ASCII Keyboard Tester Tiny
Manual

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A compact board to test vintage parallel ASCII keyboards. Use it on top of an Apple-1 or Apple][and/or connect their keyboards using the DIP connectors.

Assembly

Make sure you have all the parts, see the *Bill of Materials*. Always solder by vertical height of the components, from low to high:

- **Resistors** first (R1, R2). Use a plastic lead bend tool, or bend the leads by hand, before inserting the resistors into the board.
- One **pin header** next (J1). Solder one pin first. Then melt the solder of this pin again while moving the header on the other side in the right angle. Finish by soldering the rest of the pins. <u>Watch out to not touch the same pin that is being soldered, it gets hot!</u>
- Solder in four rows of 8-pin **female in-line machined pin sockets** (J5-J8), together with the two **16-pin double spring contact sockets** (J2, J3).
  - First, insert J6 & J8 on the back side and solder them at the front side. Solder one pin of each row first. Then melt the solder of this pin again while moving the adapter on the other side in the perfect angle. Finish by soldering the rest of the pins.
  - Second, insert J2 & J3 on the front side and solder at the back side. Make sure they are oriented correctly, check if the notch of the socket matches the outline on the board. Start with soldering two opposite pins, then melt the soldered pins again while pushing the socket all the way down on the top side. When the socket sits nicely, then (re)solder all pins.
  - Third, insert J5 & J7 on the back side and solder them at the front side. Use the *16 pin male-male IC <u>adapter</u>* (not the IC socket, as its pins are too thick) as a guide while soldering each pair. This way the in-line sockets will be soldered in vertically correct. Finally remove the IC adapter in a vertical direction, preferably using an IC extractor tool, as the pins are bend easily.
  - **<u>Important:</u>** before applying power, check J2-J8 for shorts between all side to side pins using a multimeter in continuity mode.
- Remaining **sockets** (U1-U3) follow, insert the IC's later.
- Continue with the **resistor nets** (RN1-RN3). Make sure the side with the 'dot' matches the hole on the PCB indicated by a square. Solder one pin first, align the resistor net and finish off soldering all pins.
- Solder the **DIP Switch** (SW1). Let the 'ON'-position point to the top edge of the PCB.
- Put the **ceramic capacitor** (C1) in, the orientation does not matter, solder it. Then cut the leads and reheat again to reflow for best results. Regular **capacitors** (C2, C3) next, make sure the cathode (-) side of the capacitor is in the shaded, 'filled' half of the circle on the board. The anode (+) should be in the 'empty' half of the circle.
- Insert the **LED**'s (D1 - D12), check the schematics for the right colors. The long leg is the anode (+) and the short leg the cathode (-). The short leg should go through the square pad and the long leg through the round pad. the long leg is the anode (+) and the short leg the cathode (-). Also, the base of the LED is not a full circle, but has a flat edge. This edge (cathode side) should match the outline on the board.

- Insert the **IC**'s (U1 - U3), make sure the notch of the IC (first-pin side) matches the notch-side of the socket (and the outline of the board). It is handy to use an IC straightener tool to bend the legs of the IC correctly before inserting them.
- Install the **standoffs** on the backside. Leave out the bottom-left standoff when using the board on top of an Apple Computer. Install the three **rubber end caps** by 'screwing' (turn clockwise) and at the same time pushing them into the bottom side of the stands. A drip of glue (rubber suitable) makes it even more solid. This way the motherboard of the Apple computer is protected against scratches.
- **<u>Important last step:</u>** affix the **adhesive felt** on top of the marked area at the backside of the PCB. Make sure to push it well but gently to minimize the height of the felt. This is to make sure the soldered pins do not touch the computer and will cause a short circuit. The spare NAND gate pads are covered by doing this, remember this in case they are needed in the future.

Usage

In the early days of micro computing, ASCII keyboards send their data to the computer in **parallel** form, i.e. all bits 'go' through a separate cable at the same time. This tester can be used to check these keyboards. More modern keyboards send data in ***serial*** form, that is bit after bit through a single cable. This tester <u>cannot</u> test these keyboards, at least not without some form of conversion.

When a key is pressed, the circuitry of a keyboard generates an **ASCII** code and sends this to the computer. The original ASCII standard encodes 128 characters into a **7-bit code**, *see* Figure 1.

Most of the characters can be displayed or printed. Some of them are *control characters*, like 'BS' being backspace and 'CR' being carriage return, *see* Figure 2. For convenience, some important ASCII codes are listed on the back of the tester itself.

