
Chapter 5

Input/Output

5.1 I/O Devices

In this chapter we will describe on the I/O devices of the MPF-III. Below is a list of the I/O devices:

- 1) Keyboard
- 2) 80-column
- 3) Video-display generator
- 4) Speaker
- 5) Cassette input and output
- 6) Game input and output
- 7) Printer interface
- 8) Sound generator

5.1.1 Keyboard

The MPF-III keyboard decoder can generate 232 ASCII codes (\$00-\$06, \$1F-\$FF). To get a character code through the keyboard, a machine language program reads a byte from the keyboard data location. Consult the following table:

LOCATION		DESCRIPTION
HEX	DECIMAL	
\$C000	49152	Keyboard data and strobe
\$C010	49168	Any-key-down flag and clear strobe switch

The low order 7 bits (bit 0-bit 6) constitutes the character code of the byte at the keyboard data location. The high order bit (bit 7) is the strobe bit. Your program can detect if any key (except for PB0 and PB1) is pressed by reading the byte at address 49168. Bit 7 is called Any-key-down, if a key is pressed, its value becomes 1, otherwise it is 0. The bit has a value of 128, therefore if you use the PEEK function to get the value of the byte, you will find it is equal to or greater than 128 if a key is pressed, otherwise, it is less than 128.

The high order bit of the keyboard data byte is the strobe bit. If a key is pressed, the strobe bit will remain high until we read or write the clear strobe location to reset it. This location is a combination of flag and switch. The flag will detect if a key is pressed, and the switch will clear the strobe bit. The switch function of this memory location is called a soft switch. You will reset the keyboard strobe whether you read or write this location.

NOTE: Whenever you read Any-key-down flag, you will clear the keyboard strobe at the same time. Therefore, if you want to read flag and strobe in a program, you must read the strobe bit at first.

Once the keyboard strobe is cleared, it will remain low until any key is pressed. Even if you clear the strobe, you can read the character code at the keyboard data location. This is because the low order 7 bits will remain the same until a key is pressed.

The codes generated when the keys are pressed are listed in the following tables. The codes from 80 to FF except 83 and 93 have the auto-repeat feature. If you press these keys for more than 0.9 second, the corresponding code will be sent out continuously at a rate of 15/second.

NOTE: In the binary key representation on the top of the following table, the three bits are used to show the status of ALT, the shift key **Shift**, and the control key (CTRL). It is 1 if the corresponding key is pressed, otherwise it is 0.)

Tables of ASCII Character Codes

KEY	ALT / ↑ / CTRL							
	000	001	010	011	100	101	110	111
Ø INSC	ØØ	ØØ	BØ	BØ	ØØ	ØØ	BØ	BØ
1 CLRL	Ø1	Ø1	B1	B1	Ø1	Ø1	B1	B1
2 ↓	8A	8A	B2	B2	8A	8A	B2	B2
3 CPES	Ø2	Ø2	B3	B3	Ø2	Ø2	B3	B3
4 ←	88	88	B4	B4	88	88	B4	B4
5	B5	B5	B5	B5	B5	B5	B5	B5
6 →	95	95	B6	B6	95	95	B6	B6
7 CLRS	Ø3	Ø3	B7	B7	Ø3	Ø3	B7	B7
8 ↑	8B	8b	B8	B8	8B	8B	B8	B8
9 HOME	Ø4	Ø4	B9	B9	Ø4	Ø4	B9	B9
. DELC	Ø5	Ø5	AE	AE	Ø5	Ø5	AE	AE
+ RUN	Ø6	Ø6	AB	AB	Ø6	Ø6	AB	AB
- LIST	1F	1F	AD	AD	1F	1F	AD	AD
HALT	93	93	93	93	93	93	93	93
BREAK	83	83	83	83	83	83	83	83

F1	20	2C	38	44	50	50	50	50
F2	21	2D	39	45	51	51	51	51
F3	22	2E	3A	46	52	52	52	52
F4	23	2F	3B	47	53	53	53	53
F5	24	30	3C	48	54	54	54	54
F6	25	31	3D	49	55	55	55	55
F7	26	32	3E	4A	56	56	56	56
F8	27	33	3F	4B	57	57	57	57
F9	28	34	40	4C	58	58	58	58
F10	29	35	41	4D	59	59	59	59
F11	2A	36	42	4E	5A	5A	5A	5A
F12	2B	37	43	4F	5B	5B	5B	5B

