REVISION NOTICE

This publication replaces previous descriptions of "Complex Operation Interpretive Routine 1," program H1-22.0. Explanations have been clarified and the program reference changed to its current designation.

FUNCTION

"Complex Operation Interpretive Routine 1" enables the user to interpret and execute the instructions B, A, S, M, D, H, and C as if they were complex operation instructions referring to a 2-word abstract accumulator. Also it provides for shifting the abstract accumulators to the right or left from 0 to 10 places. Finally, it permits address modification of instructions and tests for the final address without leaving the complex operation mode of programming.

INPUT

Real and imaginary parts of a complex number must be carried at the same "q" and be in consecutive memory locations, i.e., real in XXXX and imaginary in XXXX + 1.

OUTPUT

Real and imaginary parts of a complex number are placed in memory locations specified by the subject program. See "PROGRAMMING," page 2.

COMPLEX OPERATION INTERPRETIVE ROUTINE 1

CALLING SEQUENCE

Location	Order	Address	
XXXX	R	Lo	
XXXX + 1	U	Lo	
XXXX + 2			
XXXX + 3			
.			Complex operation instructions.
.			
.			
XXXX + n	XE	0000	"Exit" instruction
XXXX + n + 1	etc.		

Lo is the initial location of program H1-22.0.

PROGRAMMING

After executing the R Lo and U Lo instructions (where Lo is the first instruction of Program H1-22.0) the computer interprets and executes instructions as defined below. For simplicity, "m" is defined as a complex memory address (i.e., memory location m and m + 1), and m' is defined as a standard one-word memory address.

Order	Address	Interpretation
B	m	BRING The contents of m replace the contents of the abstract accumulators.
A	m	ADD The contents of the abstract accumulators plus the contents of m replace the contents of the abstract accumulators.
S	m	SUBTRACT The contents of the abstract accumulators minus the contents of m replace the contents of the abstract accumulators.

PROGRAMMING (Cont.)

Order	Address	Interpretation
M	m	MULTIPLY The contents of the abstract accumulators times the contents of m replace the contents of the abstract accumulators.
D	m	DIVIDE The contents of the abstract accumulators divided by the contents of m replace the contents of the abstract accumulators.
H	m	HOLD Store the contents of the abstract accumulators into location m. The contents of the abstract accumulators are unchanged.
C	m	CLEAR Store the contents of the abstract accumulators into memory location m. The abstract accumulators are then set to zero.
U	m'	UNCONDITIONAL TRANSFER The next instruction to be interpreted is in location m'. The user's attention is called to the fact that after the execution of this instruction the computer will continue to execute orders in the complex operation mode. This instruction may not be used as an exit from the routine.
XE	0000	EXIT Exit from the complex operation mode of interpreting instructions and begin executing instructions in conventional "machine language" with the instruction following the XE 0000 instruction.

PROGRAMMING (Cont.)

To facilitate the programmer's task of address modification, this routine contains a special address accumulator. The following 4 instructions permit the programmer to perform address modification and test the final address without leaving the complex operation mode

Order	Address	Interpretation
E	m	ENTER This instruction enters the address portion of the word at m into the address accumulator.
XI	$T_1T_2S_1S_2$	INCREMENT This instruction increments the address accumulator by T_1T_2 (track) and S_1S_2 (sector) leaving the adjusted address in the address accumulator.
Y	m'	STORE ADDRESS This instruction stores the address portion of the address accumulator into the address portion of memory location m'. The address accumulator remains unaltered.
XZ	$T_1T_2S_1S_2$	ZERO TEST AND JUMP If the address portion of the address accumulator is equal to "$T_1T_2S_1S_2$" the following instruction is skipped. When "$T_1T_2S_1S_2$" differs from the address accumulator, the instruction following XZ $T_1T_2S_1S_2$ is executed. Note that this comparison is based only on the address portions.

PROGRAMMING (Cont.)

Since the basic arithmetic operations A, S, M, and D obey the conventional "q" laws, it is still the responsibility of the programmer to provide the proper binal point manipulations. To facilitate shifting to the right or left, the following instructions are provided

Order	Address	Interpretation
XR	00 n_1n_2	RIGHT SHIFT This instruction will shift the abstract accumulators "n_1n_2" places to the right. Where "n_1n_2" is an integer in the range: $0 \leq n_1n_2 \leq 10$.
XP	00 n_1n_2	LEFT SHIFT This instruction will shift the abstract accumulators "n_1n_2" places to the left. Where "n_1n_2" is an integer in the range: $0 < n_1n_2 \leq 10$.

