ELLIOTT 900

Volume 2: PROGRAMMING INFORMATION

Part 2: PROGRAM DESCRIPTIONS

Section 17: QDASQRT (B. 106A)

Contents

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Chapter 1: INTRODUCTION

1.1 Purpose

To calculate, as a double-length fraction, the square root of a double-length fraction, a.

1.2 Form of Distribution

The program is distributed as a SIR mnemonic tape.

1.3 Method of Use

The routine is assembled as a block of the user's program and entered as a sub-routine. It can be run at any program level and in any store module.

When QDASQRT is used, QDLA must also be held in store.

1.4 Accuracy

The maximum error is 3×2^{-34}. (0.2×10^{-9})

Chapter 2: FUNCTIONS

2.1 Notation

x(m. s) = most significant half of x
x(l. s) = least significant half of x

2.2 Format

A double-length fraction, x, is held in two consecutive locations, X and X+1;

Bit 18 of X+1 must be zero;
Bit 18 of X gives the sign of x;
Bits 17-1 of X give the 17 most significant bits of x.
Bits 17-1 of X+1 give the least significant bits of x.

Negative number representation is by the usual 2's complement notation.

2.3 Entry and Exit

A double-length number is held in two consecutive locations: only the first location is given below.

Entry

place a in QDASQRT+44
and enter 11QDASQRT
8QDASQRT+1

Exit √a in QDASQRT+46

N.B. The instruction pair

11 QDASQRT
8 QDASQRT+1

must not be part of a pseudo-program interpreted by QDLA.

2.4 Identifiers

QDASQRT must be declared as a global identifier in all blocks of a SIR program which refer to it.

Chapter 3: ERROR INDICATION

If $a<0$
then 0000.010 is output continuously.

Chapter 4: METHOD USED

QDASQRT uses QDLA to interpret some of the double-length calculations.

4.1 Special Cases

QDASQRT first tests for special values of the operand. If a is equal to any of these the appropriate answer is read and exit made immediately.

Special values are:

$a = 0$
$a = 1-2^{-34}$

In these cases $\sqrt{a}$ is taken as a

4.2 General Cases

Otherwise QDASQRT uses an iterative formula

taking $n = 0, 1, 2, 3, \ldots$

and $x_0 = 1 - 2^{-34}$

$$x_{n+1} = \tfrac{1}{2}(x_n + a/x_n)$$

When $x_{n+1} \geq x_n$

then x_n is the best approximation to $\sqrt{a}$.

Chapter 5: TIME TAKEN

5.1 Special Cases

$a = 0$ 570 microseconds.

$a = 1-2^{-34}$ 1053 microseconds.

5.2 General Cases

Approximate time taken is

$$3.0 + 12.5\,n \text{ milliseconds}$$

where n is the number of iterations necessary.

Chapter 6: STORE USED

QDASQRT uses 52 consecutive locations.