Bits b_7 b_6 b_5 →					0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4	b_3	b_2	b_1	Row ↓ / Column →	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	¦
1	1	0	1	13	CR	GS	—	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Figure 1: The original 7-bit ASCII character encoding from 1967 [1]

NUL — null, or all zeros
SOH — start of heading
STX — start of text
ETX — end of text
EOT — end of transmission
ENQ — enquiry
ACK — acknowledge
BEL — bell
BS — backspace
HT — horizontal tabulation
LF — line feed
VT — vertical tabulation
FF — form feed
CR — carriage return
SO — shift out
SI — shift in
DLE — data link escape
DC1 — device control 1
DC2 — device control 2
DC3 — device control 3
DC4 — device control 4
NAK — negative acknowledge
SYN — synchronous idle
ETB — end of transmission block
CAN — cancel
EM — end of medium
SUB — substitute
ESC — escape
FS — file separator
GS — group separator
RS — record separator
US — unit separator
SP — space
DEL — delete

Figure 2: Explanation of the ASCII control characters

DIP settings

The **8th bit** is used by some keyboards as well. It can be a *parity bit*: an error detecting code for the computer to see if the transmitted character code is correct. Or it can be part of the encoded character, as in *extended* ASCII [2] encodings, which provide more (or even different) characters than shown earlier in Figure 1. To enable this 8th bit, the left DIP switch (1 of SW1) should be in the 'ON' position.

The right DIP switch (2 of SW1) is to enable the **Apple-1 adapter mode**: this ties the 8th bit to +5V. This is handy when using an Apple][keyboard on an Apple-1 computer, so the tester functions as an adapter.

> To test an Apple-1 keyboard properly, make sure the *8th bit* setting is ON and the *Apple-1 adapter mode* is OFF. This enables proper testing of the value of the 8th bit, it should always be a logic one (LED Parity/8 should always lit whatever key is pressed).

Power supply

For stand alone usage, without a computer attached, the keyboard tester needs a (custom built) power supply and should be connected to pin header J1. The board itself works with only **+5V** being connected. However, most vintage keyboards need **-12V** as well, and rarely **+12V**. For example, a suitable power supply to use is the Mean Well PT-65B [3], which provides all three different voltages.

The table below gives an overview of the voltages *supplied* by the board's connectors and *needed* by several keyboards. This list is not exhaustive, see the specific keyboard and/or computer documentation to discover which voltages are needed.

Connector and keyboards	+5V	-12V	+12V
Apple-1 / J2	**✓**	**✓**	**✓**
Newton Computer's Datanetics Rev B Keyboard replica	✓		
Original Datanetics Rev B using MM5740/AAE encoder [4]	✓	✓	
Apple][/ ITT 2020 / J3	**✓**	**✓**	
Early Apple][keyboards with MM5740/AEE encoder	✓	✓	
Later Apple][keyboards with separate plug-in boards using a SMC KR3600 encoder	✓	✓	
General Instrument AY-5-2376 [5] based keyboards, like SWTPC's KBD-5 [6] and Elektor's ASCII keyboard [7]	✓	✓	
National MM5740/AAx based	✓	✓	

Table 1: Overview of supplied (in bold) and needed voltages

Connecting

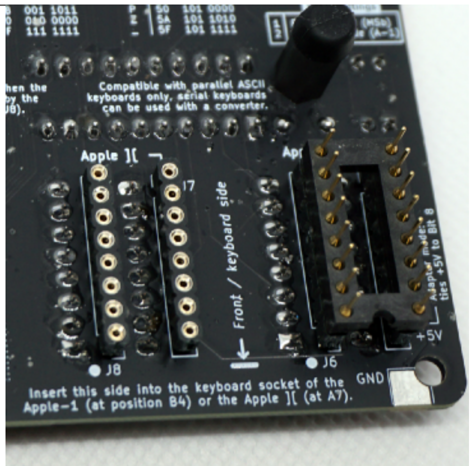

Figure 3: Apple-1 computer ‘selected’ with the male-male adapter

This tester can eavesdrop and show the signals generated by a keyboard and transmitted to an Apple-1 or Apple][computer, without interfering normal operation.

At the bottom side of the tester, use the male-male DIP adapter to ‘select’ for Apple-1 or Apple][usage. *See* Figure 3.

Make sure power of the computer is turned off first and then put the tester **on top of the computer’s keyboard socket** and make sure all 16 pins are in their respective holes of the socket.

In this setup, the tester is solely powered by the computer and does not need an extra power supply trough J1.

Do not use the tester on top of an Apple-1 or Apple][when first testing *uncommon*, *custom* or *self-made* ASCII keyboards. A power supply should be used instead (connected to J1, *see* the previous chapter), so the tester can be used **stand alone**. This way no damage can be done to the vintage computer.

