KDF9

user code digest

ENGLISH ELECTRIC LEO

ONE-SYLLABLE INSTRUCTIONS

	USER CODE	FINAL STATE OF N1	N2	N3	NOTES
1	+	x	c	d	x=b+a
7+	+F	x	c	d	
3	+D	x	y	e	x,y=c,d+a,b
13+	+DF	x	y	e	
1	—	x	c	d	x=b—a
7+	—F	x	c	d	
3	—D	x	y	e	x,y=c,d—a,b
13+	—DF	x	y	e	
1	NEG	x	b	c	x=—a
2+	NEGF	x	b	c	
2	NEGD	x	y	c	x,y=—a,b
5+	NEGDF	x	y	c	
16	×	x	c	d	x=a×b
10	×F	x	c	d	
14	×D	x	y	c	x,y=a×b
18	×DF	x	y	c	
	×+F	x	y	e	x,y=a×b+c,d
35+	÷	x	c	d	x=b/a (—1 ≤x<1)
30+	÷F	x	c	d	x=b/a
35+	÷D	x	d	e	x=b,c/a (—1 ≤x<1)
30+	÷DF	x	d	e	x=b,c/a
35+	÷R	x	r	d	b,c=a×x+2—47r (—1 ≤x<1)
35+	÷I	r	x	c	b=a×x+r
1	ROUND	x	c	d	x=a,b ROUNDED TO SINGLE LENGTH
2+	ROUNDF	x	c	d	
	ROUNDH	x	b	c	x=a ROUNDED TO HALF LENGTH
	ROUNDHF	x	b	c	
1	ABS	x	b	c	x= | a |
2+	ABSF	x	b	c	
2+	STAND	x	b	c	x=a IN STANDARD FLOATING FORM
	FLOAT	x	c	d	x=b×2a —128≤ a ≤+127
	FLOATD	x	y	d	x,y=b,c×2a —128≤ a ≤+127
	FIX	x	y	b	y×2x=a

	USER CODE	FINAL STATE OF N1	N2	N3	NOTES
	MAX	x	y	c	x IS THE MAX. OF a & b, y IS THE MIN,
	MAXF	x	y	c	OVERFLOW SET IF REVERSED.
3	STR	x	y	b	y=a WITH DO=O, x=48 COPIES OF DO OF a.
4	CONT	x	c	d	x=b WITH THE SIGN DIGIT OF a
	SIGN	x	c	d	x=+1 IF b>a x= 0 IF b=a x=—1 IF b<a
	SIGNF	x	c	d	
1	NOT	x	b	c	x=1's COMPLEMENT OF a
2	OR	x	c	d	x=a *or* b
2	AND	x	c	d	x= a *and* b
1	NEV	x	c	d	x=a *nev* b
26	BITS	x	b	c	x=NO. OF NON ZERO BITS IN a
2	ERASE	b	c	d	REMOVE a
3	ZERO	O	a	b	SET A ZERO WORD IN N1
3	DUP	a	a	b	DUPLICATE a
5	DUPD	a	b	a	DUPLICATE a,b. b in N4
2	REV	b	a	c	REVERSE a & b
4	REVD	c	d	a	REVERSE a,b & c,d. b in N4
2	PERM	b	c	a	INTERCHANGE abc CYCLICALLY
	CAB	c	a	b	EQUIVALENT TO TWO PERMS
	DUMMY	a	b	c	NO EFFECT
	VR	a	b	c	CLEAR OVERFLOW REGISTER
	=TR	b	c	d	SET TEST REGISTER=DO OF a
	TOB	x	c	d	x=a CONVERTED TO BINARY USING RADIX WORD b *
	FRB	x	c	d	x=a CONVERTED FROM BINARY USING RADIX WORD b

*NOTE EACH DIGIT OF a MUST BE IN 6-BIT BINARY (NOT EXCESS 16 AS IN THE CHARACTER CODE).

