

# PAL-II

# User Manual

V1.0

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*Happy Hacking 6502*

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# Chapter 1

## Your PAL-II Microcomputer Kit

Congratulations and welcome to the exciting old world of micro-computers! As the owner of a PAL-II Microcomputer Kit, you now have at your disposal a completely operational, high-quality components and very capable digital computer after simple assembly. By selecting the PAL-II kit, you have eliminated all the problems of PCB making, components sourcing of constructing a vintage KIM-1 computing system. Your time is now available for soldering the kit and enjoy this beautiful KIM-1 replica. In fact, if you will follow a few simple procedures outlined in this manual, you should be able to achieve initial operation of your PAL-II module within a few minutes after unpacking and assemble it. For more detailed technical/background information, we recommend you read the three books with the original KIM-1 system: KIM-1 User's Manual, Hardware Manual and Programming Manual.

AND THANKS TO ALL THE KIM-1, PAL-1 ENTHUSIASTS FOR HELP TO WORK THIS OUT!

# Chapter 2

## GETTING STARTED

### 2.1 PARTS COMPLEMENT

After unpacking the shipping container for your PAL-II kit, you should have located the following items:

- 4 Boxes – Chips box
- Sockets and Switches box
- Passive electric components box
- Keypad box
- 1 PAL-II PCB (In reusable ESD bag)
- 1 Printed System Schematic
- 1 Printed Parts Layout
- 1 Printed Bill of Materials

## 2.2 A FEW WORDS OF CAUTION

### **WARNING**

Your PAL-II kit includes recycled vintage, hard to find ICs. Although all such ICs are tested before package, but they are more sensitive/fragile than modern chip. Please handle with care with these chips. Always discharge before touching your PAL-II kit and carefully deal with chip's leg when fitting it in socket.

## 2.3 SOLDERING TIPS

After unpacked all components, you need to solder them on the PAL-II PCB. We suggest you follow the steps like:

*Resistors -> Diode -> DIP switches -> IC sockets -> Pin header connectors -> Oscillator -> Capacitors -> LEDs -> Transistors -> Switches (keypad and selectors) -> Keycaps and Keypad Cover*

For a beautifully assembled module, ensure all components are properly aligned before soldering.

You can use the parts layout page (Appendix B) for an easy component locate or use the online interactive BOM to location.

Keyboard finished reference photo:

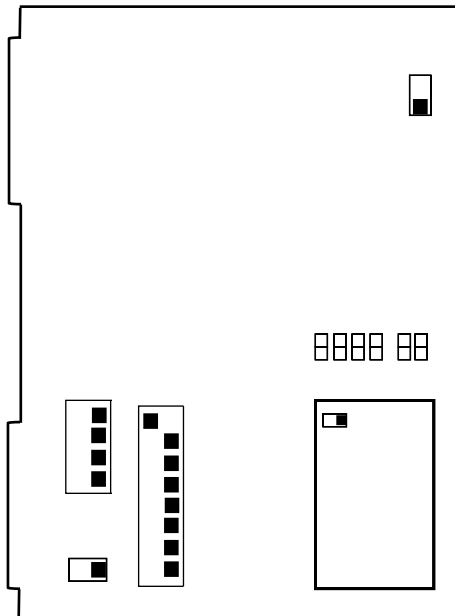


We recommend using a PH1 SCREWDRIVER to tighten the three keypad cover screws. Please take care not to overtighten these screws to avoid cracking the screw seats. A safer approach is to rotate the screws 90 degrees at a time, check the distance between the screw head and the PCB, and repeat this process until the screw head makes contact with the PCB, at which point you should stop.

## 2.4 FIRST BOOT

When you finished the assembly, passed the short circuit and cold soldering check, you can power your PAL-II up for the first time.

Put the PAL-II to the default configuration like this:



Vector selector: DOWN, 8K7 selector: RIGHT

K1-K4 RAM selector: 1,1,1,1

8K Decoder selector: 0,1,1,1,1,1,1,1

SST: RIGHT

FIGURE 1

ONLY use a 5V DC power supply for your PAL-II. We recommend using a USB-to-TTL converter, as it provides both power and serial communication in a single device.

Place the module such that the keypad is positioned in the lower-right corner. Observe that two connector areas extend to the left of the module. The connector area on the lower-left is referred to as the Application Connector (A), while the connector area on the upper-left is designated as the Expansion Connector (E) for future system expansions.