KEY	ALT/ ↑ / CTRL							
	000	001	010	011	100	101	110	111
←	88	88	88	88	88	88	88	88
TAB	89	89	89	89	89	89	89	89
↔	8D	8D	8D	8D	8D	8D	8D	8D
ESC	9B	9B	9B	9B	9B	9B	9B	9B
SPACE	AO	AO	AO	AO	AO	AO	AO	AO
' "	A7	A7	A2	A2	A7	A7	A2	A2
, <	AC	AC	BC	BC	AC	AC	BC	BC
—	AD	AD	DF	9F	AD	AD	DF	9F
• >	AE	AE	BE	BE	AE	AE	BE	BE
/ ?	AF	AF	BF	BF	AF	AF	BF	BF
O)	BO	Bo	A9	A9	5C	5C	5C	5C
1 !	B1	B1	A1	A1	5D	5D	5D	5D
2 @	B2	80	CO	80	5E	5E	5E	5E
3 #	B3	B3	A3	A3	5F	5F	5F	5F
4 \$	B4	B4	A4	A4	60	60	60	60
5 %	B5	B5	A5	A5	7B	7B	7B	7B
6 ^	B6	9E	DE	9E	7C	7C	7C	7C
7 &	B7	B7	A6	A6	7D	7D	7D	7D
8 *	B8	B8	AA	AA	7E	7E	7E	7E
9 (B9	B9	A8	A8	7F	7F	7F	7F
: :	BB	BB	BA	BA	BB	BB	BA	BA
= +	BD	BD	AB	AB	BD	BD	AB	AB
[{	DB	9B	FB	9B	DB	9B	FB	9B
\	DC	9C	FC	9C	DC	9C	FC	9C
DEL	FF	FF	FF	FF	FF	FF	FF	FF

KEY	ALT / ↑ / CTRL							
	000	001	010	011	100	101	110	111
] }	DD	9D	FD	9D	DD	9D	FD	9D
~	EØ	EØ	FE	FE	EØ	EØ	FE	FE
A	E1	81	C1	81	61	61	61	61
B	E2	82	C2	82	62	62	62	62
C	E3	83	C3	83	63	63	63	63
D	E4	84	C4	84	64	64	64	64
E	E5	85	C5	85	65	65	65	65
F	E6	86	C6	86	66	66	66	66
G	E7	87	C7	87	67	67	67	67
H	E8	88	C8	88	68	68	68	68
I	E9	89	C9	89	69	69	69	69
J	EA	8A	CA	8A	6A	6A	6A	6A
K	EB	8B	CB	8B	6B	6B	6B	6B
L	EC	8C	CC	8C	6C	6C	6C	6C
M	ED	8D	CD	8D	6D	6D	6D	6D
N	EE	8E	CE	8E	6E	6E	6E	6E
O	EF	8F	CF	8F	6F	6F	6F	6F
P	FØ	9Ø	DØ	9Ø	70	70	70	70
Q	F1	91	D1	91	71	71	71	71
R	F2	92	D2	92	72	72	72	72
S	F3	93	D3	93	73	73	73	73
T	F4	94	D4	94	74	74	74	74
U	F5	95	D5	95	75	75	75	75
V	F6	96	D6	96	76	76	76	76
W	F7	97	D7	97	77	77	77	77
X	F8	98	D8	98	78	78	78	78
Y	F9	99	D9	99	79	79	79	79
Z	FA	9A	DA	9A	7A	7A	7A	7A

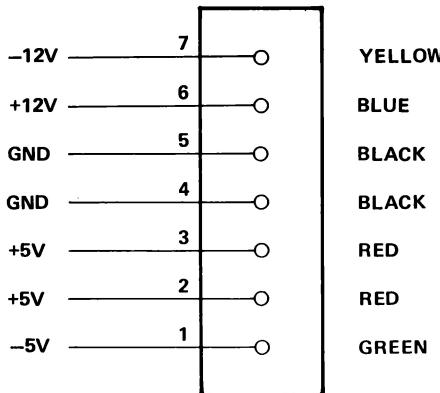


Fig. 1-4 Power Cord Connector

1.2.3 Keyboard

The MPF-III keyboard consists of 90 keys and two LED indicator indicating status of CAPS LOCK and NUM LOCK. The keyboard is connected to the system unit by a cable and a nine-pin D-type connector. The keyboard is of ergonomic design, smart in appearance and ease to operate.

