
        JSR MOV_FP_REG      FAF5 20 39 EA      MOVE ARGUMENT X,R7 TO R0.
        LDA R0_3           FAF8 A5 13
        EOR #$80           FAFA 49 80      INVERT SIGN OF MANTISSA.
        STA R0_3           FAFC 85 13
        JSR EXP_1           FAFE 20 70 F7      R0 = EXP(-X).
        LDX #$68           FB01 A2 68
        LDY #$14           FB03 A0 14
        JSR MOV_FP_REG      FB05 20 39 EA      MOVE R6 TO R1.
        JSR SUB_FLOAT_2     FB08 20 CF EC      R0 = EXP(X) - EXP(-X).
        JSR NORMALISE_1     FB0B 20 D0 E2
        LDA #$00           FB0E A9 00      SET 0.5 TO R1
        STA R1_0           FB10 85 14
        STA R1_1           FB12 85 15
        STA R1_3           FB14 85 17
        LDA #$50           FB16 A9 50
        STA R1_2           FB18 85 16
        JSR MUL_FLOAT_2     FB1A 20 D9 EC      R0 = 0.5 * (EXP(X) - EXP(-X)).
        JSR NORMALISE_1     FB1D 20 D0 E2
        RTS                FB20 60

%
%-----
FUNCTION_HCOS JSR FUNC_1      FB21 20 96 F3
        JSR HCOS_1          FB24 20 2D FB
        JSR FUNC_2          FB27 20 8E F3
        JMP FUNC_RETURN     FB2A 4C 57 F4

%
%-----

```


% HYPERBOLIC COSINE FUNCTION.

COSH(X) = 0.5 * (EXP(X) + EXP(-X)).

```

%-----
HCOS_1      LDX  #$10          FB2D  A2 10
            LDY  #$6C          FB2F  A0 6C
            JSR  MOV_FP_REG    FB31  20 39 EA      MOVE ARGUMENT X,R0 TO R7.
            JSR  EXP_1         FB34  20 70 F7      R0 = EXP(X).
            LDX  #$10          FB37  A2 10
            LDY  #$68          FB39  A0 68
            JSR  MOV_FP_REG    FB3B  20 39 EA      MOVE R0 TO R6.
            LDX  #$6C          FB3E  A2 6C
            LDY  #$10          FB40  A0 10
            JSR  MOV_FP_REG    FB42  20 39 EA      MOVE ARGUMENT X,R7 TO R0.
            LDA  R0_3          FB45  A5 13
            EOR  #$80          FB47  49 80          INVERT SIGN OF MANTISSA.
            STA  R0_3          FB49  85 13
            JSR  EXP_1         FB4B  20 70 F7      R0 = EXP(-X).
            LDX  #$68          FB4E  A2 68
            LDY  #$14          FB50  A0 14
            JSR  MOV_FP_REG    FB52  20 39 EA      MOVE R6 TO R1.
            JSR  ADD_FLOAT_2    FB55  20 C5 EC      R0 = EXP(X) + EXP(-X).
            JSR  NORMALISE_1    FB58  20 D0 E2
            LDA  #$00          FB5B  A9 00          SET 0.5 TO R1
            STA  R1_0          FB5D  85 14
            STA  R1_1          FB5F  85 15
            STA  R1_3          FB61  85 17
            LDA  #$50          FB63  A9 50
            STA  R1_2          FB65  85 16
            JSR  MUL_FLOAT_2    FB67  20 D9 EC      R0 = 0.5 * (EXP(X) + EXP(-X)).
            JSR  NORMALISE_1    FB6A  20 D0 E2
            RTS                FB6D  60

```

%

%-----
% HYPABOLIC TANGENT FUNCTION.

TANH(X) = SINH(X) / COSH(X).

```

%-----
FUNCTION_HTAN JSR  FUNC_1      FB6E  20 96 F3
              JSR  HTAN_1      FB71  20 7A FB
              JSR  FUNC_2      FB74  20 8E F3
              JMP  FUNC_RETURN  FB77  4C 57 F4

```

%

