PROJECT (4) ML

(A) INSTRUCTION

@[VALUE]

0 000000000010100

- 0 → A instruction OPCODE
- remaining 15 bits → [VALUE] MAX $2^{15}-1$

(C) INSTRUCTION

optional [DESTINATION] = [COMPUTATION] ; [JUMP] optional (COMPARE TO 2…)

1 1 1 a c1 c2 c3 c4 c5 c6 d1 d2 d3 j1 j2 j3

- 1 → C instruction OPCODE
- 1 1 → unused, set to 1
- a c1 … c6 → COMP (7 bits)
- d1 d2 d3 → dest (3 bit)
- j1 j2 j3 → JUMP (3 bit)

COMP (7 bit)

a=0	a=1	C1	C2	C3	C4	C5	C6
0		1	0	1	0	1	0
+1		1	1	1	1	1	1
−1		1	1	1	0	1	0
D		0	0	1	1	0	0
A	M	1	1	0	0	0	0
!D		0	0	1	1	0	1
!A	!M	1	1	0	0	0	1
−D		0	0	1	1	1	1
−A	−M	1	1	0	0	1	1
D+1		0	1	1	1	1	1
A+1	M+1	1	1	0	1	1	1
D−1		0	0	1	1	1	0
A−1	M−1	1	1	0	0	1	0
D+A	D+M	0	0	0	0	1	0
D−A	D−M	0	1	0	0	1	1
A−D	M−D	0	0	0	1	1	1
D&A	D&M	0	0	0	0	0	0
D|A	D|M	0	1	0	1	0	1

DEST (3 bit)

DEST	d1	d2	d3	Comment
NULL	0	0	0	NO VALUE STORED
M	0	0	1	TO M
D	0	1	0	TO D
MD	0	1	1	TO BOTH M, D
A	1	0	0	TO A
AM	1	0	1	TO BOTH A, M
AD	1	1	0	" " A, D
AMD	1	1	1	TO A, M, D

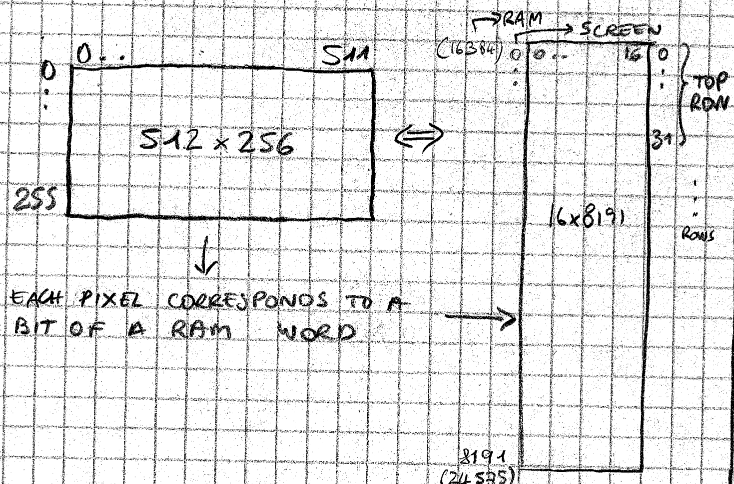
JUMP (3 bit)

JUMP	J1	J2	J3	Comment
NULL	0	0	0	NO JUMP
JGT	0	0	1	IF COMP > 0
JEQ	0	1	0	" " = 0
JGE	0	1	1	" " ≥ 0
JLT	1	0	0	" " < 0
JNE	1	0	1	" " ≠ 0
JLE	1	1	0	" " ≤ 0
JMP	1	1	1	UNCONDITIONAL

CPU REGISTERS:

- (A) → "Address register" its value is the current "pointed" RAM Register (A INSTRUCTION OR A= … SETS …)
- (M) → Its value is the CONTENT of the CURRENTLY "Pointed" RAM Register
- (D) → General purpose register

SCREEN = 16384 (.. 24575)



EACH PIXEL CORRESPONDS TO A BIT OF A RAM WORD

IN ORDER TO CHANGE PIXEL ∞ (COL, ROW)
I HAVE TO MODIFY RAM[SCREEN + i] = SCREEN[i]

$$i = 32 * ROW + \frac{COL}{16}$$

AND INSIDE THIS RAM WORD THE BIT N°

$$BIT\ N° = COL \% 16$$

KBD = 24576

Contains the scancode of the key currently being pressed. (SUBSET of ASCII !)

Key	Scancode
0	48
1	49
2	50
3	51
4	52
5	53
6	54
7	55
8	56
9	57
:	58
;	59
<	60
=	61
>	62
?	63
@	64
[	91
\	92
]	93
^	94
_	95

Key		Scancode	
A	a	65	97
B	b	66	98
C	c	67	99
D	d	68	100
E	e	69	101
F	f	70	102
G	g	71	103
H	h	72	104
I	i	73	105
J	j	74	106
K	k	75	107
L	l	76	108
M	m	77	109
N	n	78	110
O	o	79	111
P	p	80	112
Q	q	81	113
R	r	82	114
S	s	83	115
T	t	84	116
U	u	85	117
V	v	86	118
W	w	87	119
X	x	88	120
Y	y	89	121
Z	z	90	122

Key	Scancode
[space]	32
!	33
"	34
#	35
$	36
%	37
&	38
'	39
(	40
)	41
*	42
+	43
,	44
−	45
.	46
/	47

Key	Scancode
newline	128
backspace	129
←	130
↑	131
→	132
↓	133
home	134
end	135
pg ↑	136
pg ↓	137
insert	138
del	139
esc	140
f1	141
f2	142
f3	143
f4	144
f5	145
f6	146
f7	147
f8	148
f9	149
f10	150
f11	151
f12	152

OTHER ACCEPTED SYMBOLS

SP	0
LCL	1
ARG	2
THIS	3
THAT	4

VIRTUAL REGISTERS

R0	0
⋮	⋮
R15	15