Technical and Performance Manual

Tester for PS/2 to MSX Keyboard adapter

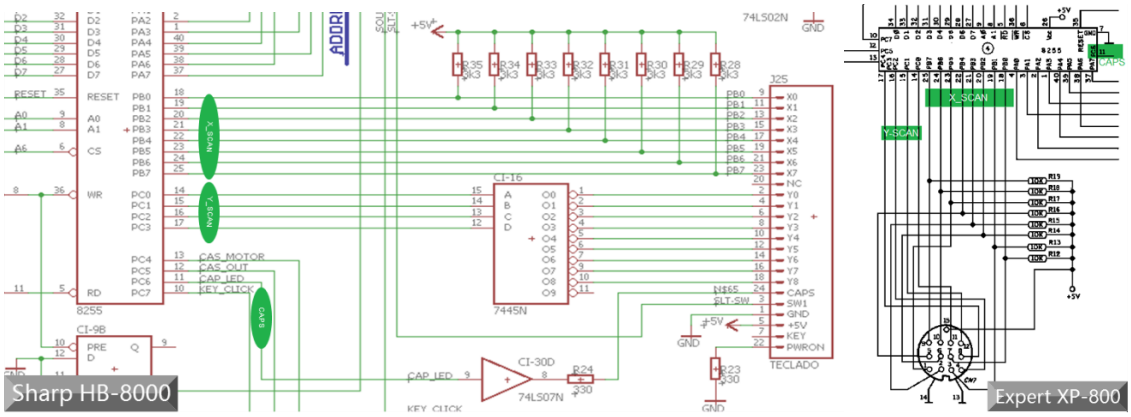
Introduction

This document aims to report applicable tests capability of the equipment developed to simulate the MSX keyboard subsystem.

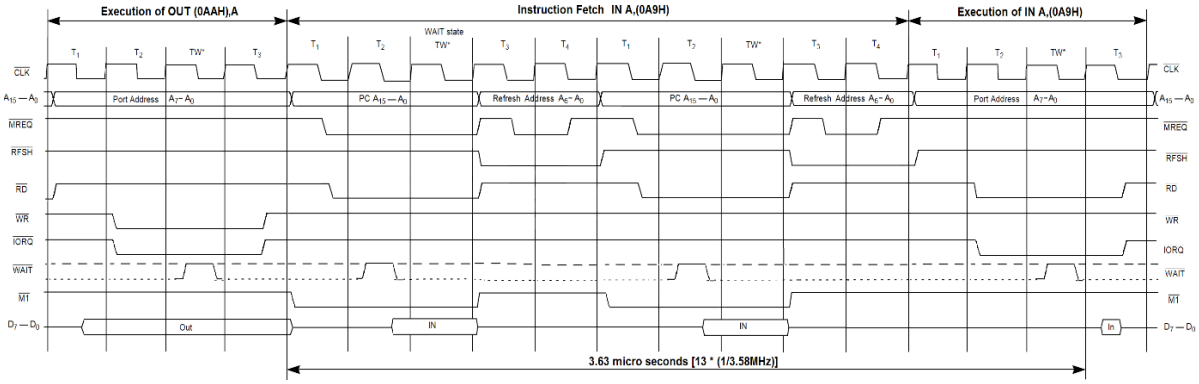
Technical foundation

How MSX reads the keyboard

The MSX standard says that to read a key from the keyboard, you have to choose a column (Y_SCAN) through PC3:0 [IO port 0xAA – The BCD decoder (CI-16 7445 in HB-8000 and the equivalent chip inside the keyboard on XP-800) will put a low level onto the selected Y line] and read 8 bits of the other side of the matrix through PB7:0 without any extra delays. Here is two MSX example schematics to illustrate how to:



The detailed Z80 timing of a real MSX is represented here:



We have a window of about 3.65µs between the data is available from *OUT (0xAA), A* until the data sampling of the *IN A, (0xA9)* command.