```

%-----
HTAN_1      LDX  #$10          FB7A  A2 10
            LDY  #$7C          FB7C  A0 7C
            JSR  MOV_FP_REG    FB7E  20 39 EA      MOVE ARGUMENT X,R0 TO R11.
            JSR  HSIN_1        FB81  20 E0 FA      R0 = SINH(X).
            LDX  #$10          FB84  A2 10
            LDY  #$64          FB86  A0 64
            JSR  MOV_FP_REG    FB88  20 39 EA      MOVE R0 TO R5.
            LDX  #$7C          FB8B  A2 7C
            LDY  #$10          FB8D  A0 10
            JSR  MOV_FP_REG    FB8F  20 39 EA      MOVE ARGUMENT X,R11 TO R0.
            JSR  HCOS_1        FB92  20 2D FB      R0 = COSH(X).
            LDX  #$64          FB95  A2 64
            LDY  #$14          FB97  A0 14
            JSR  MOV_FP_REG    FB99  20 39 EA      MOVE R5 TO R1.
            JSR  DIV_FLOAT_1    FB9C  20 E3 EC      R0 = SINH(X) / COSH(X).
            JSR  NORMALISE_1    FB9F  20 D0 E2
            RTS                FBA2  60

```

%

%-----
% PATCH FOR EXPONENTIAL FUNCTION.

% SWITCH THE TABLE BY THE SIGN OF THE ARGUMENT.

```

%-----
EXP_PATCH_1  LDA  R8_3          FBA3  A5 73
            BMI  L07            FBA5  30 04          IF MANTISSA SIGN IS MINUS, BRANCH
            LDA  #$C8          FBA7  A9 C8          IF MANTISSA SIGN IS PLUS,
            BNE  L08            FBA9  D0 02          SET $FFC8 TO TABLE HEAD ADDRESS.
L07          LDA  #$40          FBAB  A9 40          IF MANTISSA SIGN IS MINUS,
L08          STA  P6            FBAD  85 80          SET $FF40 TO TABLE HEAD ADDRESS.
            JMP  EXP_PATCH_1R  FBAF  4C 2F F8

```

%

%-----
% PATCH FOR EXPONENTIAL FUNCTION.

% OVERFLOW HANDLING WHEN ARGUMENTS ARE POSITIVE AND NEGATIVE.

```

%-----
EXP_PATCH_2  BPL  L01          FBB2  10 03          POSITIVE OVERFLOW IF X > K(0).
              JMP  ERROR_PROC  FBB4  4C B4 FB
L01           LDX  #$70         FBB7  A2 70
              LDY  #$10         FBB9  A0 10
              JSR  MOV_FP_REG   FBBB  20 39 EA          MOVE X,R8 TO R0.
              LDA  #$40         FBBE  A9 40
              STA  P6           FBC0  85 80          SET TABLE HEAD ADDRESS $FF40 TO P6.
              LDA  #$00         FBC2  A9 00          INDEX = 0.
              LDX  #$14         FBC4  A2 14
              JSR  LOAD_TABLE_1 FBC6  20 C7 F1          LOAD NEGATIVE OVERFLOW JUDGEMENT VALUE C1.
              JSR  SUB_FLOAT_2  FBC9  20 CF EC          C1 - X
              LDA  R0_3         FBCC  A5 13
              BMI  L09          FBCE  30 0B
              LDA  #$00         FBD0  A9 00          IF X < C1, RESULT IS ZERO.
              STA  R0_0         FBD2  85 10
              STA  R0_1         FBD4  85 11
              STA  R0_2         FBD6  85 12
              STA  R0_3         FBD8  85 13
              RTS              FBDA  60

%
L09           JMP  EXP_PATCH_2R FBDB  4C F1 F7
%
%-----

```

% PATCH FOR SQUARE ROOT FUNCTION.

% SAVE R1, AND MAKE IT TO EXECUTE INDIVIDUAL.

```

%-----
FUNCTION_SQRT JSR  FUNC_1       FBDE  20 96 F3
              JSR  SQRT_1       FBE1  20 FF F0
              JSR  FUNC_2       FBE4  20 8E F3
              JMP  FUNC_RETURN   FBE7  4C 57 F4
%
%-----

```

% ABSOLUTE VALUE FUNCTION.

```

%-----
FUNCTION_ABS  JSR  FUNC_1       FBEA  20 96 F3
              JSR  ABS_1        FBED  20 F6 FB
              JSR  FUNC_2       FBF0  20 8E F3
              JMP  FUNC_RETURN   FBF3  4C 57 F4
%
%-----

```

```

ABS_1         LDA  R0_3         FBF6  A5 13
              AND  #$7F         FBF8  29 7F
              STA  R0_3         FBFA  85 13
              RTS              FBFC  60
%
%-----

```

% INTEGER VALUE FUNCTION

```

%-----
FUNCTION_INT  JSR  FUNC_1       FBFD  20 96 F3
              JSR  INT_1        FC00  20 09 FC
              JSR  FUNC_2       FC03  20 8E F3
              JMP  FUNC_RETURN   FC06  4C 57 F4
%
%-----

```

