

RECOMP II USERS' PROGRAM NO. 1109

PROGRAM TITLE: OUTPUT SUBROUTINE

PROGRAM CLASSIFICATION: Subroutines

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PURPOSE: To provide an output subroutine which has
 fewer restrictions, is faster, and takes
 less space than AN-015.1 and AN-016.

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OUTPUT SUBROUTINE

Purpose

To type, in a variable fixed point format, a rounded decimal number which is located in the A and R registers in binary form. If the number in A is floating point then R holds the exponent. If the number in A is fixed point then R holds the scale factor at a binary scale of 39. The L and V loops are not destroyed and the subroutine may be entered from the loops.

Calling Sequence

The calling sequence for this subroutine is different than that used for AN-015.1 and AN-016. This change was made so that the subroutine may be used conveniently for SNAP programming. The number must be in the A register with either its exponent or scale factor in R at a binary scale of 39.

LOCATION	LEFT HALF COMMAND		RIGHT HALF COMMAND	
	OP	ADDR	OP	ADDR
ALPHA	TRA	OUTPUT	XX	CODE
CODE	PZE	LLRR.O	XX	EXIT

ALPHA and CODE are not necessarily sequential locations. CODE must not be a high speed loop address but ALPHA can be a loop address. LL and RR are two octal digits each and specify the number of digits to be typed to the left of the decimal point and right of the decimal respectively. EXIT is the address of the next instruction to be executed after leaving the subroutine and can be a high speed loop address. The OP codes for the right half commands are immaterial.

Restrictions

$LL/RR \leq 11$ (Decimal) - This can be changed by extending a table of constants in the subroutine. See the coding sheets for details.

Error Messages

If $LL/RR > 11$, computer types: LR TOO BIG
and the subroutine exits back to the main program. (No Halt)

If the number to be typed has more digits to the left of the decimal than LL, computer types: TOO BIG
and the subroutine exits back to the main program. (No Halt)

Method

The number is first normalized, rounded depending on the number of digits to be typed to the right of the decimal point, converted to a fixed point fraction, and then converted to BCD and typed.

Space Required

The subroutine occupies 112 full words of memory including 16 words for temporary storage of the L and V loops. If the contents of L and V need not be saved the program can be modified such that it occupies 96 words of memory.

Erasable Locations

(0050-0057)₈
(0065)₈
(0150-0157)₈

Timing

For normalized numbers, entering the subroutine from the loops, and exiting to the loops, the approximate timing, not including the type out time, is given by:

$$\text{time (milliseconds)} = 397. / 30.1 \times L / 28.9 \times R / 0.9 \times L \times R$$

Typing time can be estimated by:

$$\text{time (seconds)} = (L/R/3) \times \frac{\text{time (seconds)}}{\text{character}} .$$

A eleven digit number takes approximately 750 ms. for conversion to BCD.

Relocation

The subroutine is relocatable and uses a modified AN-004 Subroutine Relocation Utility Routine. The subroutine must be relocated mod 8 but cannot be relocated to any address ending in 10.0. If this is attempted an appropriate error message is typed. To relocate the subroutine see AN-004 for details.

