

RECOMP II USERS' PROGRAM NO. 1059

PROGRAM TITLE: MODIFIED BESSEL FUNCTION OF THE FIRST KIND
 $I_0(x)$, FLOATING POINT (RELOCATABLE)

PROGRAM CLASSIFICATION: General

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PURPOSE: To compute in floating point the modified
Bessel function $I_0(x)$.

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Program Title: Modified Bessel Function of the First Kind $I_0(x)$, Floating Point (Relocatable)

1. PURPOSE

1.1 To compute in floating point the modified Bessel function $I_0(x)$

2. RESTRICTIONS

2.1 Require AN-044 exponential subroutine.

3. METHOD

3.1 Truncated power series or exponential approximation, depending on size of argument.

3.1.1 $x < 7$:
$$I_0 \approx 1 + \frac{x^2}{2} + \sum_{k=1}^6 \frac{x^{2(k+1)}}{2^k k!}$$

3.1.2 $x \geq 7$:
$$I_0 \approx \frac{e^x}{\sqrt{2\pi x}} \left[1 + \frac{1}{8x} + \frac{G_1}{(8x)^2} + \frac{G_2}{(8x)^3} \right]$$

3.2 Accuracy within $\pm 0.01\%$

3.3 Reference

H. B. Dwight Tables of Integrals and Other Mathematical Data
 MacMillan Co., 1947, Equation 813.1 and 814.1.

4. USAGE

4.1 The magnitude of the argument must be in the A and R register as a positive normalized floating point number. The result is left in the A and R register upon exiting.

4.2 Calling sequences

4.2.1 If AN 044 is located at $(I_0 + 140.0)$

TRA I_0

Return

4.2.2 If AN 044 is elsewhere in memory

SLL

 TRA $(I_0 + 132.0 \text{ octal})$

α

PZE EXP

 $\alpha + 1$ Return

-2-

EXP = first location of AN-044

Io = first location of Io routine.

After you have used 4.2.2 on a run the program can now be entered by 4.2.1.

4.3 Uses locations 0000 - 0136 relocatable. No temporary storage.

4.4 Error Codes

If the limits of AN-044 are exceeded there will be a halt and transfer to (Io + 0043.1). If you press start you will return to the main program.

4.5 Both L and V loops are used by this routine.

5. Coding Information

5.1 Constants (floating point)

	0100	7.0
2 π	0102	6.283185308
	0104	1.0
C ₁	0106	4.0
C ₂	0110	36.0
C ₃	0112	576.0
C ₄	0114	14400.0
C ₅	0116	518400.0
C ₆	0120	23401600.0
	0122	2.0
G ₂	0124	37.5
	0126	8.0
G ₁	0130	4.5

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0000.0 +15.0070.0 SAX
+01.0007.0 ADD

0001.0 +42.0043.1 STA
+43.0000.0 XAR

0002.0 +60.0071.0 STO
+30.0070.0 FCA

0003.0 +06.0100.0 FSB
+52.0044.0 TRP

0004.0 +64.0010.0 CTL
+66.0020.0 CTV

0005.0 +30.0070.0 FCA
+05.0122.0 FDV

0006.0 +35.7774.0 EST
+57.7760.0 TRA

0007.0 +00.0000.0 ---
-00.0000.1 ---

0010.0 +07.7774.0 FMP
+35.7774.0 FST

0011.0 +07.7774.0 FMP
+35.7776.0 EST

0012.0 +05.0106.0 FDV
+04.7772.0 FAD

0013.0 +35.7772.0 FST
+30.7774.0 FCA

0014.0 +07.7776.0 FMP
+35.7776.0 FST

0015.0 +05.0110.0 FDV
+04.7772.0 FAD

0016.0 +35.7772.0 FST
+30.7774.0 FCA

0017.0 +07.7776.0 FMP
+35.7776.0 EST

0020.0 +05.0112.0 FDV
+04.7772.0 FAD

0021.0 +64.0030.0 CTL
+57.7760.0 TRA

0022.0 +00.0000.0 ---
-00.0000.0 ---

0023.0	+00.0000.0	---
	-00.0000.0	---
0024.0	+00.0000.0	---
	-00.0000.0	---
0025.0	+00.0000.0	---
	-00.0000.0	---
0026.0	+00.0000.0	---
	-00.0000.0	---
0027.0	+00.0000.0	---
	-00.0000.0	---
0030.0	+35.7772.0	FST
	+30.7774.0	FCA
0031.0	+07.7776.0	FMP
	+35.7776.0	FST
0032.0	+05.0114.0	FDV
	+04.7772.0	FAD
0033.0	+35.7772.0	FST
	+30.7774.0	FCA
0034.0	+07.7776.0	FMP
	+35.7776.0	FST
0035.0	+05.0116.0	FDV
	+04.7772.0	FAD
0036.0	+35.7772.0	FST
	+30.7774.0	FCA
0037.0	+64.0040.0	CTL
	+57.7760.0	TRA
0040.0	+07.7776.0	FMP
	+35.7776.0	FST
0041.0	+05.0120.0	FDV
	+04.7772.0	FAD
0042.0	+04.0104.0	FAD
	+04.7774.0	FAD
0043.0	+40.0000.0	ARS
	+57.2001.0	TRA
0044.0	+30.0070.0	FCA
	+57.0140.0	TRA
0045.0	+00.7774.0	CLA
	+77.0043.1	HTR
0046.0	+64.0050.0	CTL
	+66.0060.0	CTV

0047.0 +35.7776.0 FST Page 5
+57.7760.0 TRA

0050.0 +30.0102.0 FCA
+07.0070.0 FMP

0051.0 +35.7774.0 FST
+44.7774.0 FSQ

0052.0 +35.7774.0 FST
+30.7776.0 FCA

0053.0 +05.7774.0 FDV
+35.7776.0 FST

0054.0 +30.0104.0 FCA
+05.0126.0 FDV

0055.0 +05.0070.0 FDV
+35.7774.0 FST

0056.0 +07.7774.0 FMP
+35.0076.0 FST

0057.0 +07.0130.0 FMP
+04.7774.0 FAD

0060.0 +35.0074.0 FST
+00.7774.0 CLA

0061.0 +07.0076.0 FMP
+07.0124.0 FMP

0062.0 +04.0074.0 FAD
+04.0104.0 FAD

0063.0 +07.7776.0 FMP
+57.0043.1 TRA

0064.0 +00.0000.0 ---
-00.0000.0 ---

0065.0 +00.0000.0 ---
-00.0000.0 ---

0066.0 +00.0000.0 ---
-00.0000.0 ---

0067.0 +00.0000.0 ---
-00.0000.0 ---

0070.0 +40.0000.0 ARS
-00.0000.0 ---

0071.0 +00.0000.0 ---
-00.0002.0 ---

0072.0 +00.0000.0 ---
-00.0000.0 ---

0073.0	+00.0000.0	---
	-00.0000.0	---
0074.0	+42.2000.0	STA
	-00.0000.0	---
0075.0	-00.0000.0	---
	-00.0002.1	---
0076.0	+40.0000.0	ARS
	-00.0000.0	---
0077.0	-00.0000.0	---
	-00.0005.1	---
0100.0	+70.0000.0	---
	-00.0000.0	---
0101.0	+00.0000.0	---
	-00.0001.1	---
0102.0	+62.2077.0	---
	+52.4240.0	TRP
0103.0	+00.0000.0	---
	-00.0001.1	---
0104.0	+40.0000.0	ARS
	-00.0000.0	---
0105.0	+00.0000.0	---
	-00.0000.1	---
0106.0	+40.0000.0	ARS
	-00.0000.0	---
0107.0	+00.0000.0	---
	-00.0001.1	---
0110.0	+44.0000.0	FSQ
	-00.0000.0	---
0111.0	+00.0000.0	---
	-00.0003.0	---
0112.0	+44.0000.0	FSQ
	-00.0000.0	---
0113.0	+00.0000.0	---
	-00.0005.0	---
0114.0	+70.2000.0	---
	-00.0000.0	---
0115.0	+00.0000.0	---
	-00.0007.0	---
0116.0	+77.2200.0	HTR
	-00.0000.0	---
0117.0	+00.0000.0	---
	-00.0011.1	---

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0120.0 +60.3462.0 STO
-00.0000.0 ---

0121.0 +00.0000.0 ---
-00.0014.1 ---

0122.0 +40.0000.0 ARS
-00.0000.0 ---

0123.0 +00.0000.0 ---
-00.0001.0 ---

0124.0 +45.4000.0 FNM
-00.0000.0 ---

0125.0 +00.0000.0 ---
-00.0003.0 ---

0126.0 +40.0000.0 ARS
-00.0000.0 ---

0127.0 +00.0000.0 ---
-00.0002.0 ---

0130.0 +44.0000.0 FSG
-00.0000.0 ---

0131.0 +00.0000.0 ---
-00.0001.1 ---

0132.0 +15.0070.0 SAX
+42.0134.1 STA

0133.0 +01.0136.0 ADD
+42.0043.1 STA

0134.0 +40.0000.0 ARS
+00.0000.0 CLA

0135.0 +42.0044.1 STA
+57.0001.1 TRA

0136.0 +00.0000.0 ---
-00.0001.0 ---