Below is a list of the pin assignments of the MPF-III keyboard cable.

PIN	Signal
1	PB1
2	+5V
3	GND
4	DATA
5	CLOCK
6	STROBE
7	PB0
8	RESET
9	AKD

PB0, PB1 : Signals read into the system unit. AKD stands for "any key down". If any key is pressed, the signal is high. Otherwise it is low. The codes resulted from a press on the keys are listed in appendix D. All the codes between \$80-\$FF except \$83 and \$93 are typamatic (autorepeat) while those between \$00-\$7F are not. If you hold down a typamatic key for more than 0.9 second, the code will be sent out repeatedly at a rate of 15 times per second. The codes that can be obtained through the keyboard are \$00-\$06 and \$1F-\$FF, totaling 232. ("\$" stands for hexadecimal.)

The MPF-III keyboard is shown in FIG 1-5.



Fig. 1-5 The Keyboard

Next we will give you a detailed description of each of the 90 keys on the keyboard.

(1) Function keys

On top of the keyboard, you will find 12 function keys numbered F1-F12. In combination of the SHIFT, CTRL and ALT keys, a total of 60 codes are available.

1. Function keys F1-F12 pressed alone --- 12 codes
2. SHIFT key (1) and Function keys pressed simultaneously --- 12 codes
3. CONTROL (CTRL) key and Function keys pressed simultaneously --- 12 codes
4. SHIFT key and CONTROL key pressed simultaneously, followed by a press on the Function keys --- 12 codes
5. ALT key and Function keys pressed simultaneously --- 12 codes

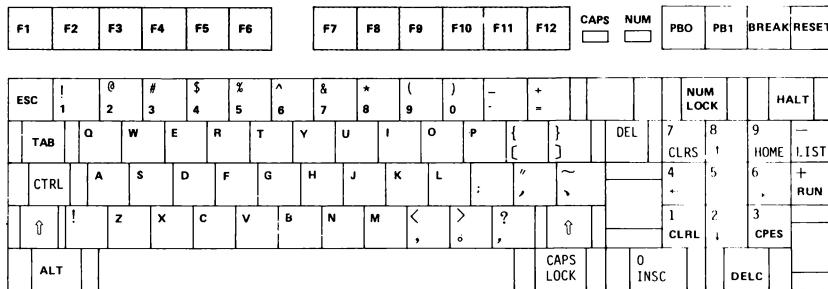


Fig. 1-6 Function key

(2) Special function key

1. PB1: This key is used for self-test of the system. First, press CTRL-RESET, followed by pressing PB1. Release CTRL-RESET first and then PB1. After these steps are completed, the MPF-III will start testing RAM, ROM, together with SG and Color Bar Test.

2. PB0 : If you want to invoke a cold start, you may first press CTRL and RESET simultaneously followed by a press on PB0 and then you release CTRL and RESET followed by PB0. In so doing you can do without powering off and on the system.
3. BREAK: You may press this key to suspend program execution while you are running a BASIC program. BREAK functions like a CTRL + C combination.
4. RESET: You may press CTRL and RESET simultaneously to obtain a warm start.
5. HALT: If you want to suspend the screen display you may press this key. A subsequent press on the same key will resume the screen display. Halt functions like a CTRL + S combination.
6. NUM LOCK : If you press this key, the indicating lamp will light up, and the numeric pad can be used like that found on a desktop calculator. This is a convenient feature when you have a lot of numeric data to handle. A subsequent press on the same key will make the lamp go out and the screen editing function keys are available.
7. CAPS LOCK: On some occasions you may want or need to type only upper case letters. The CAPS LOCK make it easy. Press the CAPS LOCK once to make the lamp light up and all alphabetic characters are displayed in uppercase. No other keys are affected. Press CAPS LOCK a second time the lamp will go out and you have the lower case alphabetic characters.
8. ESC : The ESC key when used in conjunction with I, K, M, J keys move the cursor one position up, right, down or left. After you enter the 80 - column mode with PR#3, ESC 4 can make the system return to 40-column mode and a subsequent ESC 8 will again reenter into the 80-column mode. In 80-column text display mode ESC + R can be used to select upper - or lower case characters. While the CAP lamp is off, characters are entered in lower case. But after pressing ESC R, you may type in upper case letters when the CAPS lamp is off.

In this case, letters enclosed in double quotes remain in lower case.

