UNIVAC INSTRUCTION CODE C-10

1-word Registers (12 digits) Basic uses:

rA	Used to store result of addition, subtraction, multiplication, division, and one component in a comparison.
rF	Used to store extractor, and used during multiplication.
rL	Used to store multiplicand, divisor, and one component in a comparison.
rX	Used to store least significant half of 22 digit product, and unrounded 11 digit quotient.
C	Control counter. Used to store the number of the memory location containing the current pair of instructions.
C.R.	Used to store current pair of instructions for operation.

2-word Register

rV	Used to transfer information in two consecutive words from one part of the memory to another.

10-word Register

rY	Used to transfer information in ten consecutive words from one part of the memory to another.

Six 10-word Specialized Registers

rI	Used to assemble 60 words (1 block) of information read from a tape.
r0	Used to hold 60 words of information from memory during a tape write operation. (Not directly referred to in tape write instructions).

Memory, "m", 1000 words (100 ten-word registers) numbered from 000 to 999, used to store instructions, constants and data.

Note: An instruction consists of six computer digits. The two most significant computer digits designate the function and the fourth, fifth and sixth computer digits designate the memory location. The third computer digit is not decoded. Tape, shift and Supervisory Control instructions require both digits to decode the function. The functions of all other instructions require only the most significant digit to be decoded. The second digit in these instructions may be any character, however, for ease in coding this character is omitted on work sheets. Conditional transfer instructions may be decoded in the second digit when checking a problem on the computer (see stop instructions).

UNIVAC INSTRUCTION CODE C-10

(rA) means "contents of register A", etc.

Av. Time in Microseconds	Instruction	Description
525	Am	Add (m) to (rA), result in rA; (m) also placed in rX.
445	Bm	Clear (rA), then bring (m) into rA; (m) also placed in rX.
445	Cm	Place (rA) in m. Clear rA.
3890	Dm	Divide (m) by (rL) rounding off the quotient to 11 digits; result in rA. Unrounded quotient in rX.
445	Em	Extract from (m) the characters (including digits) specified by (rF). Clear only those characters of rA which are replaced by the extracted characters. When a digit in rF is "0", leave the corresponding character in rA unaltered. When a digit in rF is "1", insert the corresponding character of m in rA.
445	Fm	Place (m) in rF.
445	Gm	Place (rF) in m.
445	Hm	Place (rA) in m without clearing rA. (i.e., Hold (rA) in rA).
445	Jm	Place (rX) in m; (rX) unaltered.
285	Km	Place (rA) in rL, clear rA; disregard m.
445	Lm	Place (m) in rL; (m) also placed in rX.
2150	Mm	Multiply (rL) by (m) rounding off the product to 11 digits; result in rA.

2150	Nm	Negative Multiplication. Multiply (rL) by -(m) rounding off the product to 11 digits; result in rA.

Note: Instructions M and N leave irrelevant information in rX.

2150	Pm	Multiply (rL by (m), storing the more significant half of the product in rA and the less significant half in rX.

Note: Instructions M, N and P leave 3 |(rL)| in rF.

Note: Instructions D, M, N and P clear rA prior to operation.

365	Qm	Equality Test. Transfer control to m if (rA) = (rL).
445	Rm	Record the number of the control count plus one as an unconditional transfer instruction in m. U(c+1) in m.
525	Sm	Subtract (m) from (rA), result in rA; -(m) also left in rX.
365	Tm	Test to determine whether (rA) > (rL) algebraically; if so, transfer control to m.
285	Um	Unconditional transfer of control to m.
485	Vm	Place 2 consecutive words, starting with m, in rV; m should be a multiple of 2. For exceptions see additional information on page 12.
485	Wm	Place (rV) in 2 consecutive memory locations starting with m; m should be a multiple of 2. For exceptions see additional information on page 12.
285	Xm	Add (rX) to (rA), result in rA, disregard m. (rX) unaltered.
650	Ym	Place 10 consecutive words, starting with m, in rY. Here m must be an integral multiple of 10.

650	Zm	Place (rY) in 10 consecutive memory locations, starting with m. Here m must be an integral multiple of 10.
285	00m	Pass to next instruction (Skip instruction.)

Note: Instructions Q, T, and U must be placed in the right-hand part of word. The instruction R, when used, should be in the left-hand part of word immediately preceding transfer instructions Q, T, or U.

