

# ELLIOTT

# 903

Volume 2: PROGRAMMING INFORMATION  
Part 2: PROGRAM DESCRIPTIONS  
Section 16: QDAATAN (B. 105A)

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## Chapter 1: INTRODUCTION

### 1.1 Purpose

To calculate, as a double-length fraction

$$t = (1/\pi) \tan^{-1} (x/y)$$

and  $b = (1/2\pi)$  true bearing,

where  $x, y$  are double-length fractions.

### 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 QDAATAN is used QDLA must also be held in store.

### 1.4 Accuracy

The maximum error is  $2^{-34}$  ( $0.6 \times 10^{-10}$ )



## Chapter 2: FUNCTIONS

## 2. 1 Notation

$x(\text{m. s.}) = \text{most significant half of } x$

$x(\text{l. s.}) = \text{least significant half of } x$

$x, t$  are as defined in 1. 1

## 2. 2 Format

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

Bit 18 of  $X$  gives the sign of  $x$

Bits 17-1 of  $X$  give the 17 most significant bits of  $x$

Bit 18 of  $X+1$  must be 0

Bits 17-1 of  $X+1$  give the 17 least significant bits of  $x$ .

Negative number representation is by the usual 2's complement notation (except that bit 18 of  $X+1$  must be 0).

## 2. 3 Number Type

All numbers must be treated by the programmer as pure fractions.

To enable this to be done QDAATAN calculates

$$t = (1/\pi) \tan^{-1} (x/y)$$

Note, therefore, that  $t$  is the value of an angle as a fraction of  $\pi$  radians ( $180^\circ$ ).

## 2. 4 Entry and Exit

A double-length number occupies two consecutive locations; only the first is given below.

Entry (for assembly by SIR)

Place  $x$  in QDAATAN+136

y in QDAATAN+138

and enter 11QDAATAN

8QDAATAN+1

Exit

t in QDAATAN+142  
b in QDAATAN+146  
b(m. s.) in the accumulator

Note. The true bearing is found by taking  
x along the easterly axis  
y along the northerly axis  
and measuring the angle in a clockwise direction.

N. B. The instruction pair must not form part of a pseudo-program  
interpreted by QDLA.

### 2. 5 Identifiers

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



Chapter 3: ERROR INDICATION

If  $x=y=0$   
then 00000.001 is output continuously.

Chapter 4: METHOD USED

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

a) The program computes

$$a = \begin{cases} |x/y| & \text{if } |x/y| < 1 \\ |y/x| & \text{if } |x/y| \geq 1 \end{cases}$$

and applies the transformation

$$z = \frac{a - (\sqrt{2} - 1)}{(3 - 2\sqrt{2})a + (\sqrt{2} - 1)}$$

Note  $|z| < 1$

b)  $s = 1/\pi \tan(\sqrt{2}-1)z$   
is calculated by a Chebyshev series.

c) The final result is found by forming

$$u = (1/\pi) \tan^{-1} |x/y| = \begin{cases} \frac{1}{8} + s & \text{for } |x| < |y| \\ \frac{1}{2} - (\frac{1}{8} + s) & \text{for } |x| \geq |y| \end{cases}$$

and  $t$  is found according to the table below

	$y \geq 0$	$y < 0$
$x/y \geq 0$	$u$	$u-1$
$x/y \leq 0$	$1-u$	$-u$

and  $b = \begin{cases} \frac{1}{2}t & \text{if } x \geq 0 \\ \frac{1}{2}t+1 & \text{if } x < 0 \end{cases}$

Chapter 5: TIME TAKEN

Approximately 42.4 milliseconds.

Chapter 6: STORE USED

QDAATAN uses 167 consecutive locations and the appropriate B-register.