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RECOMP II CODING SHEET

ABSOLUTE LOCATION	L	ABSOLUTE		H	LOCATION SYMBOL	SYMBOLIC			REMARKS	NOTES
		S	OPRN			ADDRESS	S	OPRN		
00000		+15	0044	0	START	SAX	MANT		STORE NUMBER TO BE	
		+42	0006	1		STA	PU		CONVERTED, SET PICKUP	
00010		+65	0050	0		CFL	TEMPL		FOR ADDRESS OF CODE	
		+57	0006	0		TRA	PU		WORD AND STORE L LOOP,	
00020		+76	0614	0	MESS				(4 _s TOO ⁹ / _P BIG)	
		-23	1155	0						
00030		+72	0004	0	SPACE	TYC	SPACE			
		+00	0002	0	ERROR	CLA	MESS		ERROR TYPEOUT (TOO BIG)	
00040		+72	7760	0		TYC	LO	L		
		+64	0050	0	GOOUT	CTL	TEMPL		RESTORE L AND V LOOPS	
00050		+66	0150	0		CTV	TEMPV		AND EXIT FROM SUBROUTINE	
		+57	0000	0	EXIT	TRA				
00060		+67	0150	0	PU	CFV	TEMPV		STORE V LOOP AND PICK	
		+00	0000	0		CLA			UP ADDRESS OF CODEWORD	
00070		+64	0030	0		CTL	NEXT1			
		+57	7760	1		TRA	NEXT1+0.1	L	→NEXT1+0.1	
00100		+41	0006	0	UGH	ALS	0		PUT RR TO LL AND	V0
		+60	7773	0		STO	LL	V	MODIFY TEST EXIT	
00110		+00	7766	0		CLA	CMND	L	TO DONE	V1
		+42	7765	0		STA	TEST	L		
00120		+00	0063	0		CLA	.		INSERT DECIMAL POINT	V2
		+57	7767	0		TRA	QUEER	L		
00130		+00	0000	0	LL					V3
		-00	0000	0						
00140		+04	0000	0	BIT					V4
		-00	0000	0						
00150		+00	0000	0	10B39					V5
		-00	0005	0						
00160		+00	0000	0	BCD1					V6
		-00	1710	0						
00170		+00	0000	0	BCD2					V7
		-00	0010	0						

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ABSOLUTE LOCATION	FOR-TO	ABSOLUTE			SYMBOLIC				REMARKS	NOTES	
		S	OPRN	ADDRESS	HEI D	LOCATION SYMBOL	S	OPRN			ADDRESS
0020		+	53	0046 0		NEXT2		TOV OVER		LL+RR TOO BIG → OVER	V0
				+64 00400				CTL NEXT3			
0021		+	00	7764 1				CAM MANT	L	NORMALIZE NUMBER,	V1
				+45 0000 0				FNM		ROUND, AND CONVERT	
0022		+	35	7770 0				FST NEXT2	V	TO FRACTION	V2
				+30 7776 0				FCA HALF	V		
0023		+	05	0000 0		DIV2		FDV			V3
				+04 7770 0				FAD NEXT2	V		
0024		+	05	0000 0		DIV1		FDV			V4
				+57 7765 0				TRA ENTER	L	→ ENTER	
0025		+	00	0110 0		BASE				(STARTING ADDRESS OF	V5
				-00 0000 0						POWERS OF 10 TABLE)	
0026		+	40	0000 0		HALF				(0.5 IN FLT. PT.)	V6
				-00 0000 0							
0027		+	00	0000 0							V7
				-00 0000 0							
0030		+	72	7530 0		NEXT1				(SPECIAL CONSTANT)	L0
				+42 7761 1				STA PU1	L	SET PICKUP FOR CODE WORD	
0031		+	66	0020 0				CTV NEXT2			L1
				+00 0000 0		PU1		CLA		PICKUP CODE WORD	
0032		+	42	0005 1				STA EXIT		STORE EXIT ADDRESS	L2
				+41 0010 0				ALS 8		SET LL AND RR	
0033		+	60	0013 0				STO LL			L3
				+40 0015 0				ARS 13		SET ADDRESS TO OBTAIN	
0034		+	01	7775 0				ADD BASE	V	POWER OF TEN TO CONVERT	L4
				+42 7774 0				STA DIV1	V	NUMBER TO FRACTION	
0035		+	41	0021 0				ALS 17		SET ADDRESS TO OBTAIN	L5
				+40 0013 0				ARS 11		POWER OF TEN FOR	
0036		+	01	7775 0				ADD BASE	V	ROUND OFF CONSTANT	L6
				+42 7773 0				STA DIV2	V		
0037		+	01	7774 0				ADD DIV1	V	CHECK IF LL+RR > 11	L7
				+01 7760 0				ADD NEXT1	L	→ NEXT2	