The 2x22 pin header connectors follow the KIM-1's original definitions. The upper row uses numeric labels, and the bottom row uses alphabetical labels. You can identify the starting and ending labels from the silk-screen printing on the PCB. Additionally, the ^ symbol indicates the UPPER row.

To connect the power supply:

- Use the Application Connector.
- Pin 1 is for GND, and Pin A is for VCC.

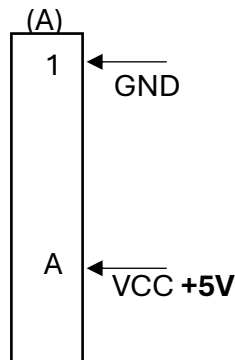


FIGURE 2

Complete connector pin definitions can be found on the next page.

Now, recheck your connections, turn on your power suppliers, and depress **RS** (reset). You should see the LED display digits light as your first check that the system is operational. If not, recheck your hookup. Find help or join discussions about PAL-II, visit the following link:

<https://groups.google.com/g/pal6502>

## 2.5 LET'S TRY A SIMPLE PROGRAM

Please follow chapter 2.4 Let's try a simple program on page 9 of the KIM-1 User's Manual.



1	VSS GND
2	PA3
3	PA2
4	PA1
5	PA4
6	PA5
7	PA6
8	PA7
9	PB0
10	PB1
11	PB2
12	PB3
13	PB4
14	PA0
15	PB7
16	PB5
17	KB Row 0
18	KB Col F
19	KB Col B
20	KB Col E
21	KB Col A
22	KB Col D

(UPPER row)

A	VCC +5V
B	K0
C	K1
D	K2
E	K3
F	K4
H	K5
J	K7
K	DECODE ENAB
L	TOP 8K SELECT
M	TOP 8K ENABLE
N	
P	
R	
S	
T	TTL (IN) KYBD
U	TTL (OUT) PTR
V	KB Row 3
W	KB Col G
X	KB Row 2
Y	KB Col C
Z	KB Row 1

(LOWER row)

Application Connector

FIGURE 3

1	SYNC
2	RDY
3	Ø1
4	IRQ
5	SO
6	NMI
7	RST
8	DB7
9	DB6
10	DB5
11	DB4
12	DB3
13	DB2
14	DB1
15	DB0
16	K6
17	SST OUT
18	
19	
20	
21	VCC +5V
22	VSS GND

(UPPER row)

A	AB0
B	AB1
C	AB2
D	AB3
E	AB4
F	AB5
H	AB6
J	AB7
K	AB8
L	AB9
M	AB10
N	AB11
P	AB12
R	AB13
S	AB14
T	AB15
U	Ø2
V	R/W
W	$\overline{R/W}$
X	PLL TEST
Y	$\overline{\text{Ø2}}$
Z	RAM/R/W

(LOWER row)

Expansion Connector

FIGURE 4

## 2.6 TTL COMMUNICATION

PAL-II provides an easier and more stable way to establish serial communication with your computer. Connect a USB-to-TTL converter to your computer to act as both a printer and keyboard for the KIM-1 system.

Connect the wires shown in the figure below:

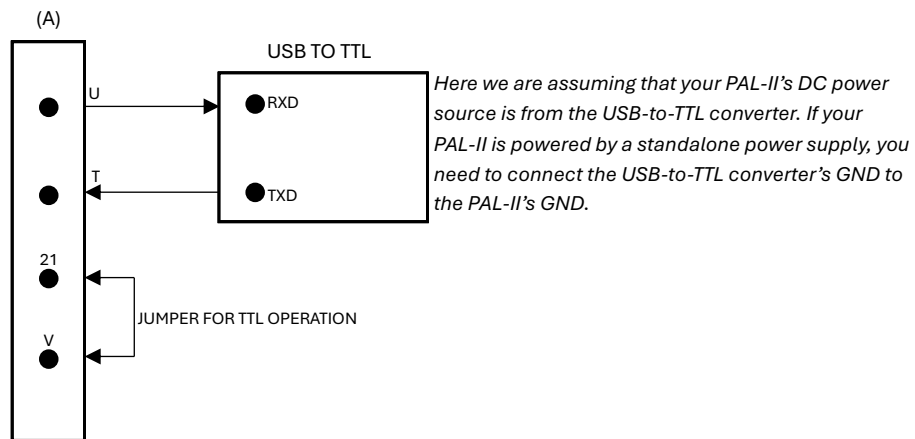


FIGURE 5

After connecting the USB-to-TTL converter, start a serial terminal on your computer and set the converter's COM port like:

- Speed: 1200 bps
- Data: 8 bits
- Parity: none
- Stop bits: 1 bit
- Flow control: none

Power on the PAL-II, press the **RS** key on the PAL-II module then press the **Enter** key on your computer. This step is most important since the PAL-II system adjusts automatically to the bit rate of the serial communication and requires this first key depression to establish this rate.