Shift Instructions. n ranges from 1 to 9

40.5n+245	.nm	Shift all digits of rA, including the sign position, n digits to the right dropping the n right-hand digits. Disregard m.
40.5n+245	;nm	Shift all digits of rA, including the sign position, n digits to the left, dropping the n left-hand digits. Disregard m.
40.5n+245	-nm	Shift all digits of rA, except the sign position, n digits to the right, dropping the n right-hand digits (equivalent to multiplying (rA) by 10^{-n} without rounding). Disregard m.
40.5n+245	0nm	Shift all digits of rA, except the sign position, n digits to the left, (equivalent to multiplying (rA) by 10^{n} without rounding). Disregard m.

Note: Accumulator overflow control transfer does not operate on shift instructions.

Tape Instructions for 1 to 9 Tapes

3500*	1nm	Read one block of data (60 words) from tape n and store in rI, tape moving in a forward direction; disregard m.
3500*	2nm	Read one block of data (60 words) from tape n and store in rI, tape moving in a backward direction; disregard m.

3500*	3nm	Transfer data (60 words) previously stored in rI to 60 consecutive memory locations, beginning with m, where m is an integral multiple of 10; then read one block of data (60 words) from tape n and store in rI, tape moving in a forward direction.
3500*	4nm	Transfer data (60 words) previously stored in rI to 60 consecutive memory locations, beginning with m, where m is an integral multiple of 10; then read one block (60 words) from tape n and store in rI, tape moving in a backward direction.
3500*	5nm	Write 60 consecutive words, starting with m, where m is an integral multiple of 10, on tape n; moving in a forward direction. Pulse density 100/in. (tape to be used in a future UNIVAC operation.)
3500*	6nm	Rewind tape n to the beginning. Disregard m.
3500*	7nm	Write 60 consecutive words, starting with m, where m is an integral multiple of 10, on tape n; tape moving in a forward direction. Pulse density 20/in. (Tape to be used in future UNIPRINTER or UNIVAC operations.)
3500*	8nm	Rewind tape n to beginning and set an interlock, disregard m. The setting of the interlock will produce a visual signal and no data can be read from or written on tape n until the mechanical interlock release switch on the UNISERVO has been actuated. More than one tape may be rewound simultaneously.

Note: Tape read instructions. Since rI, unlike all other UNIVAC registers, clears upon the transferral of its contents, the execution of a subsequent read instruction without clearing will cause digits to be

superimposed. An error signal will be produced if the resulting combinations fail to satisfy the odd-checking system when transferred to memory. When a backward read instruction is in operation, rI receives information in reverse order, starting with the least significant digit of the last word and ending with the most significant digit of the first word. Upon transferral to memory, the arrangement of information within the block is the same as in previous storage in memory.

Note: Instructions 30 m or 40 m transfer data previously stored in rI to 60 consecutive memory locations beginning with m, without moving any tape.

Note: At the start of a UNIVAC problem a 1nm or 3nm tape instruction must be used, since all tapes are mounted and removed from the left-hand reel.

Tape Instructions for Tape Number 10

Instructions for tape 10 operate in the same manner as those for tapes 1 to 9 except that n is not a number but a "minus sign."

Supervisory Control Instructions with Input and Output Selector Switch set at Position 1

3500	10m	Stop UNIVAC operations and produce a visual signal. Call for one word to be typed from the Supervisory Control keyboard into m of UNIVAC. UNIVAC operations are resumed after the word Release Button on the Supervisory Control has been actuated.
3500*	50m	Print (m), one word, on Printer associated with Supervisory Control. UNIVAC operations are resumed automatically after (m) has been transferred to an intermediate output storage location prior to printing.

Note: Additional information on Input and Output Selector Switch setting is listed in "Supervisory Control Operations."

Supervisory Control Output Switch - operates in conjunction with the 50 m instruction.

Position 1 Normal. The 50 m instruction operates as described above.

285

Position 2 Skip. The 50 m instruction is decoded as a skip instruction (00m)

Position 3 Stop. Stop UNIVAC operations and produce a visual signal. At this time the setting of the Supervisory Control Output Selector switch may be changed. Actuation of the start button causes the 50 m instruction to be performed.

* Times listed for Tape and Supervisory Control operations represent computer time only. Computations may proceed after the lapse of the indicated times, but may be interrupted if another tape instruction of the same nature (Read followed by Read, or write followed by write) occurs before the first tape reading or writing operation has been completed. The time to read or write one block of information is approximately .085 seconds for 100/in pulse density if no tape reversal is needed. If tape is reversed an additional 0.6 second is required. The first block to be read from or written on a tape required approximately 1.8 seconds. The Printer on Supervisory Control operates at approximately 10 characters per second.