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ABSOLUTE LOCATION	CONTROL	ABSOLUTE		SYMBOLIC				NOTES				
		S	OPRN	ADDRESS	HEAD	LOCATION SYMBOL	S		OPRN	ADDRESS	LOOP	REMARKS
0040	0	+	50	77630		NEXT3		TZE	OK		TEST IF NUMBER WILL FIT WITH LL TO LEFT OF DECIMAL	L0
				52		00031		TPL	ERROR			
0041	0	+	43	00000				XAR			IF WILL FIT CONVERT TO FIXED PT. OTHERWISE	L1
				04		77760		FAD	HALF			
0042	0	+	03	77760				SUB	HALF		GO TO ERROR	L2
				43		00000		XAR				
0043	0	+	64	00700		OK		CTL	SUP		→ LOOP	L3
				66		00100		CTV	UGH			
0044	0	+	00	00000		MANT						L4
				00		00000						
0045	0	+	43	00000		ENTER		XAR			→ NEXT3	L5
				57		77600		TRA	NEXT3			
0046	0	+	72	00370		OVER		TYC	4S		ERROR TYPEOUT FOR LL+RR > 11	L6
				72		00220		TYC	L			
0047	0	+	72	00120				TYC	R			L7
				57		00030		TRA	SPACE			
0050	0	-	00	00000		TEMPL					TEMP. STORAGE FOR L LOOP ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	
				00		00000						
0051	0	-	00	00000								
				00		00000						
0052	0	-	00	00000								
				00		00000						
0053	0	-	00	00000								
				00		00000						
0054	0	-	00	00000								
				00		00000						
0055	0	-	00	00000								
				00		00000						
0056	0	-	00	00000								
				00		00000						
0057	0	-	00	00000								
				00		00000						

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ABSOLUTE LOCATION	CONTROL	ABSOLUTE		HEAD	LOCATION SYMBOL	SYMBOLIC			REMARKS	NOTES	
		S	OPRN			ADDRESS	S	OPRN			ADDRESS
0060	0	+	45	0060	0	SWITCH	XAR			ONE BCD WORD IS FULL.	L0
		+	60	0065	0		STO	TS		START USING NEXT WORD.	
0061	0	+	00	7777	0		CLA	BCD2	V		L1
		+	35	7776	0		FST	BCD1	V		
0062	0	+	30	0064	0		FCA	TS-1.0			L2
		+	57	7764	0		TRA	LOOP	L	→ LOOP	
0063	0	+	00	0000	0					(DECIMAL CODE BCD)	L3
		+	00	0006	0						
0064	0	+	64	0067	0	RESET	CTL	NUSUP		END ZERO SUPPRESS	L4
		+	57	7767	1		TRA	UGHA	L	→ UGHA	
0065	0	+	00	0000	0	TS				(TEMP. STORAGE)	L5
		+	00	0000	0						
0066	0	+	64	0100	0	DONE	CTL	MORE		FINISHED CONVERTING. GO	L6
		+	57	7762	0		TRA	MID	L	TO MID	
0067	0	+	57	7761	1	NUSUP	TRA	ADD	L		L7
		+	00	7773	0	UGHA	CLA	LL	V	→ UGH	
0070	0	+	64	0067	0	SUP	CTL	NUSUP		END ZERO SUPPRESS	L0
		+	57	7761	1		TRA	ADD	L	→ ADD	
0071	0	+	00	7775	0	ZERO	CLA	10B39	V	MAKE BCD = SPACE	L1
		+	01	7776	0	ADD	ADD	BCD1	V	PACK BCD WORD. TEST IF	
0072	0	+	01	7774	0		ADD	BIT	V	WORD IS FULL. IF YES	L2
		+	53	0060	0		TOV	SWITCH		GO TO SWITCH	
0073	0	+	41	0004	0		ALS	4			L3
		+	60	7776	0		STO	BCD1	V		
0074	0	+	00	7773	0	LOOP	CLA	LL	V	TEST FOR END OF DIGITS	L4
		+	03	7774	0		SUB	BIT	V	TO LEFT	
0075	0	+	51	0064	0	TEST	TMI	RESET		IF YES → RESET	L5
		+	60	7773	0		STO	LL	V		
0076	0	+	43	0066	0	CMND	XAR	DONE		PEEL OFF ONE BCD	L6
		+	11	7775	0		MPY	10B39	V		
0077	0	+	50	7761	0	QUEER	TZE	ZERO	L	TEST FOR ZERO BCD	L7
		+	57	7760	0		TRA	SUP	L	IF YES → ZERO, NO → SUP	