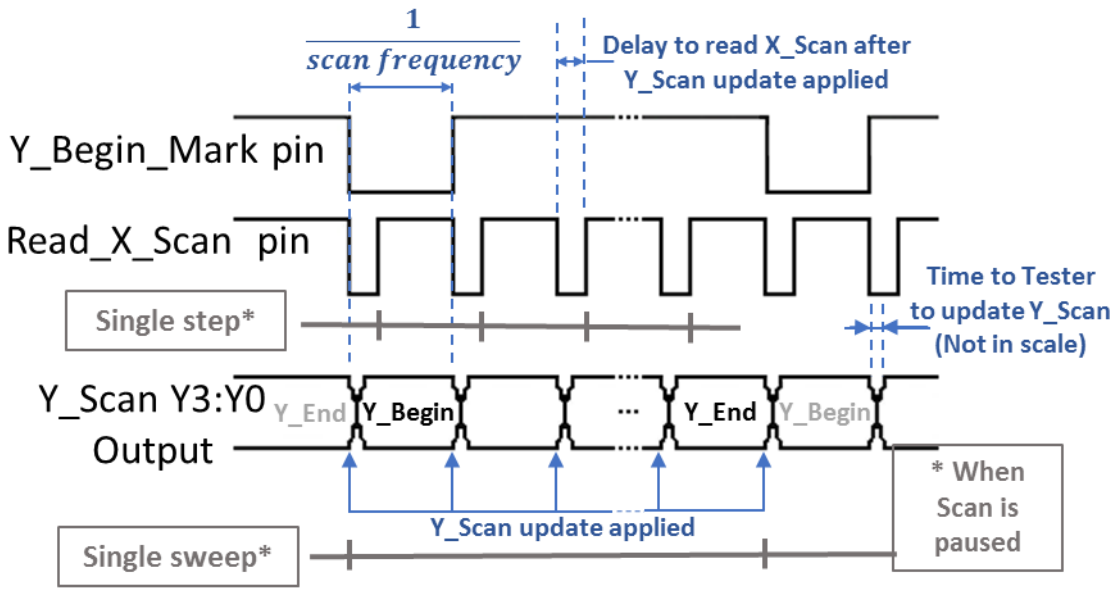
So, to make a useful develop tool MSX keyboard subsystem simulator, I need to add the following configurable parameters:

1) Scan frequency: Number of “out’s” per second;
2) Delay to read the window time between the out and the sampled data (our 3.63µs);
3) Control the start and end colunms of the sweep;
4) Pause, single sweep and step-by-step run;
5) Control of the state of Caps Lock and Kana Lock: Blink, on and off states independently configurable.

The terminal configuration screen is:

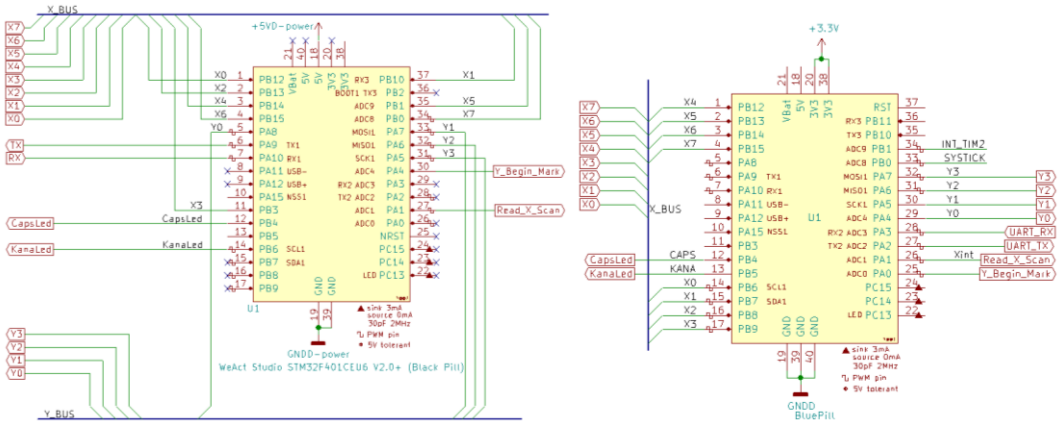
```
(?) Available options
1) General:
   r (Show Running config);
   c (Caps Lock line <- On/Off/Blink);
   k (Katakana line  <- On/Off/Blink);
2) Scan related:
   s (Scan submenu - Set first [Y Begin] and last [Y End] colunms to scan);
   + (Increase scan rate);
   - (Decrease scan rate);
   p (Toggle pause scan);
   n (Next step colunm scan)                          <= when scan is paused;
   Space (One shot scan, from [Y Begin] to [Y End]) <= when scan is paused;
3) Times / Delays / Duties:
   a) Time to read X_Scan (after Y_Scan) update:
   < (decrease by 0.25µs);
   > (increase by 0.25µs);
   b) Read duty cycle: 1 work N idle. N may be 0 to maximum for speed:
   i (After one sweep active read cycle, configure number of idle cycles).

>
```