Stop Instructions

285	,m	Breakpoint Stop, used for checking of programming; disregard m. If the two-position Breakpoint switch on the Supervisory Control is in the "Normal" position, interpret as a skip instruction. If the switch is in the "Breakpoint" position, interpret as a stop instruction. To resume UNIVAC operations actuate Start Button.
	Qnm or Tnm	Conditional Transfer Breakpoint Stop, used for checking of programming. The Breakpoint Stop operates in conjunction with the setting of 12 conditional Transfer Breakpoint Selector Buttons on Supervisory Control; "Reset", "0...9", "All". Reset - Qm and Tm instructions operate in the normal manner. 0...9 - If n corresponds to the setting of the button depressed, the UNIVAC stops, after (rA) and (rL) have been compared but before the transfer takes place. One or more of the Buttons labeled 0...9 may be depressed simultaneously. All - The UNIVAC stops after (rA) and (rL) have been compared on all Qm and Tm instructions. To complete instruction actuate Start Button.
285	90m	Stop UNIVAC operations and produce a signal; disregard m.

START UNIVAC

Initial Read Button	Fill rI with one block (60 words) from the tape specified by the setting of the "Initial Tape Selector Switch" on Supervisory Control. Then transfer (rI) to memory locations 000 to 059 inclusive. Start UNIVAC operations at memory location 000.
Start Button	Proceed with UNIVAC operations in accordance with the setting of the "Interrupted Operation Switch" on Supervisory Control. (see Supervisory Control Operations)

Accumulator Overflow

When arithmetic processes cause the capacity of rA to be exceeded, the normal control sequence is altered by the insertion of that pair of instructions which have been placed in memory location 000. Unless these instructions contain a transfer of control instruction, the previous sequence of instructions is resumed. Transfer to 000 occurs after the execution of both instructions in a word, even though overflow may have occurred during the execution of the first of a pair of instructions. When overflow occurs from addition or subtraction, the carry-over (one) from the most significant digit is lost, but the remaining digits of the sum or difference with their correct sign remain in rA. When overflow occurs during the division process because the divisor is equal to or less than the dividend (i.e., the divisor has been subtracted 10 times from the dividend without a change of sign) the operation is terminated and the accumulator overflow indicator set to operate at the completion of the current pair of instructions.

ADDITIONAL INFORMATION FOR CODE C-10

The presence of a zero in the most significant digit position of a word indicates a positive quantity.

Operation in Sign Position

(rA)	Operation	(m)	Result
number ≠ 0	+ or -	number ≠ 0	UNIVAC Error Stop
character	+ or -	character	UNIVAC Error Stop
number ≠ 0	+ or -	character	UNIVAC Error Stop
ignore	+ or -	sign	ignore
character	+ or -	sign	character
number	+ or -	sign	number

Operation in all Digit Positions Except Sign

(rA)	Operation	(m)	Result
character	+ or -	character	UNIVAC Error Stop
character	+ or -	number	character
- sign	+	number	number reduced by 1
- sign	+	- sign	space symbol
character	+	carryover digit	character

[+0] + [-0] = +0 in rA

Multiplication

Multiply -n ≠ 0 by +0 = -0

Division

Divide +0 by -n = -0

Division by a number equal to or smaller than the dividend sets up the accumulator overflow after the divisor has been subtracted 10 times from the dividend without a change of sign. rA contains 10 times the absolute difference between the divisor and the dividend.

Conditional Transfer

To operate Tm instruction algebraically the sign of both numbers must be in the sign position of the word.

Shift Instructions

OOm operates as a skip instruction
-Om causes the UNIVAC to stall setting up the "Stall Neon".
,Om causes the UNIVAC to stall setting up the "Stall Neon".
;Om causes the UNIVAC to stall setting up the "Stall Neon".

After an improper shift, the (rA) will be zero (or minus zero if the number shifted by -Om happened to be negative) because the digits have been continuously shifted until the "Stall Neon" is set up.

Extract Instruction

When a digit in rF is "0", "2", "4", "6", or "8" leave the corresponding digits in rA unaltered. When a digit in rF is "1", "3", "5", "7", or "9", insert the corresponding digit of m.