9. CTRL : CTRL in combination with some other keys can perform a variety of special functions as described earlier.
10.  : SHIFT key. Holding down this key while pressing another key generates the uppercase letter or the upper character printed on the key.
11. ALT In combination with letter/number keys, this key, this key can perform one-key BASIC command feature.

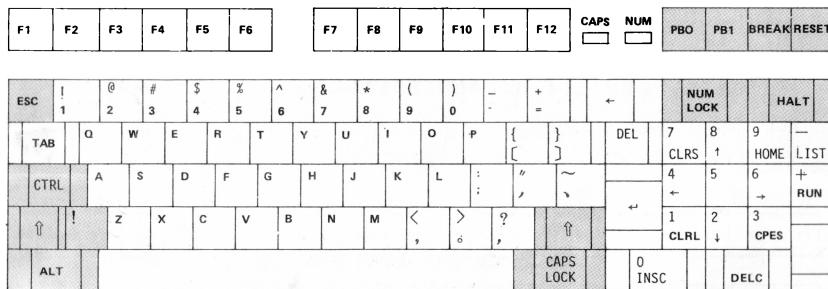


Fig. 1-7 Special Function keys

(3) One-key Screen Editing Commands

To use the one-key screen editing commands, you must key in PR#3 followed by the  key, and then key in ESC and 4 in sequence.

1. INSC : Insert a character. Pressing the INSC key will leave a space where the cursor is positioned, and the character originally at the cursor position as well as those that follow will be shifted one position to the right.
2. DELC : Delete a character. Pressing this key will delete the character currently at the cursor position and the characters that follow are shifted one position to the left.

3. CPES : Copy to end of statement. This key copies from where the cursor is located to the end of the same statement into the buffer. CPES functions the same way you press the key to the end of the statement.
4. CTRL : Clears from where the cursor is located to the end of the same line.
5. CLRS : Clear all that displayed on the screen with the cursor remaining at the original position.
6. HOME : This key moves the cursor to the upper lefthand corner with the screen display unaffected.
7. : These keys function the same way as M, I, K, J in combination with ESC. In particular, ESC enables/disables this feature. (For more details, see 3.4 screen Editor)

F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	CAPS	NUM	PBO	PB1	BREAK	RESET
ESC	!	@	#	\$	%	^	&	*	()	-	+	=	NUM LOCK		HALT	
1	2	3	4	5	6	7	8	9	0					7	8	9	-
TAB	Q	W	E	R	T	Y	U	I	O	P	{	}	DEL	CLRS	↑	HOME	LIST
CTRL	A	S	D	F	G	H	J	K	L	:	;	,		4	5	6	+
	!	Z	X	C	V	B	N	M	<	>	?	↑		←	→	RUN	
ALT													CAPS LOCK	0	INSC	DELC	

Fig. 1-8 One-key Screen Editing Key

(4) One-Key Command

1. LIST List data and/or program on the video display
2. RUN Run a program

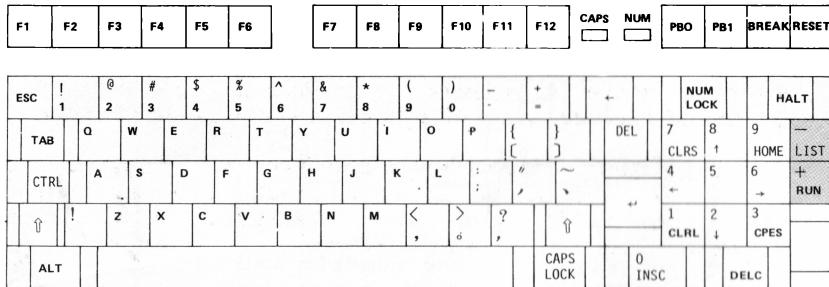


Fig. 1-9 One-Key Command

- (5) In the center of the keyboard, you will find 26 letter keys, 10 number keys and a total of 30 special symbol keys.