If everything is working properly you should immediately observe a message being showed as follows:

KIM

This is a prompting message telling you that the TTL is on-line and the PAL-II system is ready to accept commands from the TTL client. Please note that the KIM-I monitor only accept UPPERCASE commands. For more detailed information, read the chapter 2.6 Adding a teleprinter in the KIM-1 User's Manual.

## Chapter 3

### THE PAL-II SYSTEM

PAL-II is another replica of the MOS KIM-1 and serves as an upgraded version of PAL-1. Compared to PAL-1, PAL-II features more comprehensive capabilities integrated into the board, making it a version closer to the original KIM-1.

PAL-II replicates almost all the functionalities of KIM-1, except for audio-related features, aligning with the design of other KIM-1 capabilities. Additionally, PAL-II replaces KIM-1's TTY circuits with TTL circuits, making it more easy and stable for modern applications. With PAL-II, communication with a computer can be easily achieved using a USB-to-TTL converter. Without adding extra expansion loads, PAL-II can also be powered directly via the 5V output from the USB-to-TTL converter, resulting in a simpler and more user-friendly system.

Beyond restoring KIM-1's design to a great extent, PAL-II expands the onboard RAM capacity. It can be configured as a fully expanded RAM address space KIM-1 system (see Figure 1).

PAL-II provides two 2x22 connectors that adhere as closely as possible to the KIM-1 interface definitions. However, the connectors have been updated to a modern 2.54mm pinhead standard to reduce dependence on complex components. In the future, we will develop expansion modules for PAL-II to offer more flexible and diverse system functions.

Regarding system memory allocation and special memory addresses, PAL-II maintains full compatibility with the KIM-1. System operations and development are therefore consistent with the KIM-1 specifications. For more detailed information, please refer to the three books included with the KIM-1. We also recommend using *The First Book of KIM* as a convenient programming manual to enhance your experience with PAL-II.