TWO-SYLLABLE INSTRUCTIONS

USER CODE	FINAL STATE OF N1	N2	N3	NOTES
SHA±n	x	b	c	$x=a\times 2^{\pm n}$ — OVERFLOW SET IF SIGN CHANGES DURING SHIFT
SHACq	x	b	c	$x=a\times 2^{Cq}$ — OVERFLOW SET IF SIGN CHANGES DURING SHIFT
SHAD±n	x	y	c	$x,y=a,b\times 2^{\pm n}$ — OVERFLOW SET IF SIGN CHANGES DURING SHIFT
SHADCq	x	y	c	$x,y=a,b\times 2^{Cq}$ — OVERFLOW SET IF SIGN CHANGES DURING SHIFT
SHL±n	x	b	c	x=a OR x,y=a,b — SHIFTED AS A BIT PATTERN WITH NO NUMERICAL ASSOCIATIONS
SHLCq	x	b	c	x=a OR x,y=a,b — SHIFTED AS A BIT PATTERN WITH NO NUMERICAL ASSOCIATIONS
SHLD±n	x	y	c	x=a OR x,y=a,b — SHIFTED AS A BIT PATTERN WITH NO NUMERICAL ASSOCIATIONS
SHLDCq	x	y	c	x=a OR x,y=a,b — SHIFTED AS A BIT PATTERN WITH NO NUMERICAL ASSOCIATIONS
SHC±n	x	b	c	x=a SHIFTED CYCLICALLY
SHCCq	x	b	c	x=a SHIFTED CYCLICALLY
=LINK	b	c	d	TRANSFER D32-47 TO THE TOP CELL OF THE SJNS
LINK	x	a	b	x=THE CONTENTS OF THE TOP CELL OF THE SJNS
× +	x	y	e	$x,y=(a\times b)+c,d$
× +±n	x	y	e	$x,y=(a\times b)\ 2^{\pm n}+c,d$
× +Cq	x	y	e	$x,y=(a\times b)\ 2^{Cq}+c,d$

NOTE: $-64\leq n\leq +63$, $-128\leq Cq\leq +127$
FOR CYCLIC SHIFTS $-48\leq n,Cq\leq +48$.

Q-STORE INSTRUCTIONS (TWO-SYLLABLE)

USER CODE	FINAL STATE OF N1	N2	N3	Q-STORE	NOTES
Qq	Qq	a	b	NO CHANGE	
=Qq	b	c	d	a	
=+Qq	b	c	d	Qq+a	*
Cq	Cq	a	b	NO CHANGE	**
=Cq	b	c	d	L(a)/Iq/Mq	
=RCq	b	c	d	L(a)/1/O	
=+Cq	b	c	d	x/Iq/Mq	x=Cq+L(a) *
NCq	a	b	c	x/Iq/Mq	x=—Cq
DCq	a	b	c	x/Iq/Mq	x=Cq—1
Iq	Iq	a	b	NO CHANGE	**
=Iq	b	c	d	Cq/L(a)/Mq	
=RIq	b	c	d	O/L(a)/O	
=+Iq	b	c	d	Cq/x/Mq	x=Iq+L(a) *
Iq=±1	a	b	c	Cq/±1/Mq	
Iq=±2	a	b	c	Cq/±2/Mq	
Mq	Mq	a	b	NO CHANGE	**
=Mq	b	c	d	Cq/Iq/L(a)	
=RMq	b	c	d	O/1/L(a)	
=+Mq	b	c	d	Cq/Iq/x	x=Mq+L(a) *
M±Iq	a	b	c	Cq/Ip/x	x=Mq±Iq
Qk TO Qq	a	b	c	Qk	
Ck TO Qq	a	b	c	Ck/Iq/Mq	
Ik TO Qq	a	b	c	Cq/Ik/Mq	
Mk TO Qq	a	b	c	Cq/Iq/Mk	
IMk TO Qq	a	b	c	Cq/Ik/Mk	
CMk TO Qq	a	b	c	Ck/Iq/Mk	
CIk TO Qq	a	b	c	Ck/Ik/Mq	