For example, if you have a self-made keyboard, you can test if its DIP connector is correctly wired for an Apple-1 or Apple][.

Make sure all needed voltages are supplied by the power supply at J1, *see* the previous chapter, otherwise the keyboard will not work. On the previous page, *see* Table 1 for some examples of keyboards that can be connected. The forum Deskthority has a posting of MMcM where a couple of more examples of parallel keyboards are listed [8], use it as a source of inspiration.

At the top side of the tester, connect an Apple-1 or Apple][keyboard using socket J2 or J3, respectively. It is fine to use an Apple][keyboard with an Apple-1 computer or vice versa, as long as the correct socket are used. Also double check orientation of the connectors, the white dot marks pin 1 (points towards the bottom edge).

Sockets J2 and J3 also provide power to the connected keyboard, in the same way the computer does. The pinout is labeled on the tester board itself and *see* Figures 4 and 5 for the original pin description [9, 10]. Important: the figures are upside down compared to the tester's sockets.

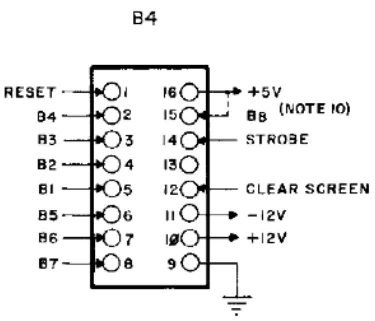

Figure 4: Pinout of the keyboard connector for the Apple-1 (J4) [9]

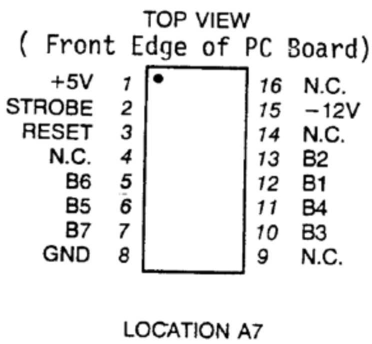

Figure 5: Pinout of the keyboard connector for the Apple][(J5) [10]

The B1 through B8 pins are the data lines, whereon the ASCII code gets transmitted. Note that, in the documentation that is out there [10], the first data pin is sometimes referred to as B0 instead of B1. The Apple-1 and Apple][accept capital letters only, so it is normal when the lowercase ASCII codes do not show up. Read more in the next chapter.

A comparison between the two connectors; the Apple-1 makes use of the **clear screen** signal, while both use the **reset** signal, *see* Figure 6. Also, the Apple-1 supplies an extra +12V.

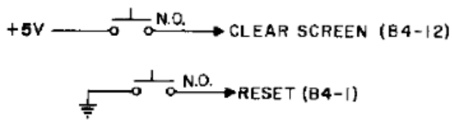

Figure 6: Apple-1 Clear Screen and Reset signals [5]

Electronic workings

The core of the tester is the 74LS374 IC, an 8 bit flip-flop [11], at location U1. This flip-flop stores the 8-bit (1 byte) ASCII **data value** coming from the attached keyboard when pressing a key. At key release, the value is still being displayed by the LED's D1-D8 (and stored in this IC) until you press another key. When the tester is first powered on, the displayed value is arbitrary before the first key press.

With the two white LED's D9 and D10 the tester visualizes the **strobe signal** coming from the keyboard. At the moment a key is pressed, the keyboard generates a very short electric pulse signal to indicate a key is being pressed.

This signal can be *falling* (going low, default high) or *rising* (going high, default low), as indicated by the sequence in which the white LEDs turn on. For example, when the strobe signal is default low (0V) and gets high (5V) at a keypress, then Rising LED (D9) is lit first. At the time of this signal change, the data bits are set on the data lines by the keyboard. In order to have a visual indication of this signal, its duration is extended by the 74LS123 IC, a retriggerable monostable multivibrator [12], at location U3. To be precise, a negative/positive edge-triggered one-shot is used [13].

The keyboard's **clear screen** and **reset** signals are fed through a 74LS00 NAND-gate [14], at location U2. The outputs of this IC are the LED's D12 and D11, which visualize both signals respectively. The clear screen signal is a positive going signal, while the reset signal is a negative going signal, *see* Figure 6.

Compatibility

For keyboard and computer compatibility *see* the Table on page 3.

This ASCII Keyboard Tester Tiny is compatible with the **Poor Man's Keyboards**. However, it is <u>not</u> compatible with the **One Byte Hex Display** (discontinued), at least not in a plug-and-play way. It could be wired up using the latch output solder holes above the 8 LEDs on the board.

When a proper Hex display is preferred, or further breadboard experimenting is needed, use the brand new **8-bit Workbench** instead. It has even more capabilities with its extension interface and extension boards.

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