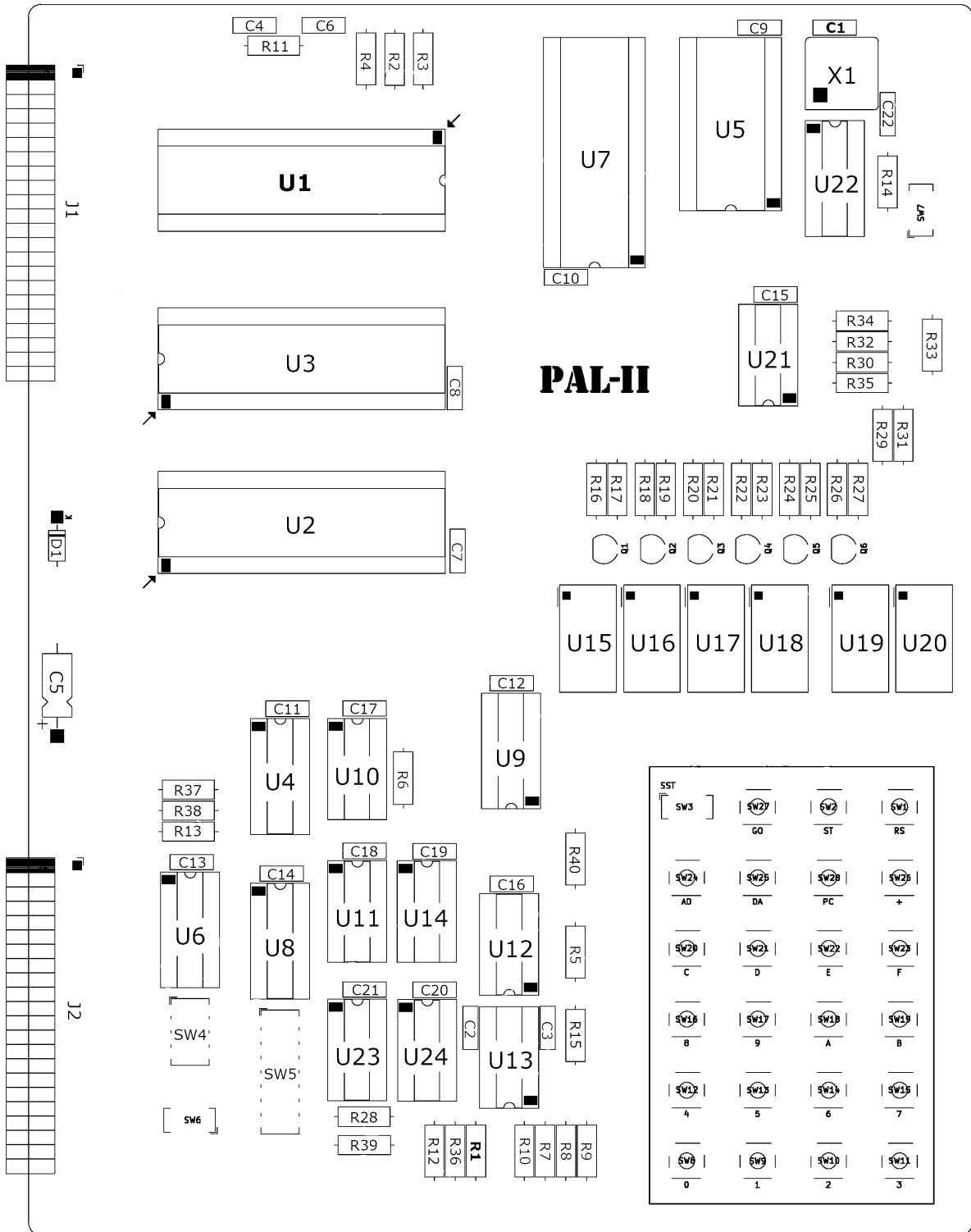
# APPENDIX A

## BOM

ITEM	PART	QTY.	DESCRIPTION
1.	U1	1	6502 Microprocessor
2.	U2	1	6532 RAM I/O Timer Chip-02
3.	U3	1	6532 RAM I/O Timer Chip-03
4.	U5	1	28C16 Parallel EEPROM 256Kb (32K x 8)
5.	U7	1	628128 Static RAM 1Mb (128K x 8)
6.	U4	1	74LS138 3 to 8 Decoder
7.	U6, U8, U9	3	74LS145 BCD Decoder
8.	U10	1	74LS04 Hex Inverter
9.	U21, U23	2	74LS06 Hex Inverter Open Collector
10.	U11, U14, U24	3	74LS00 Quad NAND
11.	U12	1	74LS38 Quad NAND Open Collector
12.	U22	1	74LS133 13-input NAND
13.	U13	1	556 Timer
14.	D1	1	6.2V 1W Zener Diode - 1N4735A
15.	Q1 through Q6	6	PNP Transistor - 2N4403
16.	U15 through U20	6	FJ3101DH 7 seg. red LED C.Anode
17.	R1 through R6	6	3.3K $\Omega$ Resistor
18.	R7, R8	2	47K $\Omega$ Resistor
19.	R9-15,17,19,21,23,25,27,28,36-R40	19	1K $\Omega$ Resistor
20.	R16,18,20,22,24,26	6	220 $\Omega$ Resistor
21.	R29 through R35	7	680 $\Omega$ Resistor
22.	C1, C6-C22	18	0.1uf Capacitor
23.	C2, C3	2	0.22uf Capacitor
24.	C4	1	220pf Capacitor
25.	C5	1	1uf Polarized Capacitor
26.	X1	1	1 MHz Oscillator
27.	SW1, SW2, SW8-SW28	23	Push button switch (keypad)
28.	SW3	1	4mm Stem SPDT Switch
29.	SW6, SW7	2	SPDT Switch
30.	SW4	1	4x DIP Switch
31.	SW5	1	8x DIP Switch
32.	J1, J2	2	2x22 P2.54mm Horizontal connector
33.		18	IC Sockets
34.		23	Keycaps /w Legends
35.		1	Black SLA Keypad Cover
36.		3	M2x5 Black SS ST Screws
37.	PAL-II V2.3 PCB	1	FR4, Pb-free, Taiwan NAN YA
38.	Paperwork	3	Schematic, BOM, Layout
39.		1	MOS sticker
40.		1	Storage Bag (Static Free, Pink)
41.		1	Shipping Box

# APPENDIX B

## PAL-II PARTS LAYOUT



For interactive bom:  
<http://pal2.aibs.ws/ibom>