Timing definitions and controls used in this design:



The electronics

The electronics is quite simple => Only need a low cost Blue Pill (STM32F103C6T6 or greater) or Black Pill (STM32F401CCU6 or greater), with no PCB at all:



The choice of this was based on the pre-requisites:

1) Easy to get (High availability and low cost);

2) Use of the same platform of STM32F1 and STM32F4 based PS/2 to MSX Keyboard adapter (Hardware and Software develop tools), to minimize time to go, as learning time is mitigated;

3) Capability to use the same basic Firmware Structure: only develop complementary functions;

Real examples of working.

1) MSX **Gradiente** Expert XP-800 application:

Column scan frequency: 120KHz;

Y_Begin: 0;

Y_End: 9

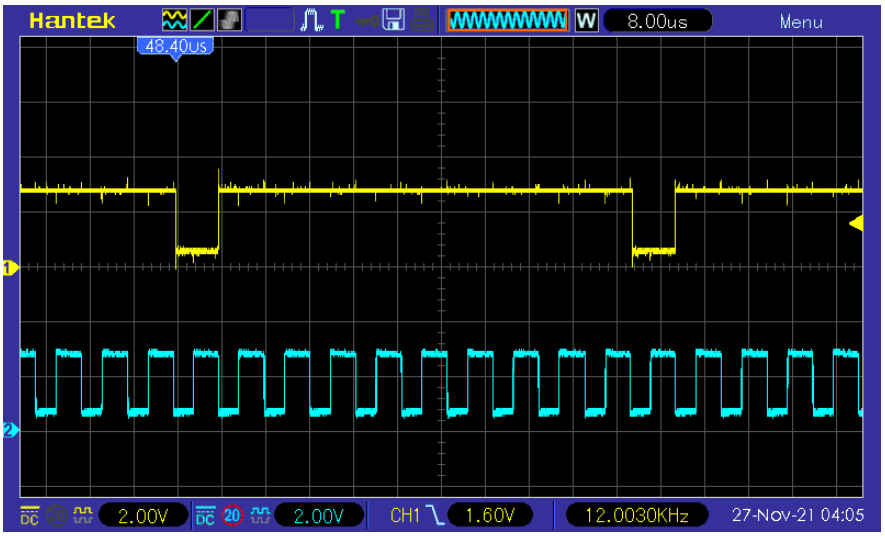
Here is the keyboard map:

POSIÇÃO DA CHAVE
CARACTER

00 Ø	01 8	02 , "	03 C	04 K	05 S	06 SHIFT	07 F4/F9	08 SPACE BAR	09 +
10 1	11 9	12 Ç	13 D	14 L	15 T	16 CTRL	17 F5/10	18 HOME CLS	19 —
20 2	21 --	22 , <	23 E	24 M	25 U	26 L GRA	27 ESC	28 INSERT	29 *
30 3	31 = +	32 >	33 F	34 N	35 V	36 CAPS LOCK	37 TAB	38 DELETE	39 /
40 4	41 \	42 /	43 G	44 O	45 W	46 R GRA	47 STOP	48 ←	49
50 5	51 [	52 ~ / ' ^	53 H	54 P	55 X	56 F1/F6	57 BS	58 ↑	59
60 6	61]	62 A	63 I	64 Q	65 Y	66 F2/F7	67 SELECT	68 ↓	69
70 7	71 ;	72 B	73 J	74 R	75 Z	76 F3/F8	77 RETURN	78 →	79