```

INT_1         LDA  R0_3         FC09  A5 13
              AND  #$7F         FC0B  29 7F
              BEQ  L03          FC0D  F0 04          IF EXPONENT PART = 0, BRANCH.
              CMP  #$40         FC0F  C9 40
              BCC  L01          FC11  90 0B          IF EXPONENT PART <= 39, BRANCH.
L03           LDA  #$00         FC13  A9 00
              STA  R0_2         FC15  85 12          SET 0 TO R0.
              STA  R0_1         FC17  85 11
              STA  R0_0         FC19  85 10
              NOP              FC1B  EA
              NOP              FC1C  EA
              RTS              FC1D  60
%
%-----

```

```

L01           CMP  #$01         FC1E  C9 01          WHEN EXPONENT PART = 1,
              BNE  L02         FC20  D0 0D          SET 0 TO LOWER 5 DIGIT.
              LDA  R0_2         FC22  A5 12
%
%-----

```

	AND	#\$F0	FC24	29	F0	
	STA	R0_2	FC26	85	12	
L05	LDA	#\$00	FC28	A9	00	
	STA	R0_1	FC2A	85	11	
	STA	R0_0	FC2C	85	10	
	RTS		FC2E	60		
%						
L02	CMP	#\$02	FC2F	C9	02	WHEN EXPONENT PART = 2,
	BNE	L04	FC31	D0	03	SET 0 TO LOWER 4 DIGIT.
	CLC		FC33	18		
	BCC	L05	FC34	90	F2	
%						
L04	CMP	#\$03	FC36	C9	03	WHEN EXPONENT PART = 3,
	BNE	L06	FC38	D0	0B	SET 0 TO LOWER 3 DIGIT.
	LDA	R0_1	FC3A	A5	11	
	AND	#\$F0	FC3C	29	F0	
	STA	R0_1	FC3E	85	11	
L08	LDA	#\$00	FC40	A9	00	
	STA	R0_0	FC42	85	10	
	RTS		FC44	60		
%						
L06	CMP	#\$04	FC45	C9	04	WHEN EXPONENT PART = 4,
	BNE	L07	FC47	D0	03	SET 0 TO LOWER 2 DIGIT.
	CLC		FC49	18		
	BCC	L08	FC4A	90	F4	
%						
L07	CMP	#\$05	FC4C	C9	05	WHEN EXPONENT PART = 5,
	BNE	L09	FC4E	D0	06	SET 0 TO LOWER 1 DIGIT.
	LDA	R0_0	FC50	A5	10	OTHERWISE, NOTHING WILL BE DONE.
	AND	#\$F0	FC52	29	F0	
	STA	R0_0	FC54	85	10	
L09	RTS		FC56	60		

```
% PATCH TO PREVENT OUTPUT SPACE CODE IN FORMAT ;;      (V.1.3.1  AUG/06/2022)
%-----
ENDLINE_PR_5AJSR  DISP_BUFFER_2  FC57    20 E6 ED      DISPLAY BUFFER WITH NO SPACE CODE
                JMP  ENDLINE_PROC 5  FC5A    4C AB F0
```

----- TABLES -----

----- MACLAURIN SERIES COEFFICIENT OF LN FUNCTION -----

FE80	22 22 22 00	0	2.22222E-1 (2/9)
FE84	14 57 28 00	1	2.85714E-1 (2/7)
FE88	00 00 40 00	2	4.00000E-1 (2/5)
FE8C	67 66 66 00	3	6.66667E-1 (2/3)
FE90	00 00 20 01	4	2.00000E0 (2/1)
FE94	00 00 10 01	5	1.00000E0 (1)

----- DECOMPOSITION CONSTANT OF LN FUNCTION -----

.ORIGIN \$FE98		INDEX	DECIMAL VALUE
FE98	59 02 23 01	6	2.30259E0 (LN(10))
FE9C	00 00 00 00	7	0 (LN(1))
FEA0	47 31 69 00	8	6.93147E-1 (LN(2))
FEA4	29 86 13 01	9	1.38629E0 (LN(4))
FEA8	44 79 20 01	10	2.07944E0 (LN(8))
FEAC	00 00 50 00	11	0.5 (1/2)
EFB0	00 00 25 00	12	0.25 (1/4)
FEB4	00 50 12 00	13	0.125 (1/8)