NOTE: L(a) = THE LEAST SIGNIFICANT 16 BITS OF A
$1\leq q\leq 15$, $0\leq k\leq 15$
QO=CO=IO=MO=O

* N1 IS NESTED DOWN TO N2 DURING THE EXECUTION OF THESE INSTRUCTIONS
** THE SIGN DIGIT, D32, IS EXTENDED UP TO DO

OUT (THREE-SYLLABLE)
ENTRIES TO DIRECTOR

N1	N2	N3	NOTES
ZERO OR EMPTY	NOT USED	NOT USED	ENDS PROGRAM. TERMINATES ALL PERIPHERAL TRANSFERS IMMEDIATELY. CLEARS NS & SJNS. CALLS FOR NEXT PROGRAM.
1	PROGRAM NUMBER		ENDS PROGRAM. DOES NOT DEALLOCATE PERIPHERALS OR CLEAR NESTING STORES. ENTERS THE PROGRAM GIVEN IN N1 AND N2.
2	TIME LIMIT	NOT USED	TERMINATES PROGRAM AS IN OUT 0; ENTERS THE PROGRAM ALREADY IN STORE AT E0, TAKING THE TIME LIMIT FROM N2.
3	NOT USED	NOT USED	PUTS THE TIME TAKEN SO FAR (SECONDS TO 23 I.P.) IN N1, AND RETURNS TO THE NEXT INSTRUCTION.
4	IDENTIFIER	NOT USED	ALLOCATES THE TAPE DECK CARRYING THE TAPE WITH THE GIVEN IDENTIFIER. THE DEVICE NUMBER IS LEFT IN N1.
5	INTEGER	NOT USED	ALLOCATES UNITS OTHER THAN MAGNETIC TAPE. THE INTEGER IN N2 DEFINES THE UNIT. 1 8 CHANNEL PAPER TAPE PUNCH 2 PAPER TAPE READER 3 HIGH SPEED ON-LINE PRINTER 4 CARD READER 5 5 CHANNEL PAPER TAPE PUNCH THE DEVICE NUMBER IS LEFT IN N1.
6	DEVICE No.	NOT USED	DEALLOCATES THE DEVICE
7	DEVICE No.	NOT USED	DEALLOCATES A MAGNETIC TAPE WHICH IS LEFT LOADED.
8	Q O/p/q	NOT USED	OUTPUT WORDS p+1 TO q INCLUSIVE IN THE STREAM WHOSE NUMBER IS IN WORD p. (N.B. THE CONTENTS OF p ARE ALTERED IN EXECUTION).

FETCH AND STORE INSTRUCTIONS
DIRECTLY ADDRESSED (THREE-SYLLABLE)

USER CODE	EFFECT ON Qq C	I	M	FINAL STATE OF N1	N2	N3	TRANSFER ADDRESS
Yy	—	—	—	x	a	b	Yy
YyMq	—	—	—	x	a	b	Y(y+Mq)
YyMqQ	Cq—1	—	Mq+Iq	x	a	b	Y(y+Mq)
=Yy	—	—	—	b	c	d	Yy
=YyMq	—	—	—	b	c	d	Y(y+Mq)
=YyMqQ	Cq—1	—	Mq+Iq	b	c	d	Y(y+Mq)

Yy MAY BE REPLACED BY ANY OF THE FOLLOWING
YAy, YBy .... YZy, (Excluding YIy and YOy), Vv, Ww, Ee, VvLl, VvPp.

INDIRECTLY ADDRESSED (2 SYLLABLE)

USER CODE	EFFECT ON Qq C	I	M	FINAL STATE OF N1	N2	N3	TRANSFER ADDRESS
MkMq	—	—	—	x	a	b	Mk+Mq
MkMqQ	Cq—1	—	Mq+Iq	x	a	b	Mk+Mq
MkMqH	—	—	—	x	a	b	Mk+½Mq *
MkMqQH	Cq—1	—	Mq+Iq	x	a	b	Mk+½Mq *
=MkMq	—	—	—	b	c	d	Mk+Mq
=MkMqQ	Cq—1	—	Mq+Iq	b	c	d	Mk+Mq
=MkMqH	—	—	—	b	c	d	Mk+½Mq *
=MkMqQH	Cq—1	—	Mq+Iq	b	c	d	Mk+½Mq *

