Z501/1

THE ENGLISH ELECTRIC CO., LTD.

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Report No. NS t 212

Date 11.12.57.

DEUCE Subroutine Nos. 236-239 (A13F, A14F, A15F, A16F).

Reference

Order No. J.P. O'Brien,

Report by R.A. Smith.

Front Sheet.

Data Sheets 1-2

Figure Sheets S6/11106-7.

SUMMARY.

The attached document contains details of a DEUCE Subroutine which has been prepared and tested at N.R.L. Blackheath.

R.A. Smith.

MATHEMATICS DEPARTMENT.

HEF

Description.

A number $a \times 2^b$ is in standard floating binary (s.f.b.) if a=b=0 or if b is an integer $(-2^{31} \leqslant b < 2^{31})$ and $-\frac{1}{2} > a \geqslant -1$ or $\frac{1}{2} \leqslant a < 1$. b is always stored in an even m.c. and a in the following odd m.c. to 30 b.p.

These routines do arithmetical operations on s.f.b. numbers
A13F does ADD, SUBTRACT, MULTIPLY AND PREPARE.
A14F does ADD, SUBTRACT, MULTIPLY, DIVIDE AND PREPARE.
A15F does ADD, SUBTRACT, MULTIPLY, DIVIDE, SQUARE ROOT AND PREPARE.
A16F does ADD, SUBTRACT, MULTIPLY, DIVIDE, SQUARE ROOT, SUM SERIES, AND PREPARE.

A13F is part of A14F, which is part of A15F, which is part of A16F.
PREPARE, which is used (automatically) after each floating operation, takes a double length number of p binary places in DS21 (and $\overline{62-p}\ P_1$ in TS13) & puts it into s.f.b. To put a single length number of p b.p. into s.f.b. put the number in 21_3, $\overline{30-p}\ P_1$ in 13 and enter PREPARE at 2_{21}.

All subroutines under the headings A01F, A02F and A03F are superceded by these routines, since they use fewer instructions.

All are zero order, except SUM SERIES which is First Order.

(These routines may fail without warning if $|b_1 - b_2| >$ about 2^{15}.

Data.

$x = a_1 2^{b_1}$, $y = a_2 2^{b_2}$ for ADD, SUBTRACT, MULTIPLY, DIVIDE; $x = a.2^b$ for SQUARE ROOT; $x = a2$ and coeffs. $k_0, k_1, \ldots k_n$ in D.L.A. m.c.'s 0 to 2n+1 $(n \leqslant 15)$ for SUM SERIES: all numbers in s.f.b.

Result.

$c = a_3\, 2^{b_3}$ in s.f.b.
where $c = x \pm y,\ xy,\ {}^x/y,\ \sqrt{x}$ or $\sum_{i=0}^{n} k_i x^i$.

Failures.

3, 14-28 if y=0 in DIVISION. Force discrim. to continue.

4, 15-27 if x<0 in SQUARE ROOT. Give 5 single shots with discrim. key OFF and machine on STOP to continue.

NOTE: Cards exist for A15F & A16F in position 7 i.e. with add subtract mult & divide in DL's 7 & 8 & the extra instns. for square root & sum series in DL 6, entry to square root & sum series being 6_0 & 6_{25} respectively.

Instructions for Use. ADD, SUBTRACT, MULT. DIVIDE AND SQ. ROOT.

Stores Used.	13	14	15	16	19_2	20*	21
Contents at Entry.	-	-	-	-	LINK	y	x
Contents at Exit.	-	-	-	-	LINK	y	c

SUM SERIES.

Stores Used.	13	14	15	16	19_2	19_3	20	21	$17_{0,1}$
Contents at Entry.	-	-	-	-	LINK	B	-	-	x
Contents at Exit.	-	-	-	-	LINK	~~B~~ -	-	c	x

* Not required by SQUARE ROOT.

Occupies.

A13F D.L. $2_{0,2,3,5,6,8-14,16-25,27-31}$, $3_{0-11,13-22,25-29}$.
A14F D.L.'s 2, 3.
A15F D.L.'s 2,3,$4_{0-4, 6, 8-19, 21, 22}$.
A16F D.L.'s 2,3,4 (except 4_7 and 4_{28})
Cards exist for all D.L.'s.

Entry.

2_{31} ADD; 2_{27} SUBTRACT; 2_{25} MULTIPLY; 2_{26} DIVIDE.
4_0 SQUARE ROOT; 4_{25} SUM SERIES.
3_{25} PREPARE (Double length No.), 2_{21} PREPARE (single length No.)