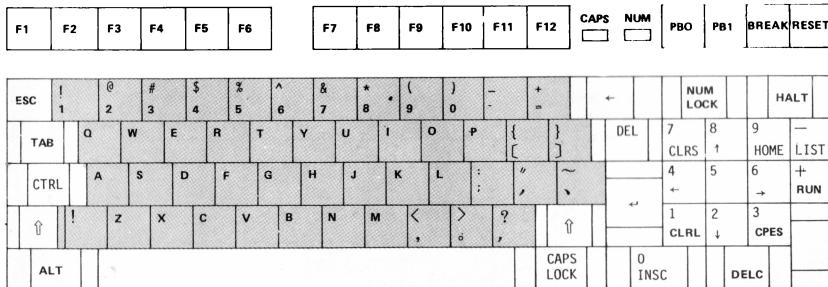


Fig. 1-10 The Typewriter Keyboard

- (6) Press NUM LOCK key (The lamp lights up) and you have the 10-key numeric pad as found on a calculator for input of numeric data.

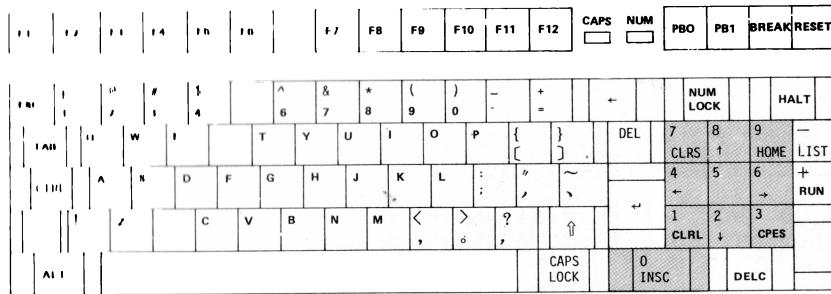


Fig. 1-11 The Numeric Pad

- (7) On the bottom of the keyboard you will find a long bar, which is the space key used to produce spaces.

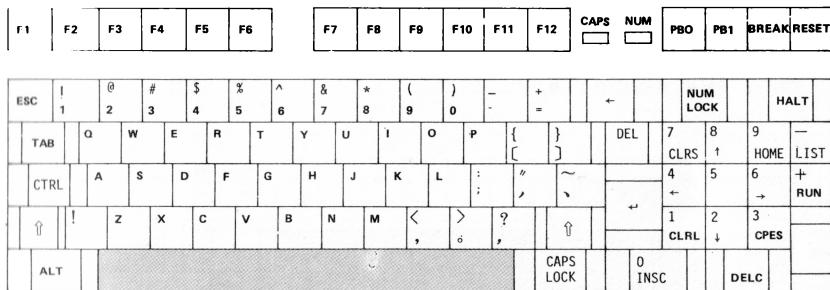


Fig. 1-12 The Space Key

	F1	F2	F3	F4	F5	F6		F7	F8	F9	F10	F11	F12		CAPS	NUM	PBO	PB1	BREAK/RESET
ESC	!	€	#	\$	%	^	*	&	()	-	+	=	+	NUM LOCK		HALT		
	2	3	4	5	6	7	8	9	0						DEL	7	8	9	
TAB	Q	W	E	R	T	Y	U	I	O	P	{	}	[]		CLRS	↑	HOME LIST	
CTRL	A	S	D	F	G	H	J	K	L	:	“	,	,	,	4	5	6	+	
!	Z	X	C	V	B	N	M	<	>	?	↑	,	,	↑	1	2	3	RUN	
ALT															CAPSLock	0	INS	DELC	

Fig. 1-13 The MPF-III Keyboard

D ASCII Character Codes

In the binary key representation on the top of the following table, the three bits are used to show the status of ALT, the shift key (\uparrow), and the control key (CTRL). It is 1 if the corresponding key is pressed, otherwise it is 0.

KEY	ALT / \uparrow / CTRL							
	000	001	010	011	100	101	110	111
Ø INSC	ØØ	ØØ	BØ	BØ	ØØ	ØØ	BØ	BØ
1 CLRL	Ø1	Ø1	B1	B1	Ø1	Ø1	B1	B1
2 ↓	8A	8A	B2	B2	8A	8A	B2	B2
3 CPES	Ø2	Ø2	B3	B3	Ø2	Ø2	B3	B3
4 ←	88	88	B4	B4	88	88	B4	B4
5	B5	B5	B5	B5	B5	B5	B5	B5
6 →	95	95	B6	B6	95	95	B6	B6
7 CLRS	Ø3	Ø3	B7	B7	Ø3	Ø3	B7	B7
8 ↑	8B	8b	B8	B8	8B	8B	B8	B8
9 HOME	Ø4	Ø4	B9	B9	Ø4	Ø4	B9	B9
. DELC	Ø5	Ø5	AE	AE	Ø5	Ø5	AE	AE
+ RUN	Ø6	Ø6	AB	AB	Ø6	Ø6	AB	AB
- LIST	1F	1F	AD	AD	1F	1F	AD	AD
HALT	93	93	93	93	93	93	93	93
BREAK	83	83	83	83	83	83	83	83