NOTE: IF THE INSTRUCTION ENDS IN N, (e.g. MkMqN), THE TRANSFER ADDRESS IS INCREASED BY 1.
* Mq MUST BE POSITIVE FOR THESE INSTRUCTIONS

V-STORE SPECIFICATIONS

USER CODE	NOTES
Vv=z/s	STORE SINGLE LENGTH FIXED POINT CONSTANT
VvD=z/s	STORE DOUBLE LENGTH FIXED POINT CONSTANT IN Vv AND Vv+1
Vv=Fz	STORE SINGLE LENGTH FLOATING POINT CONSTANT
VvD=Fz	STORE DOUBLE LENGTH FLOATING POINT CONSTANT
Vv=Bt/s	STORE OCTAL INTEGER t
Vv=AYy	STORE CORE ADDRESS OF Yy, ALL VALID ADDRESS FORMS MAY BE USED
Vv=Qc/i/m	STORE THREE SIGNED 16 BIT INTEGERS. c, i OR m MAY BE IN ANY FORM PERMITTED FOR SET
VvU=(SPEC.)	STORE CONSTANT IN DO-D23
VvL=(SPEC.)	STORE CONSTANT IN D24-D47
Vv=Cc	c IS A SEQUENCE OF NOT MORE THAN 8 CHARACTERS—EXCLUDING ; AND —>

SET (3 SYLLABLES)

USER CODE	FINAL STATE OF N1	N2	NOTES
SETBt	t	a	T IS AN OCTAL INTEGER t< 177777
SETh	h	a	SEE BELOW

SET PUTS A SIGNED 16 BIT NUMBER INTO D32-D47 of N1 :
h MAY BE EITHER A VALID ADDRESS FORM :
AYy, AYAy, AYBy . . . AYZy (EXCLUDING AYIy and AYOy)
AVv, AWw, AVvPp, AVvLI, ARr, ARrPp, ARrLI.
or :
A SIGNED INTEGER IN THE RANGE $-32768 \leq h \leq +32767$.

TEST POINT
THE USER CODE INSTRUCTION Tt; IS COMPILED AS SETt; JSL1 ;

INPUT INSTRUCTIONS (TWO-SYLLABLE)

MONITOR TYPEWRITER	PAPER TAPE READER	PAPER TAPE PUNCH	CARD READER	MAGNETIC TAPE UNIT	LINE PRINTER	GENERAL FORM
REAC TRQq	READ PRQq	L.I.V.	BINARY READ	FORWARD READ MFRQq	L.I.V.	PIAQq
READ TO E.M. TREQq	READ TO E.M. PREQq	L.I.V.	BINARY READ TO E.M.	FORWARD READ TO E.M. MFREQq	L.I.V.	PIBQq
CHARACTER READ	CHARACTER READ PRCQq	L.I.V.	BINARY CHARACTER READ	FORWARD READ	L.I.V.	PICQq
CHARACTER READ TO E.M.	CHARACTER READ TO E.M. PRCEQq	L.I.V.	BINARY CHARACTER READ TO E.M.	FORWARD READ TO E.M.	L.I.V.	PIDQq
READ	READ	L.I.V.	ALPHA-NUMERIC READ	BACKWARD READ MBRQq	L.I.V.	PIEQq
READ TO E.M.	READ TO E.M.	L.I.V.	ALPHA-NUMERIC READ TO E.M.	BACKWARD READ TO E.M. MBREQq	L.I.V.	PIFQq
CHARACTER READ	CHARACTER READ	L.I.V.	ALPHA-NUMERIC CHARACTER READ	BACKWARD READ	L.I.V.	PIGQq
CHARACTER READ TO E.M.	CHARACTER READ TO E.M.	L.I.V.	ALPHA-NUMERIC CHARACTER READ TO E.M.	BACKWARD READ TO E.M.	L.I.V.	PIHQq