Multiple Word Transfers

Vm and Wm may be used without additional restrictions if m in both is an integral multiple of 2. Vm may be used when m is odd provided the least significant digit in m is not 9, and provided Wm is also odd and the least significant digit is not 9. When a combination of odd and even other than 9 is used the order of words is reversed, e.g.:

V	001	(001) = A	V	002	(002) = A
		(002) = B			(003) = B
W	004	(004) = B	W	005	(005) = B
		(005) = A			(006) = A

when 9 is used,

V	003	(003) = A
		(004) = B
W	019	(019) = A
		(010) = B

In Ym and Zm transfer instructions, the least significant digit of the memory location is ignored, and the transfer operates on an integral multiple of 10, e.g.:

Y 999 = Y 990

Read or write instructions starting with memory location 950 or greater complete the 60-word block by using 000...009 etc.

Rewind Instructions where "n" in each case is the same

Possible Combination	Combinations causing UNIVAC to stall
6n followed by 8n	8n followed by 8n
6n followed by 6n	8n no tape on Servo n
tape "n" not used followed by 8n	6n no tape on Servo n
tape "n" not used followed by 6n	8n followed by any other tape order on Servo n prior to substitution of new tape.

UNIVAC INSTRUCTION CODE C-10

Pulse Code

Pulse Code	Char.	Inst.	Description	Time in μs
1 00 0000	Ignore			
0 00 0001	Space			
0 00 0010	Minus	-nm	Right shift; sign unshifted	40.5n+245
1 00 0011	0	0nm	Left shift; sign unshifted	40.5n+245
0 00 0100	1	1nm	Tape -> rI, forward; SC -> m	3500*
1 00 0101	2	2nm	Tape -> rI, backward	3500*
1 00 0110	3	3nm	(rI) -> m; tape -> rI, forward	3500*
0 00 0111	4	4nm	(rI) -> m; tape -> rI, backward	3500*
0 00 1000	5	5nm	Write on tape 100 pulses/in;(m)->SC	3500*
1 00 1001	6	6nm	Rewind tape	3500*
1 00 1010	7	7nm	Write on tape 20 pulses/in.	3500*
0 00 1011	8	8nm	Rewind tape, set interlock	3500*
1 00 1100	9	90m	UNIVAC STOP	285
	Carriage			
0 01 0000	Return			
1 01 0001	,	,m	Breakpoint stop	285
1 01 0010	.	.nm	Right shift, all digits	40.5n+245
0 01 0011	;	;nm	Left shift, all digits	40.5n+245
1 01 0100	A	Am	Add; (m) + (rA) --> rA	525
0 01 0101	B	Bm	Clear rA; (m) --> rA	445
0 01 0110	C	Cm	Clear (rA) --> m	445
1 01 0111	D	Dm	Divide; (m)/(rL) --> rA	3890
1 01 1000	E	Em	Extract	445
0 01 1001	F	Fm	(m) --> rF	445
0 01 1010	G	Gm	(rF) --> m	445
1 01 1011	H	Hm	(rA) --> m; Hold (rA)	445
0 01 1100	I			

Pulse Code	Char.	Inst.	Description	Time in μs
0 10 0000	Tabular			
1 10 0001				
1 10 0010			S.C. --> C.R.	
0 10 0011	/			
1 10 0100	J	Jm	(rX) --> m	445
0 10 0101	K	Km	(rA) --> rL; clear rA	285
0 10 0110	L	Lm	(m) --> rL; mult'cand, dvsr.	445
1 10 0111	M	Mm	Multiplication (m)(rL) --> rA	2150
1 10 1000	N	Nm	Negative Mult.-(m)(rL) --> rA	2150
0 10 1001	O			
0 10 1010	P	Pm	Mult. without round-off	2150
1 10 1011	Q	Qm	Equality test; (rA) = (rL)	365
0 10 1100	R	Rm	U (c+1) --> m	445
1 10 1101	Printer Shift to upper case			
1 10 1110				
0 10 1111	Printer Shift to lower case			
1 11 0000	Printer stop			
0 11 0001	Print. Bkpt. Stop			
0 11 0010				
1 11 0011				
0 11 0100	+			
1 11 0101	S	Sm	Subtract; - (m) + (rA) --> rA	525
1 11 0110	T	Tm	Test (rA) > (rL)	365
0 11 0111	U	Um	Unconditional Transfer	285
0 11 1000	V	Vm	2-word transfer (m) ---> rV	485
1 11 1001	W	Wm	2-word transfer (rV) --> m	485
1 11 1010	X	Xm	(rX) + (rA) --> rA	285
0 11 1011	Y	Ym	10 word transfer (m) --> rY	650
1 11 1100	Z	Zm	10 word transfer (rY) --> m	650
0 11 1101	Printer Single character shift			

Most significant binary digit in Pulse Code is an odd checking digit.

FEH/pdv

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