NOTES

1. The TRANSFER CONTROL button feature was not programmed into the routine. Use of the negative test (-T) instruction will result in a halt.

2. In the explanation of orders above, use was made of the "X" to prevent modification of the corresponding address. If modification is desired, do not precede the order with "X".

3. Use of the "T' order will result in a programmed halt.

4. Use of E0000 for the first complex operation instruction is forbidden.

5. Shifts exceeding 10 places will be incorrectly interpreted. The table may be expanded to include large shifts if the user desires.

ERROR HALTS

Location	Meaning
Lo + 0122 (track 01 sector 22)	Negative test (-T) instruction given.
Lo + 0154 (track 01 sector 54)	T instruction given.
Lo + 0135 (track 01 sector 35)	N instruction given.

STORAGE

192 locations (3 tracks) of instructions and constants are required in memory. No temporary storage is required.

ACCUMULATOR LOCATIONS

Lo + 0059	Real accumulator.
Lo + 0033	Imaginary accumulator.
Lo + 0219	Address accumulator.

TIME

The following table gives the approximate time required to execute each instruction. The times given are maximum times and in practice will be slightly less than the times given

Order	Drum Revolutions	Time (ms.)
B	11	187
Y	8	136
R	14	238
I	6	102
D	41	697
Z ≠	11	187
Z =	13	221
M	22	374
P	17	389
E (enter)	9	153
E (exit)	6	102
U	8	136
C	14	238
H	14	238
A	14	238
S	14	238

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Problem COMPLEX OPERATIONS Track ______

Program Input Codes	Stop	Location	Instruction		Stop	Contents of Address	Notes
			Op.	Address			
;000	'						
/000	'	☒					
		0000	B	[α+2]	'		
		01	T	0122	'		→ -T
		02	S	0252	'	1@15	
		03	T	0223	'	☒	→ Z
		04	S	0054	'	1@15	
		05	T	0207	'		→ B
		06	S	0056	'	1 @15	
		07	T	0243	'	☒	→ Y
		08	U	0009	'		
		09	S	0252	'	1@15	
		10	T	0220	'		→ R
		11	S	0054	'	☒ 1@15	
		12	T	0227	'		→ I
		13	S	0056	'	1@15	
		14	T	0150	'		→ D
		15	U	0016	'	☒	
		16	S	0252	'	1@15	
		17	T	0135	'		→ N
		18	S	0054	'	1@15	
		19	T	0155	'	☒	→ M
		20	S	0056	'	1@15	
		21	T	0237	'		→ P
		22	U	0023	'		
		23	S	0252	'	☒ 1@15	
		24	T	0246	'		→ E
		25	S	0054	'	1@15	
		26	T	0037	'		→ U
		27	S	0056	'	☒ 1@15	
		28	T	0154	'		→ T
		29	A	0217	'	12@15	H, C, A, S
		30	H	0045	'		
		31	A	0060	'	☒ 1@29	

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Problem COMPLEX OPERATIONS Track ____

Program Input Codes	Stop	Location	Instruction Op. Address	Stop	Contents of Address	Notes
	'					
	'	☒				
		0032	U0062	'		
		33	[ ]	'		IMAG. ACC.
		34	A0061	'		
		35	B0000	'	☒	
		36	A0058	'	1@29	
		37	Y0000	'		HERE ON U
		38	A0060	'		
		39	Y0125	'	☒	
		40	U0000	'		
		41	Y0120	'		
		42	Y0114	'		
		43	U0146	'	☒	
		44	B0059	'		
		45	[ ]	'		
		46	C0059	'		
		47	B0033	'	☒	
		48	[ ]	'		
		49	C0033	'		
		50	U0035	'		
		51	B0000	'	☒	
		52	A0117	'		
		53	U0036	'		
		54	XB0000	'		
		55	[ ]	'	☒	TEMP. #2
		56	XB0000	'	1@15	
		57	XY0000	'		
		58	XZ0001	'	1@29	
		59	[ ]	'	☒	REAL ACC.
		60	XZ0001	'	1@29	
		61	[ ]	'		TEMP. #1
		62	H0048	'		
		63	U0044	'	☒	

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Problem COMPLEX OPERATIONS Track______