OUTPUT INSTRUCTIONS (TWO-SYLLABLE)

MONITOR TYPEWRITER	PAPER TAPE READER	PAPER TAPE PUNCH	CARD READER	MAGNETIC TAPE UNIT	LINE PRINTER	GENERAL FORM
WRITE TWQq	L.I.V.	WRITE PWQq	L.I.V.	WRITE MWQq	WRITE LPQq	POAQq
WRITE TO E.M. TWEQq	L.I.V.	WRITE TO E.M. PWEQq	L.I.V.	WRITE TO E.M. MWEQq	WRITE TO E.M. LPEQq	POBQq
CHARACTER WRITE	L.I.V.	CHARACTER WRITE PWCQq	L.I.V.	WRITE LAST BLOCK MLWQq	CHARACTER WRITE	POCQq
CHARACTER WRITE TO E.M.	L.I.V.	CHARACTER WRITE TO E.M. PWCEQq	L.I.V.	WRITE LAST BLOCK TO E.M. MLWEQq	CHARACTER WRITE TO E.M.	PODQq
L.I.V.	L.I.V.	CHARACTER GAP PGAPQq	L.I.V.	GAP MGAPQq		POEQq
L.I.V.	L.I.V.	WORD GAP	L.I.V.	WIPE MWIPEQq		POFQq

MANIPULATIVE INSTRUCTIONS (TWO-SYLLABLE)

MONITOR TYPEWRITER	PAPER TAPE READER	PAPER TAPE PUNCH	CARD READER	MAGNETIC TAPE UNIT	LINE PRINTER	GENERAL FORM
L.I.V.	L.I.V.	L.I.V.	L.I.V.	FORWARD SKIP MFSKQq	L.I.V.	PMAQq
NO EFFECT	SET TR IF 8 CHANNEL SET	NO EFFECT	SET TR IF RECHECK SWITCH OFF	SET TR IF TAPE AT BTC MBTQq	NO EFFECT	PMBQq
NO EFFECT	NO EFFECT	NO EFFECT	NO EFFECT	SET TR IF LAST BLOCK LEVEL PRESENT MLBQq	NO EFFECT	PMCQq
L.I.V.	L.I.V.	L.I.V.	L.I.V.	REWIND MRWDQq	L.I.V.	PMDQq
L.I.V.	L.I.V.	L.I.V.	L.I.V.	BACKWARD SKIP MBSKQq	L.I.V.	PMEQq
NO EFFECT	NO EFFECT	NO EFFECT	NO EFFECT	SET TR IF E.T.W. PRESENT METQq	NO EFFECT	PMFQq

OTHER PERIPHERAL OPERATIONS (TWO-SYLLABLE)

USER CODE	OPERATION
MANUALQq	SET DEVICE UNREADY
BUSYQq	SET TR IF DEVICE BUSY
PARQq	SET TR IF:— PARITY FAIL (P/T. READ OR M/T) CHECK FAIL (CARD READ) ERROR (PRINTER)
TLOQq	SET TR IF ANY PART OF THE MAIN STORE AREA IS LOCKED OUT
INTQq	INTERRUPT IF DEVICE BUSY

JUMP INSTRUCTIONS (THREE-SYLLABLE)

USER CODE	FINAL STATE OF N1	N2	N3	NOTES
JEe	a	b	c	JUMP TO SYLLABLE O OF Ee.
Jr	a	b	c	JUMP TO REFERENCE r
JSEe	a	b	c	JUMP TO SYLLABLE O OF Ee, LEAVING THE ADDRESS OF THE INSTRUCTION IN THE SJNS.
JSr	a	b	c	JUMP TO REFERENCE r LEAVING THE ADDRESS OF THE INSTRUCTION IN THE SJNS
JrV	a	b	c	JUMP IF OVERFLOW SET, CLEAR OVERFLOW
JrNV	a	b	c	JUMP IF OVERFLOW NOT SET. CLEAR OVERFLOW