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ABSOLUTE LOCATION	ORGANIZATION	ABSOLUTE		HEED	LOCATION SYMBOL	SYMBOLIC			REMARKS	NOTES	
		S	OPRN			ADDRESS	S	OPRN			ADDRESS
0100	0+	43	00000		MORE	XAR				SHIFT BCD WORD	L0
			+45 00000			FNM					
0101	0+	41	00070			ALS	7				L1
			+57 77670			TRA	GOGO	L		→ GOGO	
0102	0+	30	77760		MED	FLA	BCD1	V		ADD TERMINATE TO BCD	L2
			+66 01400			CTV	ALMOST			WORD BEING WORKED ON	
0103	0+	01	77750			ADD	TERM	V		LAST.	L3
			+60 77770			STO	BCD2'	V			
0104	0+	43	00000			XAR				TEST IF MORE THAN ONE	L4
			+03 77760			SUB	BCD1'	V		BCD WORD WAS PACKED.	
0105	0+	50	77600			TRE	MORE	L		IF NO → MORE	L5
			+01 77760			ADD	BCD1'	V		SHIFT BCD WORD	
0106	0+	45	00000			FNM					L6
			+41 00010			ALS	1				
0107	0+	60	77760		GOGO	STO	BCD1'	V			L7
			+00 77770			CLA	BCD2'	V		→ ALMOST	
0110	0+	40	00000		CONSTS					POWERS OF 10 TABLE	
			-00 00000							FLOATING POINT	
0111	0+	00	00000								
			-00 00001								
0112	0+	50	00000							10 ¹	
			-00 00000								
0113	0+	00	00000								
			-00 00020								
0114	0+	62	00000							10 ²	
			-00 00000								
0115	0+	00	00000								
			-00 00030								
0116	0+	76	40000							10 ³	
			-00 00000								
0117	0+	00	00000								
			-00 00050								

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		S	OPRN			ADDRESS	S	OPRN		
0120	0+	47	04000						10 ⁴	
		-00	00000							
0121	0+	00	00000							
		-00	00070							
0122	0+	60	65000						10 ⁵	
		-00	00000							
0123	0+	00	00000							
		-00	00101							
0124	0+	75	02200						10 ⁶	
		-00	00000							
0125	0+	00	00000							
		-00	00120							
0126	0+	46	11320						10 ⁷	
		-00	00000							
0127	0+	00	00000							
		-00	00140							
0130	0+	57	53601						10 ⁸	
		-00	00000							
0131	0+	00	00000							
		-00	00151							
0132	0+	73	46541						10 ⁹	
		-40	00000							
0133	0+	00	00000							
		-00	00170							
0134	0+	45	20131						10 ¹⁰	
		+44	00000							
0135	0+	00	00000							
		-00	00210							
0136	0+	56	44161						10 ¹¹	
		+35	00000							
0137	0+	00	00000							
		-00	00221							

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		S	OPRN							ADDRESS	OPRN		
0140	0	+	45	0000	ALMST		FNM					SHIFT BCD word	V0
							ALS	1					
0141	0	+	60	7777			STO	BCD2'	V				V1
							CLA	MANT				TEST SIGN OF NUMBER	
0142	0	+	52	0147			TPL	BCD2'				+ → BCD2'	V2
							CLS	BCD1'	V			- MAKE FIRST BCD	
0143	0	+	60	7776			STO	BCD1'	V			WORD NEG.	V3
							TYC	FIS				TYPE FIS	
0144	0	+	12	7776	TYPE		TYW	BCD1'	V			TYPE BCD	V4
							TRA	GETOUT				→ GETOUT	
0450	0	+	00	0000	TERM							(TERMINATE CODE)	V5
0146	0	+	00	0000	BCD1'								V6
0147	0	+	72	0004	BCD2'		TYC	SPACE				TYPE SPACE	V7
							TRA	TYPE	V			→ TYPE	
0150	0	-	00	0000	TEMPV							TEMP. STORAGE FOR V LOOP	
0151	0	-	00	0000									
0152	0	-	00	0000									
0153	0	-	00	0000									
0154	0	-	00	0000									
0155	0	-	00	0000									
0156	0	-	00	0000									
0157	0	-	00	0000									