Times.

ADD/SUBTRACT: 2+P m.s. if $b_1 = b_2$
5+P m.s. if $|b_1 - b_2| \leq 16$.
7+P m.s. if $16 < |b_1 - b_2| < 32$
4+P m.s. if $|b_1 - b_2| \geq 32$
average about 7 m.s.

MULT: 5 or 6 m.s., average $5\frac{1}{2}$ m.s.
DIVIDE: 4 or 5 m.s., average $4\frac{1}{2}$ m.s.
SQ. ROOT. 11 or 13 m.s. average 12 m.s.
SUM SERIES. roughly 15n + 10 m.s.

P is the shift in PREPARE to bring leading digit of a_3 to the P_{31} position.

NOTE: 1 m.s. can be saved in ADD/SUBTRACT by replacing 3_{26} by 2, D-25, 0, 0 and having $31P_1$ in D_{28} (e.g. 4_{28}). If this is done +, -, x, ÷ and $\sqrt{}$ are at least as fast, on average as earlier routines.

Parameter. B for SUM SERIES is 4, A-20d, 2n-1, 26.

Constants Available.

0, 19-0, 0, 0 in 3_{28} and 4_{29}.
0, 13-0, 0, 0 in 2_{18}.
$-P_3$ in 3_8.

NOTE: MULT. cannot be expected to give the right answer if it is one-shotted through.

DEUCE Subroutine No. 236-239 (A13F, A14F, A15F, A16F).

Floating Arithmetic.

A13F and A14F

D.L. 2. Track

Card Nos.

mc	NIS	S	D	C	W	T
0	2	16	27		0	0
1	2	24	16		0	1
2	3	30	13		0	1
3	3	21	13		0	0
4	2	21	13		0	1
5	2	21	22	d	1	17
6	3	3	15		0	3
7	3	1	24		0	4
8	2	13	14		0	0
9	2	21	14		0	0
10	2	24	26		0	0
11	2	15	21		0	0
12	2	15	14		0	0
13	3	21	15		1	1
14	3	20	15		0	0
15	2	16	21		0	4
16	2	3	25		0	0
17	2	14	21		0	4
18	0	13	0		0	0
19	2	26	28		0	0
20	3	21	22	l	0	3
21	3	30	21		1	2
22	3	13	21		0	4
23	3	15	13		0	0
24	3	27	26		0	3
25	3	20	16		0	0
26	3	21	28		2	2
27	2	30	13		0	0
28	3	13	25	l	0	16
29	3	20	26		0	1
30	2	30	21		0	0
31	3	20	15		0	1

remove marked instructions for A13F

A13F + A14F

D.L. 3. Track

Card Nos.

mc	NIS	S	D	C	W	T
0	3	13	15		0	0
1	3	24	15		0	0
2	3	20	13		0	0
3	2	26	27		0	0
4	3	21	26		0	0
5	3	0	24		0	0
6	2	13	27		0	0
7	3	21	25		1	0
8		—P3				
9	3	13	23		30	31
10	3	14	13		0	5
11	3	22	23		0	0
12	2	21	16		0	1
13	3	27	25		0	0
14	2	13	27		0	0
15	2	24	14	d	0	2
16	3	30	21		0	
17	2	20	25		1	1
18	3	22	21	l	2 (15,	30
19	3	13	28		0	0
20	3	22	21	3	31	31
21	2	14	22		0	0
22	3	14	28		0	1
23	3	14	28		0	30
24	3	20	26		0	4
25	3	21	28	d	0	1
26	2	27	25	l	2	0
27	2	21	14		1	1
28	0	19	0		0	0
29	3	21	14		0	2
30	3	4	24		12	12
31	2	20	14		0	0

remove marked instructions for A13F

A15F + A16F

D.L. 4. Track

Card Nos.

mc	NIS	S	D	C	W	T	
							Y
							X
							0
							1
0	4	21	14		0	0	2
1	4	15	21		0	0	3
2	4	27	15		0	0	4
3	4	1	24		0	13	5
4	4	3	13		2	3	6
5	4	28	26	d	0	16	7
6	4	16	22		0	0	8
7							9
8	4	22	16		10	0	Y
9	4	21	28		1	0	X
10	4	13	28		0	1	0
11	3	30	21		1	15	1
12	4	25	28		0	1	2
13	2	23	13		0	0	3
14	4	13	25	l	3	17	4
15	4	22	23		0	31	5
16	4	21	15		1	1	6
17	4	4	24		19	19	7
18	4	15	21		0	29	8
19	4	4	22		0	1	9
20	2	4	19		2	3	Y
21		46	23,30,8,1,23,14				X
22	4	21	16		1	9	0
23	4	13	19		0	4	1
24	4	19	13		1	5	2
25	4	19	1		3	4	3
26	2	1	19		2	3	4
27	2	4	19		1	2	5
28							6
29	0	19	0		0	0	7
30	4	17	20	d	0	20	8
31	4	30	21	d	0	28	9

remove marked instructions for A15F (in both subs. I.L's 2 & 3 are complete)