F1	20	2C	38	44	50	50	50	50
F2	21	2D	39	45	51	51	51	51
F3	22	2E	3A	46	52	52	52	52
F4	23	2F	3B	47	53	53	53	53
F5	24	30	3C	48	54	54	54	54
F6	25	31	3D	49	55	55	55	55
F7	26	32	3E	4A	56	56	56	56
F8	27	33	3F	4B	57	57	57	57
F9	28	34	40	4C	58	58	58	58
F10	29	35	41	4D	59	59	59	59
F11	2A	36	42	4E	5A	5A	5A	5A
F12	2B	37	43	4F	5B	5B	5B	5B

KEY	ALT / ↑ / CTRL							
	000	001	010	011	100	101	110	111
←	88	88	88	88	88	88	88	88
TAB	89	89	89	89	89	89	89	89
↔	8D	8D	8D	8D	8D	8D	8D	8D
ESC	9B	9B	9B	9B	9B	9B	9B	9B
SPACE	AO	AO	AO	AO	AO	AO	AO	AO
‘ ’	A7	A7	A2	A2	A7	A7	A2	A2
, <	AC	AC	BC	BC	AC	AC	BC	BC
—	AD	AD	DF	9F	AD	AD	DF	9F
• >	AE	AE	BE	BE	AE	AE	BE	BE
/ ?	AF	AF	BF	BF	AF	AF	BF	BF
O)	BO	Bo	A9	A9	5C	5C	5C	5C
1 !	B1	B1	A1	A1	5D	5D	5D	5D
2 @	B2	80	CO	80	5E	5E	5E	5E
3 #	B3	B3	A3	A3	5F	5F	5F	5F
4 \$	B4	B4	A4	A4	60	60	60	60
5 %	B5	B5	A5	A5	7B	7B	7B	7B
6 ^	B6	9E	DE	9E	7C	7C	7C	7C
7 &	B7	B7	A6	A6	7D	7D	7D	7D
8 *	B8	B8	AA	AA	7E	7E	7E	7E
9 (B9	B9	A8	A8	7F	7F	7F	7F
: :	BB	BB	BA	BA	BB	BB	BA	BA
= +	BD	BD	AB	AB	BD	BD	AB	AB
[{	DB	9B	FB	9B	DB	9B	FB	9B
\	DC	9C	FC	9C	DC	9C	FC	9C
DEL	FF	FF	FF	FF	FF	FF	FF	FF

KEY	ALT / ↑ / CTRL							
	000	001	010	011	100	101	110	111
] }	DD	9D	FD	9D	DD	9D	FD	9D
~	EØ	EØ	FE	FE	EØ	EØ	FE	FE
A	E1	81	C1	81	61	61	61	61
B	E2	82	C2	82	62	62	62	62
C	E3	83	C3	83	63	63	63	63
D	E4	84	C4	84	64	64	64	64
E	E5	85	C5	85	65	65	65	65
F	E6	86	C6	86	66	66	66	66
G	E7	87	C7	87	67	67	67	67
H	E8	88	C8	88	68	68	68	68
I	E9	89	C9	89	69	69	69	69
J	EA	8A	CA	8A	6A	6A	6A	6A
K	EB	8B	CB	8B	6B	6B	6B	6B
L	EC	8C	CC	8C	6C	6C	6C	6C
M	ED	8D	CD	8D	6D	6D	6D	6D
N	EE	8E	CE	8E	6E	6E	6E	6E
O	EF	8F	CF	8F	6F	6F	6F	6F
P	FØ	9Ø	DØ	9Ø	70	70	70	70
Q	F1	91	D1	91	71	71	71	71
R	F2	92	D2	92	72	72	72	72
S	F3	93	D3	93	73	73	73	73
T	F4	94	D4	94	74	74	74	74
U	F5	95	D5	95	75	75	75	75
V	F6	96	D6	96	76	76	76	76
W	F7	97	D7	97	77	77	77	77
X	F8	98	D8	98	78	78	78	78
Y	F9	99	D9	99	79	79	79	79
Z	FA	9A	DA	9A	7A	7A	7A	7A