TABELA DE REFERÊNCIA (MATRIZ X-Y) X CARACTER

The yellow line (channel 1) marks Y_Begin (freq=120K/10 [0 to 9]) and blue line marks each column (120KHz). The start of data begins at falling transition (valid on both situations):



2) Sharp/Epcom Hotbit HB-8000 application:

Column scan frequency: 120KHz;

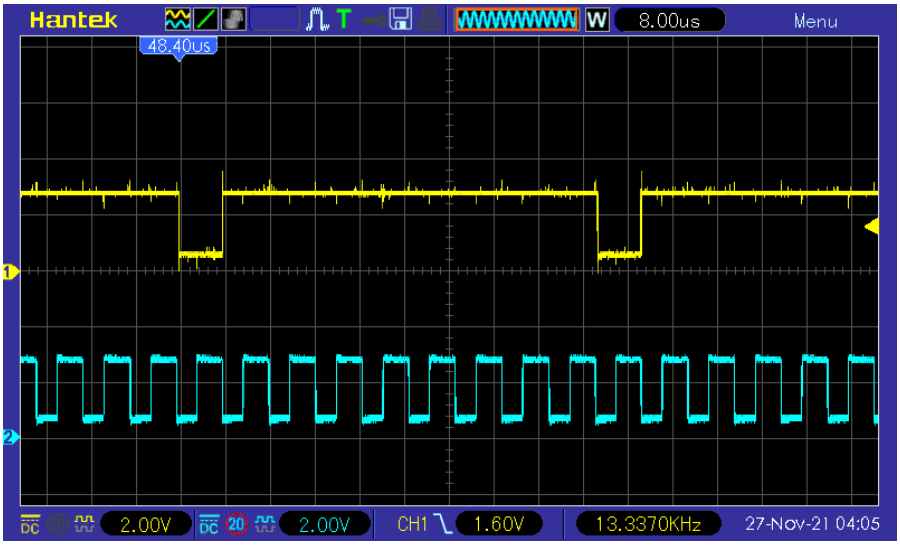
Y_Begin: 0;

Y_End: 8

The keyboard map – Here the yellow mapping are the keys who shift function differs from PS/2:

	Y = 0	Y = 1	Y = 2	Y = 3	Y = 4	Y = 5	Y = 6	Y = 7	Y = 8
X = 0	) 0	* 8	^ ~	C c	K k	S s	SHIFT	F4	Space
X = 1	! 1	(9	[ ]	D d	L l	T t	CTRL	F5	CLS HOME
X = 2	@ 2	_ -	; ,	E e	M m	U u	GRAPH	ESC	INS
X = 3	# 3	+ =	: .	F f	N n	V v	CAPS	TAB	DEL
X = 4	$ 4	^ \	? /	G g	O o	W w	CODE/ KANA	STOP	LEFT
X = 5	% 5	` ´	> <	H h	P p	X x	F1	BackSpace	UP
X = 6	" 6	' ¨	A a	I i	Q q	Y y	F2	SLCT	DOWN
X = 7	& 7	Ç ç	B b	J j	R r	Z z	F3	RETURN	RIGHT