```
%----- BISECTION METHOD COMPARISON VALUES OF ATAN FUNCTION -----
%
%
```

	.ORIGIN	\$FF00		
%				
%			INDEX	DECIMAL VALUE

FF00	98 53 78 00	0	7.85398E-1 (PI/4)
FF04	99 26 39 00	1	3.92699E-1 (PI/8)
FF08	50 63 19 00	2	1.96350E-1 (PI/16)
FF0C	48 17 98 79	3	9.81748E-2 (PI/32)
FF10	74 08 49 79	4	4.90874E-2 (PI/64)
FF14	37 54 24 79	5	2.45437E-2 (PI/128)
FF18	18 27 12 79	6	1.22718E-2 (PI/256)
FF1C	92 35 61 78	7	6.13592E-3 (PI/512)
FF20	96 67 30 78	8	3.06796E-3 (PI/1024)
FF24	98 33 15 78	9	1.53398E-3 (PI/2^11)
FF28	90 69 76 77	10	7.66990E-4 (PI/2^12)
FF2C	95 34 38 77	11	3.83495E-4 (PI/2^13)
FF30	48 17 19 77	12	1.91748E-4 (PI/2^14)
FF34	38 87 95 76	13	9.58738E-5 (PI/2^15)
FF38	69 93 47 76	14	4.79369E-5 (PI/2^16)
FF3C	84 96 23 76	15	2.39684E-5 (PI/2^17)

%----- ARGUMENT DECOMPOSITION CONSTANT OF EXP FUNCTION -----
%

.ORIGIN \$FF40

		INDEX	DECIMAL VALUE
FF40	34 10 92 82	0	-92.1034 (EXP=-9.99999E39)
FF44	81 03 16 53	1	1.60381E-28 (EXP(-64))
FF48	42 66 12 67	2	1.26642E-14 (EXP(-32))
FF4C	35 25 11 74	3	1.12535E-7 (EXP(-16))
FF50	63 54 33 77	4	3.35463E-4 (EXP(-8))
FF54	56 31 18 79	5	1.83156E-2 (EXP(-4))
FF58	35 53 13 00	6	1.35335E-1 (EXP(-2))
FF5C	79 78 36 00	7	3.67879E-1 (EXP(-1))

%----- BISECTION METHOD COMPARISON VALUES OF ATAN FUNCTION -----
%

.ORIGIN \$FF78

FF78	80 70 15 01	30	1.57080 (PI/2)
FF7C	00 00 10 01	31	1.00000

%----- MACLAURIN SERIES COEFFICIENT OF SIN FUNCTION -----
%

.ORIGIN \$FF80

		INDEX	DECIMAL VALUE
FF80	73 55 27 75	0	2.75573E-6
FF84	13 84 19 77	1	1.98413E-4
FF88	33 33 83 78	2	8.33333E-3
FF8C	67 66 16 00	3	1.66667E-1
FF90	00 00 10 01	4	1E0
FF94	19 83 62 01	5	6.28319 (2*PI)
FF98	39 12 47 01	6	4.71239 (1.5*PI)
FF9C	59 41 31 01	7	3.14159 (PI)
FFA0	80 70 15 01	8	1.57080 (0.5*PI)

%----- MACLAURIN SERIES COEFFICIENT OF EXP FUNCTION -----
%

.ORIGIN \$FFA4

		INDEX	DECIMAL VALUE
FFA4	73 55 27 75	0	2.75573E-6 (1/9!)
FFA8	16 80 24 76	1	2.48016E-5 (1/8!)
FFAC	13 84 19 77	2	1.98413E-4 (1/7!)
FFB0	89 88 13 78	3	1.38889E-3 (1/6!)
FFB4	33 33 83 78	4	8.33333E-3 (1/5!)
FFB8	67 66 41 79	5	4.16667E-2 (1/4!)
FFBC	67 66 16 00	6	1.66667E-1 (1/3!)
FFC0	00 00 50 00	7	0.5 (1/2!)
FFC4	00 00 10 01	8	1.0 (1/1!)

%----- DECOMPOSITION CONSTANT OF EXP FUNCTION -----
%

.ORIGIN \$FFC8

		INDEX	DECIMAL VALUE
FFC8	84 32 89 02	0	89.3284 (EXP=6.23485E38)
FFCC	15 35 62 28	1	6.23515E27 (EXP(64))
FFD0	30 96 78 14	2	7.89630E13 (EXP(32))

FFD4	11 86 88 07	3	8.88611E6	(EXP(16))
FFD8	96 80 29 04	4	2.98096E3	(EXP(8))
FFDC	82 59 54 02	5	5.45982E1	(EXP(4))
FFE0	06 89 73 01	6	7.38906E0	(EXP(2))
FFE4	28 18 27 01	7	2.71828E0	(EXP(1))

%

% END OF PROGRAM

%-----

%-----

% 2023/04/20