Program Input Codes	Stop	Location	Instruction Op.	Instruction Address	Stop	Contents of Address	Notes
	'						
	'	☒					
		01 00	N	0253	'		
		01	Y	0144	'		
		02	Y	0138	'		
		03	U	0126	'	☒	
		04	B	0033	'		
		05	U	0114	'		
		06	[	]	'		
		07	D	0106	'	☒	
		08	B	[R]	'		
		09	M	[R]	'		
		10	U	0211	'		
		11	C	0033	'	☒	
		12	U	[ ]	'	0108 0201	
		13	XZ	6363	'		
		14	M	[R]	'		
		15	[	]	'	☒ A0061 S0061	
		16	U	0111	'		
		17	XZ	0001	'	1@29	
		18	M	0033	'	b → bd	
		19	C	0055	'	☒	
		20	B	[R]	'	C	
		21	U	0130	'		
		22	XZ	0000	'		ERROR HALT"
		23	C	0059	'	☒	
		24	U	0104	'		
		25	T	[ ]	'		EXIT
		26	R	0112	'		
		27	U	0203	'	☒	
		28	U	0108	'		
		29	XZ	0001	'	1@29	
		30	M	0059	'		
		31	U	0133	'	☒	

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Problem Complex Operations ________ Track ________

Program Input Codes	Stop	Location	Instruction Op.	Address	Stop	Contents of Address	Notes
	'						
	'	☒					
		0132	S	0055	'		
		33	[	]	'		
		34	U	0123	'		
		35	XZ	0000	'	☒	Error Halt N
		36	C	0115	'		
		37	B	0059	'		
		38	M	[I]	'		
		39	C	0061	'	☒	
		40	U	0144	'		
		41	S	0061	'		
		42	S	0060	'	1@29	
		43	U	0230	'	☒	
		44	B	[I]	'	d	
		45	U	0118	'		
		46	A	0060	'		
		47	Y	0212	'	☒	
		48	Y	0213	'		
		49	U	0101	'		
		50	Y	0108	'		
		51	Y	0109	'	☒	
		52	U	0041	'		
		53	A	0055	'		
		54	XZ	0000	'		Error Halt "T"
		55	Y	0120	'	☒	Here Mult.
		56	Y	0114	'		
		57	A	0129	'		
		58	Y	0144	'		
		59	Y	0138	'	☒	
		60	B	0132	'		
		61	C	0133	'		
		62	B	0034	'		
		63	B	0112	'	☒	

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Problem COMPLEX OPERATIONS Track ______

Program Input Codes	Stop	Location	Instruction Op. Address	Stop	Contents of Address	Notes
	'					
	'	☒				
		0200	U0136	'		
		01	U0035	'		
		02	U0230	'		
		03	B0153	'	☒	
		04	C0133	'		
		05	R0141	'		
		06	U0136	'		
		07	H0057	'	☒ $2^{@}15$	HERE ON B
		08	U0030	'		
		09	H0045	'		
		10	U0062	'		
		11	H0061	'	☒	
		12	R[I]	'		
		13	M[I]	'		
		14	U0252	'		
		15	Y[ ]	'	☒	
		16	U0035	'		
		17	XH0000	'	$12^{@}15$	
90000001	'	18	wwwj	'		$1^{@}15 - 1^{@}29$
		19	[ ]	'	☒	ADDRESS ACC.
		20	A0242	'		HERE ON R
		21	H0045	'		
		22	U0062	'		
		23	E0218	'	☒	HERE ON Z
		24	S0219	'		
		25	T0035	'	≠	
		26	U0142	'	MAYBE =	
		27	E0113	'	☒	HERE ON I
		28	A0219	'		
		29	U0240	'		
		30	T0051	'	=	
		31	U0035	'	☒ ≠	

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Problem________ Track________

Program Input Codes	Stop	Location	Instruction Op. Address	Stop	Contents of Address	Notes
	'					
	'	☒				
		0232	A0061	'		
		33	U0234	'		
		34	A0106	'		
		35	B0107	'	☒	
		36	U0209	'		
		37	A0100	'		HERE ON P
		38	H0045	'		
		39	U0062	'	☒	
		40	Y0219	'		
		41	U0035	'		
		42	P0253	'		
		43	Y0215	'	☒	HERE ON Y
		44	B0219	'		
		45	U0215	'		
		46	H0218	'		HERE ON E
		47	T0123	'	☒	
		48	A0060	'		
		49	Y0250	'		
		50	BC J	'		
		51	U0240	'	☒	
		52	XB0000	'		
70000011	'	53	7WWWWWWJ	'	1@0	
		54	40000000	'	1@1	
		55	20000000	'	☒ 1@2	
		56	10000000	'	1@3	
		57	8000000	'	1@4	
		58	4000000	'	1@5	
		59	2000000	'	☒ 1@6	
		60	1000000	'	1@7	
		61	800000	'	1@8	
		62	400000	'	1@9	
		63	200000	'	☒ 1@10	

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