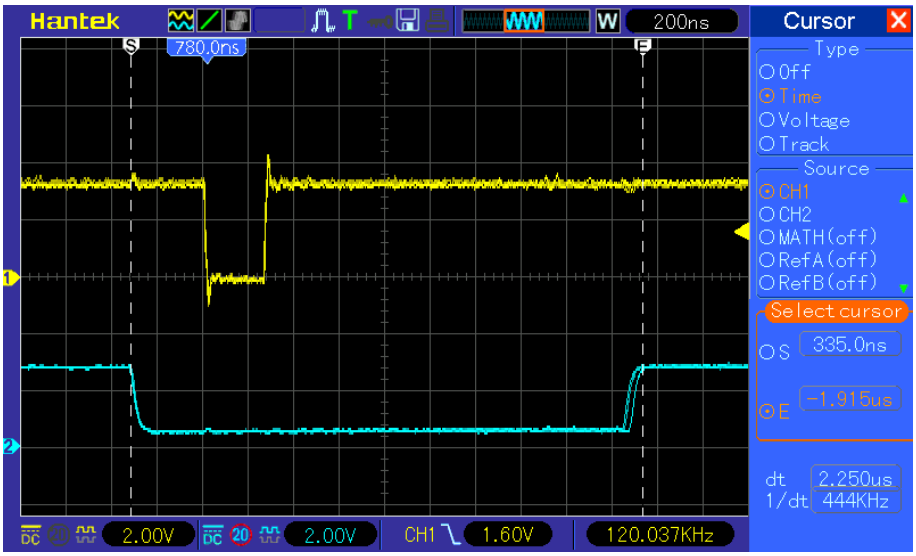
Now the yellow line shows 13.33KHz, because we are scanning 9 columns [0 to 8], instead of 10 [0 to 9] as used in XP-800:

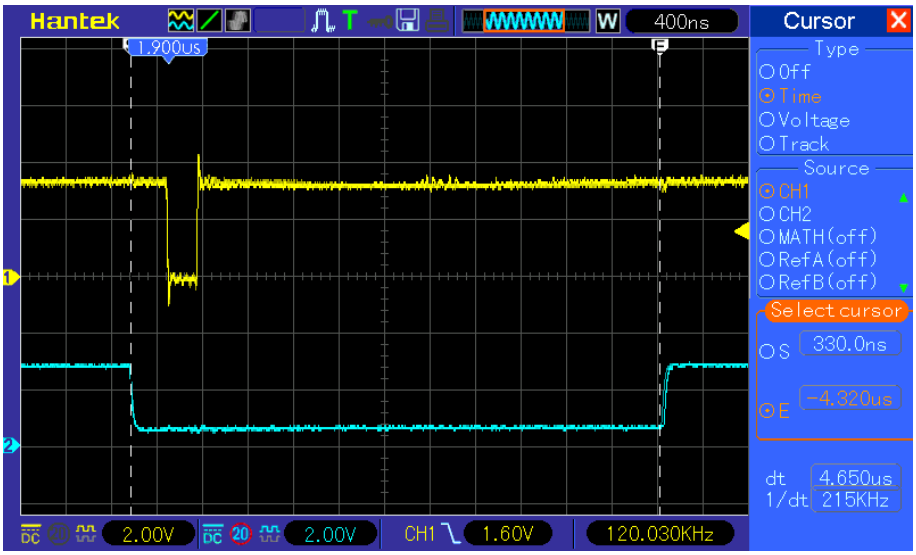


Here are the benchmarks of setting reading window.

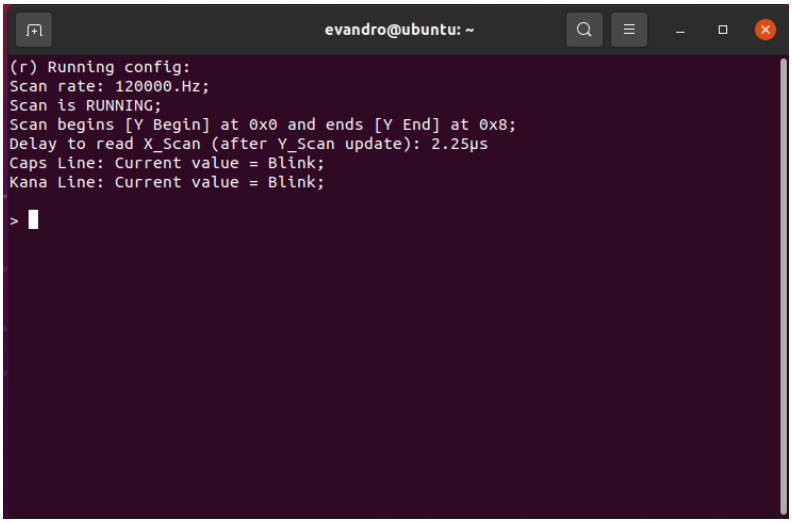
IMPORTANT: Scan frequency and delay to read timing are referred to ***each*** colunm, not the all the keyboard.