USER CODE	FINAL STATE OF N1	N2	N3	NOTES
JrTR	a	b	c	JUMP IF TEST REGISTER SET. CLEAR TEST REGISTER
JrNTR	a	b	c	JUMP IF TEST REGISTER NOT SET. CLEAR TEST REGISTER
JrEN	a	b	c	JUMP IF NESTING STORE EMPTY
JrNEN	a	b	c	JUMP IF NESTING STORE NOT EMPTY
JrEJ	a	b	c	JUMP IF SJNS EMPTY
JrNEJ	a	b	c	JUMP IF SJNS NOT EMPTY
JrCqZ	a	b	c	JUMP IF Cq is ZERO
JrCqNZ	a	b	c	JUMP IF Cq IS NOT ZERO*
Jr>Z	b	c	d	JUMP IF a>Q
Jr≥Z	b	c	d	JUMP IF a≥O
Jr=Z	b	c	d	JUMP IF a=O
Jr≠Z	b	c	d	JUMP IF a ≠ O
Jr<Z	b	c	d	JUMP IF a<O
Jr≤Z	b	c	d	JUMP IF a≤O
Jr=	b	c	d	JUMP IF a=b
Jr≠	b	c	d	JUMP IF a≠b
EXITnARr	a	b	c	JUMP TO THE ADDRESS GIVEN BY (SJNS Address) + ARr + n/2

*JrCqNZS IS A SPECIAL 2 SYLLABLE JUMP FOR SHORT LOOPS

NOTE: REFERENCE r MAY BE REPLACED BY ANY OF THE FOLLOWING FORMS Pp, LI, rPp, rLI, rPO.

THE ONLY JUMP INSTRUCTIONS WHICH CAN PLANT AN ADDRESS ARE JSr AND JSEe, JSr>Z ETC. ARE NOT ALLOWED.

C.N. Paper Tape Code. Case Normal.
C.S. Paper Tape Code. Case Shift.
P. Printer Code.
C.R. Card Reader Code.

1st OCTAL DIGIT \ 2nd OCTAL DIGIT		0	1	2	3	4	5	6	7
0	C.N. C.S. P. C.R.	SPACE SPACE SPACE BLANK	Y,6,8	CRLF CRLF LS Y,2,8	PC O,2,8	TAB TAB ISS O,5,8	Y,5,8	C.S. C.S. % O,4,8	C.N. C.N. ' Y,7,8
1	C.N. C.S. P. C.R.	: 4,8	= 3,8	(X,5,8	) X,2,8	£ X,3,8	* X,4,8	, O,3,8	/ : / O,1
2	C.N. C.S. P. C.R.	0 ↑ 0 0	1 [1 1	2] 2 2	3 < 3 3	4 > 4 4	5 = 5 5	6 × 6 6	7 ÷ 7 7

C.N. Paper Tape Code. Case Normal.
C.S. Paper Tape Code. Case Shift.
P. Printer Code.
C.R. Card Reader Code.

3	C.N. C.S. P. C.R.	8 (8 8	9) 9 9	— — 0,6,8	10 £ 10 X,6,8	; ; ; Y,4,8	+ = + Y	— * — X	. , . Y,3,8
4	C.N. C.S. P. C.R.	0,7,8	A a A Y,1	B b B Y,2	C c C Y,3	D d D Y,4	E e E Y,5	F f F Y,6	G g G Y,7
5	C.N. C.S. P. C.R.	H h H Y,8	I i I Y,9	J j J X,1	K k K X,2	L l L X,3	M m M X,4	N n N X,5	O o O X,6
6	C.N. C.S. P. C.R.	P p P X,7	Q q Q X,8	R r R X,9	S s S 0,2	T t T 0,3	U u U 0,4	V v V 0,5	W w W 0,6
7	C.N. C.S. P. C.R.	X x X 0,7	Y y Y 0,8	Z z Z 0,9	E.F. 5,8	E.D. 6,8	→ → E.M. 7,8	X,7,8	2,8