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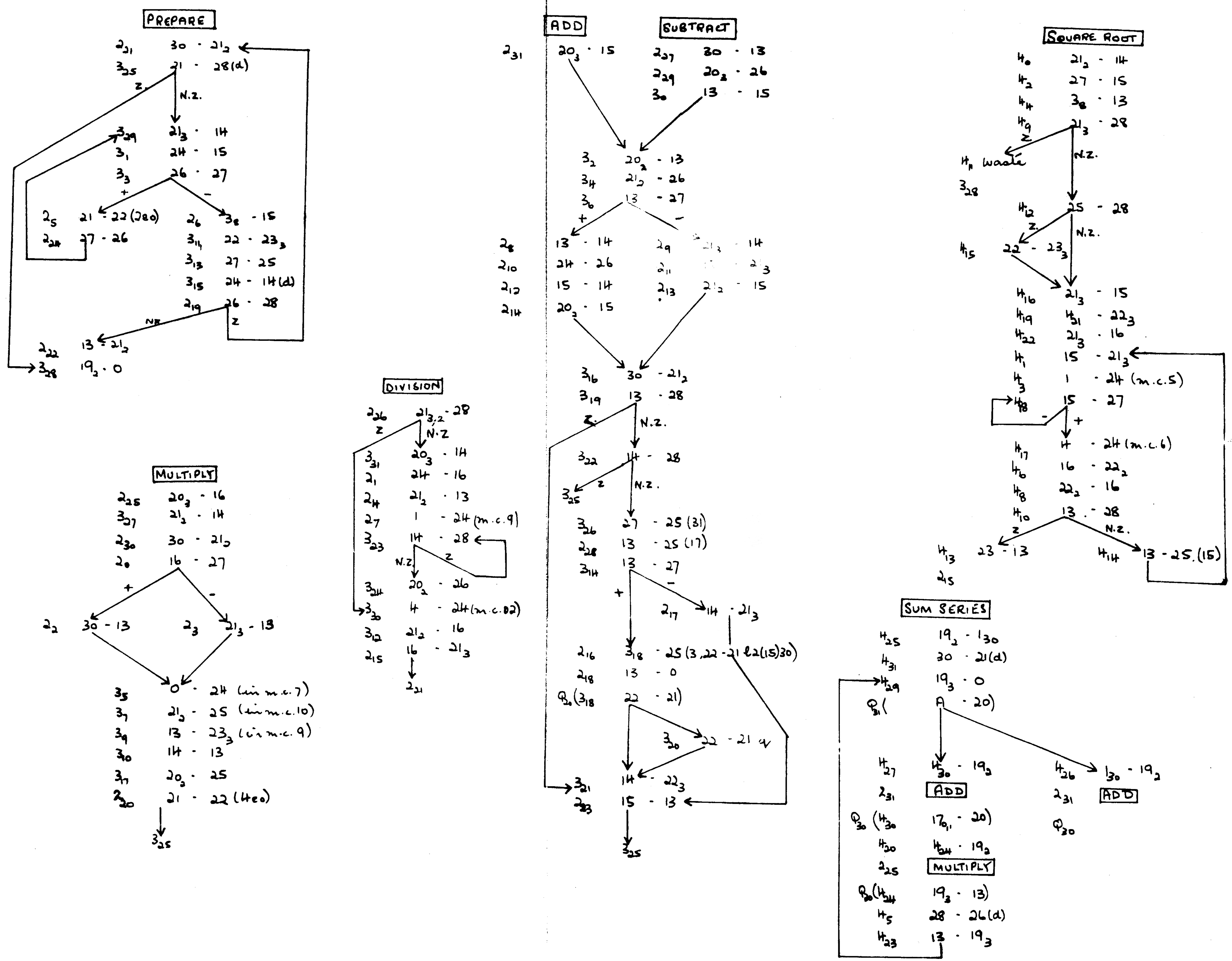

Date

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Floating Arithmetic.

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