The default timing is 3.65µs to match to the 3.63µs of a 3.58Mhz clocked MSX, but you can set it to a range of 2.25 to 4.65µs, in steps of .25µs:



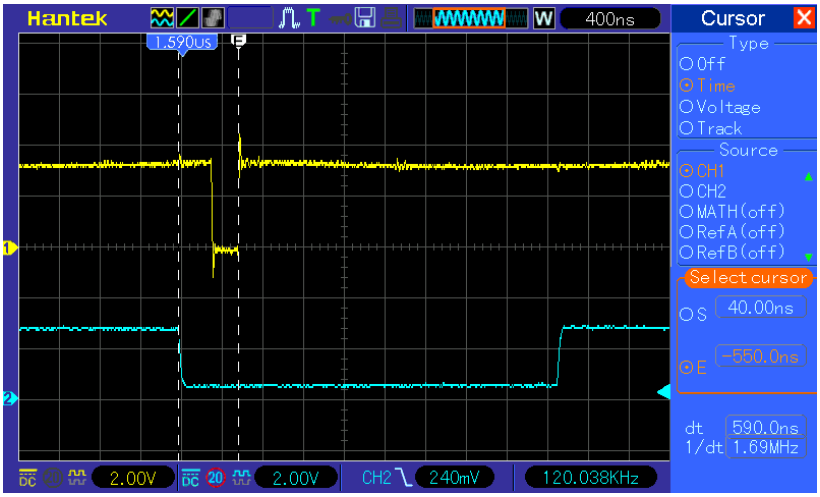


This is a typical running config consult print (option r):



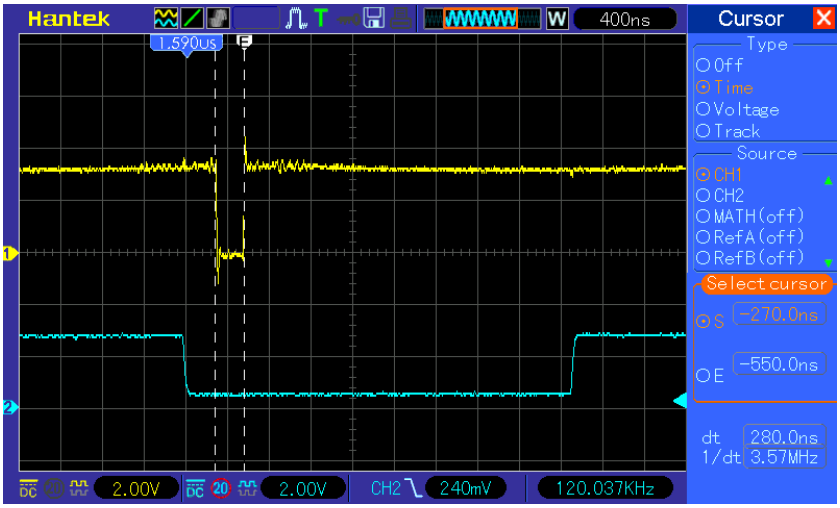
How to use this tool to measure the performance of the PS/2 to MSX Keyboard adapter:

1) To measure the delay to the Adapter answer the request, here an example:



In this example, we can see the total performance of a response from the point the Tester put data (Pin S, at port A1 of Tester) to the point the routine ended processing (Pin E, on the PS2-MSXF4 Adapter's port B7).

Other data could be how much time it spends "on processing":



To get referenced, the blue trace window is a 3.65µs wide: