

UNIVERSITY OF ILLINOIS
DIGITAL COMPUTER

ILLINOIS CODE B2 - 50

TITLE	Complex Number Operations (DOI or SADOI)	
TYPE	Closed	
NUMBER OF WORDS	54	
TEMPORARY STORAGE	0,1,2,3	
ACCURACY	Addition - exact	Division $\pm 2^{-38}$
	Multiplication $\pm 2^{-39}$	Modulus $\pm 2^{-38}$
DURATION	Addition 3 1/2 msec.	Division 11 1/2 msec.
	Multiplication 6 msec.	Modulus 10 msec.
READ AROUND	Negligible	
DESCRIPTION	<p>If modulus is desired a closed square root routine must be used in conjunction with this routine. The address of its first word, j, must be in location 4 in the form $j \times 2^{-39}$ when the complex number routine is read in using the D.O.I.. The Complex Number Routine will perform the operations of the L orders, 66, and 7J orders for complex numbers. It assumes that the real part (RP) and imaginary part (IP) of any complex number are stored in consecutive locations in the memory and reference is made to the address of the real part only. Operands and results must all lie within the unit circle, i.e. for any number involved $(RP)^2 + (IP)^2 < 1$. The negative of the IP of any resultant is left in R_1 so that conjugates may be easily formed by merely storing in the IP location of the resultant.</p>	
ADDITION	Entry to the routine is made as follows:	
	i-1 LA a_1 LB b_1	
	i 50 c_1 50 i	
	i+1 26 n	
	<p>where $a_1, b_1,$ are the addresses of the RP of the operands, c_1 is the address for the RP of the result, i is the sequence number in the main routine, and n is the address of the first word in the Complex Number Routine.</p> <p>A,B = 0,1,...,6 so that the L orders are interpreted in the usual way for real and imaginary parts separately, e.g.</p>	

i-1 L5 a₁ L0 b₁
 i 50 c₁ 50 i
 i+1 26 n

forms $N(a_1) - N(b_1) = N(c_1)$ and $N(a_2) - N(b_2) = N(c_2)$.

MODULUS

L7 is written for both LA and LB using the same address a₁ in each and is interpreted to form

$$a = \sqrt{a_1^2 + b_1^2}$$

and place it in c₁ and 0 in c₂.

MULTIPLICATION

Multiplication is accomplished by entering the routine with the sequence

i-1 50 a₁ 7J b₁
 i 50 c₁ 50 i
 i+1 26 n

The complex product with $RP = a_1 b_1 - a_2 b_2$ and $a_2 b_1 + a_1 b_2$ is placed in c₁ and c₂.

DIVISION

Division is entered similarly except using L5 a₁ 66 b₁ in i-1. This puts $RP = (a_1 b_1 + a_2 b_2) / (b_1^2 + b_2^2)$ in c₁ and $IP = (a_2 b_1 - a_1 b_2) / (b_1^2 + b_2^2)$ in c₂.

RT: 7/12/60

DATE <u>September 26, 1952</u>
CODED BY <u>D. Clutterham</u>
APPROVED BY <u>J.P. Nash</u>

LOCATION	ORDER		NOTES	PAGE 1
0	QOK(B2) 40 F			B2
	S5 F			
1	46 22L L4 52L		Plant c_1	
2	42 24L 46 23L		Plant link Plant c_2	
3	L0 53L 42 4L			
4	41 3F L5 F	By 3'	$NR_1 = (\dots a_1 \dots b_1)$	
5	46 35L 46 32L		Plant a_1 "	
6	46 45L 42 26L		" Plant b_1	
7	42 31L 42 36L		" "	
8	42 43L 42 47L		" "	
9	L4 52L 40 20L		$NR_1 = (\dots a_2 \dots b_2)$	
10	46 30L 46 37L		Plant a_2 "	
11	46 40L 46 43L		" "	
12	42 28L 42 30L		Plant b_2 "	
13	42 35L 42 40L		" "	
14	42 44L 42 49L		" "	
15	00 20F 46 28L		$NR_1 = (\dots b_2 \dots)$ Plant b_2	
16	46 49L L0 52L		" $NR_1 = (\dots b_1 \dots)$	

LOCATION	ORDER		NOTES	PAGE 2 B2
17	46 27L		Plant b_1	
	46 48L		"	
18	36 25L L0 47L		Test for + or (X or +)	
19	32 47L 26 20L		Test for add or modulus	
20	00 F	By 9'	Add	
21	00 F 40 3F L5 F			
22	40 (c_1)F	By 1	Store resultant	
23	L5 3F 40 (c_2)F	By 2	Set-up conjugate	
24	L1 3F 22 24L	By 2	Link	
25	22 ()F L0 26L		Test for X or +	
26	36 40L 74 0F	From 18		
27	50 (b_1)F	By 6		
28	7J (b_1)F	By 17		
29	40 3F 50 (b_2)F	By 15		
30	7J (b_2)F	By 12	a + b	
31	L4 3F 40 3F			
32	50 (a_2)F	By 10		
33	7J (b_2)F 40 0F 50 (b_1)F	By 12 By 7		
32	7J (a_1)F	By 5		
33	26 33L L4 F 66 3F			

LOCATION	ORDER		NOTES	PAGE 3 B2
34	S5 F 40 F			
35	50 (a ₁)F 7J (b ₂)F	By 5 By 13		
36	40 2F 50 (b ₁)F	By 7		
37	7J (a ₂)F L0 2F	By 10		
38	66 3F S5 F			
39	40 3F 22 21L			
40	50 (a ₂)F 7J (b ₂)F	By 11 By 13	From 25	
41	40 3F L5 F			
42	L0 3F 40 F		a x b	
43	50 (a ₂)F 7J (b ₁)F	By 11 By 8		
44	40 3F 50 (b ₂)F	By 14		
45	7J (a ₁)F L4 3F	By 6		
46	40 3F 22 21L			
47	L6 1023F 50 (b ₁)F	By 8	From 19	
48	7J (b ₁)F 40 F	By 17		
49	50 (b ₂)F 7J (b ₂)F	By 16 By 14	b	
50	L4 F 50 50L			

LOCATION	ORDER	NOTES
51	26 S4	N(4) = Add of square root routine
	26 22L	
52	00 1F	
	00 1F	
53	00 2F	
	00 2F	