S.R.43

THE ENGLISH ELECTRIC CO., LTD.

NELSON RESEARCH LABORATORIES
STAFFORD
MATHEMATICAL PHYSICS LABORATORY.

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Report No. NS t 118
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Reference
Order No.

Front Sheet.

Data sheets 1.

Fig. sheets. S6/10442.

DEUCE Subroutine No.128 (T11)

Report by
T.D. Westrup.

SUMMARY.

The attached report gives details of a DEUCE Subroutine for calculating $\sinh^{-1}x$ or $\cosh^{-1}x$ to 26 b.p., given x to p binary places.

The subroutine was prepared, tested, copied into all instruction delay lines and checked in each at N.R.L., Blackheath.

c. Robin

MATHEMATICAL PHYSICS LABORATORY.

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NELSON RESEARCH LABORATORIES NS t 118.
STAFFORD E. E. CO. LTD. Sheet No.: 1.

Description.	Fourth order subroutine, using an economised power series to compute $\sinh^{-1}x$ or $\cosh^{-1}x$ to 26 b.p.
Data.	x to p binary places. $(0 \leqslant p \leqslant 31)$.
Uses.	E06 (99) (DLA, 0-31) S06 (15) (DLB,0-9, 11, 18, 23, 26). M12 (14) (DLB, 12-17, 19-22, 24, 25, 27). Coeffts. a_r $(r = 0, 1,\ldots,8)$ stored in DLC m.c.s. t,t+1,.. t+8. F02 (43) (DLD, 1-25, 28, 29, 31.)
Result.	$y = \sinh^{-1}x$ ir $\cosh^{-1}x$ to 26 b.p.
Failure.	Failure indication for $\sinh^{-1}x$, if $(x^2 + 1)\ 2^{2p} \geqslant 2^{62}$, and for $\cosh^{-1}x$, if $x < 1$. Failure is either A 7-24 or D 7-24.
Coefficients.	in C_t to C_{t+8} as for E06 (99).

Instructions for Use.

Stores used.	13	14	15	16	21_2	21_3
Contents at entry.	Link	x	–	–	–	–
Contents at exit.	–	$y \log_2 e$ (26 b.p.)	zero	$\log_e 2$ (30 b.p.)	–	y

Occupies.	m.c.s. 9-31 of D.L.E.
Entry.	m.c. 28 for $\sinh^{-1}$ m.c. 29 for $\cosh^{-1}$.
Time.	28 m.s. + time for E06.
Parameters.	DLE m.c. 22 add AP_2 m.c.'s 10 and 27 add BP_2 m.c. 24 add DP_2 m.c.'s 20,21 put 2^{2p} (double-length). others as for E06 (99); q = 31-p.
Constants available	$\log_e 2$ to 30 b.p. in m.c. 11 of DLE. others as for E06 (99) and F02 (43)
Waste Instruction.	m.c.12 of DLE contains (1 0-0 0 1), obeyed in 1_{30}, leading to link.

March, 1956.

D.L. 2 Track

Card Nos.

mc	NIS	S	D	C	W	T	
							Y
							X
							0
							1
0							2
1							3
2							4
3							5
4							6
5							7
6							8
7							9
8							Y
9	2	2	16		0	31	X
10	B	2	13		0	0	0
11	F = (30, 15, 1, 2 5, 5, 22·0)						1
12	1	0	0		0	1	2
13	2	23	13		0	1	3
14	2	23	16		0	7	4
15	2	15	28		0	0	5
16	2	16	25		0	1	6
17	2	2	22	2	1	5	7
18	2	2	23	2	0	4	8
19	2	13	14		0	1	9
20		Reserved for 2^{2p}					Y
21		(double length)					X
22	A	2	16		1	5	0
23	2	23	14		0	2	1
24	D	2	13		0	10	2
25	2	21	14		1	7	3
26	2	13	14		0	13	4
27	B	2	13		1	15	5
28	2	30	15		0	1	6
29	2	28	15		0	0	7
30	2	29	22		0	15	8
31	2	13	1		0	13	9

$\boxed{\sinh^{-1} x}$ $\boxed{\cosh^{-1} x}$

2_{28} 30 − 15 2_{29} 28 − 15

2_{31} 13 − 1_1

2_{14} 23 − 16

2_{23} 23 − 14 x to $(p-1)$ b.p.

2_{27} 2_{30} − 13 [2 29 − 22 0 15]

B_{12} $\boxed{\text{M12}}$

$1_{30}(2_{30}$ 29 − $22_2)$ x^2 to $2p$ b.p.

2_{15} 15 − 28

z nz

2_{17} $2_{20,21}$ − $22_{2,3}$ 2_{18} $2_{20,21}$ − $23_{2,3}$ $[2^{2p}]$

$x^2 \pm 1$ to $2p$ b.p.

2_{24} 2_{26} − 13 [2 13 − 14 0 13] Link

D_4 $\boxed{\text{F02}}$

$1_{30}(2_{26}$ 13 − 14) $\sqrt{x^2 \pm 1}$ to p b.p.

2_{13} 23 − 13

2_{16} 16 − 25 $x + \sqrt{x^2 \pm 1}$ to $(p-1)$ b.p.

2_{19} 13 − 14

2_{22} 2_{25} − 16 [2 21 − 14 1 7] Link

A_{29} $\boxed{\text{E06}}$ $q = 31 - p$

$1_0(2_{25}$ 21_3 − 14)

2_9 2_{11} − 16 F = $\log_e 2$ to 30 b.p.

2_{10} 2_{12} − 13 [1 0 − 0 0 1] Link

B_{12} $\boxed{\text{M12}}$

$1_{30}(2_{12}$ 0 − 0) Waste

1_1

NSE 118

FLOW DIAGRAM AND CODING FOR DEUCE

SUBROUTINE [illegible]

Date

File Ref.