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TYNEMOUTH MINI PET KIT B BUILD INSTRUCTIONS

PARTS LIST

CAPACITORS – ALL RATED 16V OR HIGHER

2 x 22pF (*or to match crystal, usually marked 220 or 220J)*
23 x 100nF axial *(usually marked 100n or 104)*
1 x 100µF *(axial electrolytic rated 25V or higher)*

RESISTORS – ALL ¼W 5% OR BETTER (4 BAND RESISTOR COLOUR CODES SHOWN)

1 x 68Ω
4 x 470Ω
1 x 1KΩ
1 x 2.2KΩ

RESISTOR ARRAYS (PIN 1 MARKED BY DOTS ON PACKAGE AND PCB)

2 x 4K7 7 bussed resistor array, 8 pin *(usually marked 8X-1-472)*
5 x 10K 8 bussed resistor array, 9 pin *(usually marked 9X-1-103)*

SEMICONDUCTORS - NEW TEXAS INSTRUMENTS CHIPS RECOMMENDED.

2 x 6.8V Zener diodes 500mW
3 x 1N4001 rectifier diodes
1 x Green 5mm LED
1 x Red 5mm LED
2 x TIP29 / TIP29A or similar NPN power transistor
3 x 74LS07
1 x 74HC00
1 x 74HC10
1 x 74HC86
2 x 74HC138
1 x 74LS145
1 x 74HC166
1 x 74HC257
1 x 74HC393
1 x WDC W65C02S *(do not fit anything else into this position other than a W65C02S, it will not work, the pinout is different)*
2 x WDC W65C21N *(not W65C21S)*
1 x WDC W65C22N *(not W65C22S)*
1 x 62256 32K SRAM 600mil wide (e.g. Alliance AS6C62256 or Cyprus CY62256)
1 x 2K Dual Port RAM (IDT7132)
1 x 27C256 EPROM *(font ROM)*
1 x 27C040 EPROM *(OS/BASIC ROM)*
1 x ATmega164P (*pre-programmed*)
1 x 7805 or 7805 switching replacement (*rated at least 250mA, more if adding accessories*)
1 x 16 MHz Crystal (*HC-49/U package*)

CONNECTORS / SWITCHES / SOUNDER

2 x miniature tactile switch 6x6mm *(e.g. Diptronics DTS-61N)*
1 x Piezo AC transducer *(not a buzzer or any sounder that has internal circuitry)*
1 x 10 way DIP switch
5 x 16 pin, 7 x 14 pin IC sockets *(optional, turned pin recommended*)
1 x 48 pin, 5 x 40 pin, 1 x 32 pin, 2 x 28 pin IC sockets *(turned pin recommended*)
1 x 7 way 0.1" connector for video *(pin 2 removed)*
1 x 20 way 0.1" connector for keyboard *(pin 2 removed)*
1 x 9 way 0.156" connector *(pin 3 removed) or* 1 x 5 way 0.156" connector for power

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OPTIONAL PARTS

The parts in the section highlighted in blue on the PCB diagram are optional, and can be used to add an alternative 9V DC power in and composite video out. These are not required if you are using the PETs internal monitor, and so can be omitted. It could be useful for testing if you have monitor problems.

COMPOSITE VIDEO OUTPUT

1 x 1uF *(usually marked 1u or 105)*
2 x 75Ω 
1 x 2.2KΩ
1 x 4.7KΩ
1 x 1N4148 signal diode
1 x BC548B or similar NPN transistor
1 x Phono jack *(e.g. CUI RCJ-011 – Digi-Key CP-1400-ND)*

9V DC IN

2 x 2 way header with jumper *(optional or fit wire links)*
1 x 2.1 mm DC Jack

OPTIONAL CONNECTORS

2 x 2 way 0.1" connector for external reset and NMI switches
2 x 7 way 0.1" connector for alternate datasette connections *(pin 3 removed)*

NOTES ON IC SELECTION

This board has been designed to work with 74HC series logic and modern WDC 65Cxx series chips. The W65C02S is not pin compatible with the original NMOS 6502, and so nothing designed to plug into a 6502 socket should be used with the Mini PET. No PET ROM/RAM, PET Diagnostics, 64K RAM boards or Super PET boards or anything else will work in that socket.

The chips that act as external driver chips, the 74LS07s used to drive the IEEE-488 bus and the 74LS145 used to drive the keyboard are not available in 74HC series. This is not an issue as they all have open collector outputs and are driven from NMOS outputs on the W65C21N / W65C22N (do not use W65C212S / W65C212N versions)

ASSEMBLY

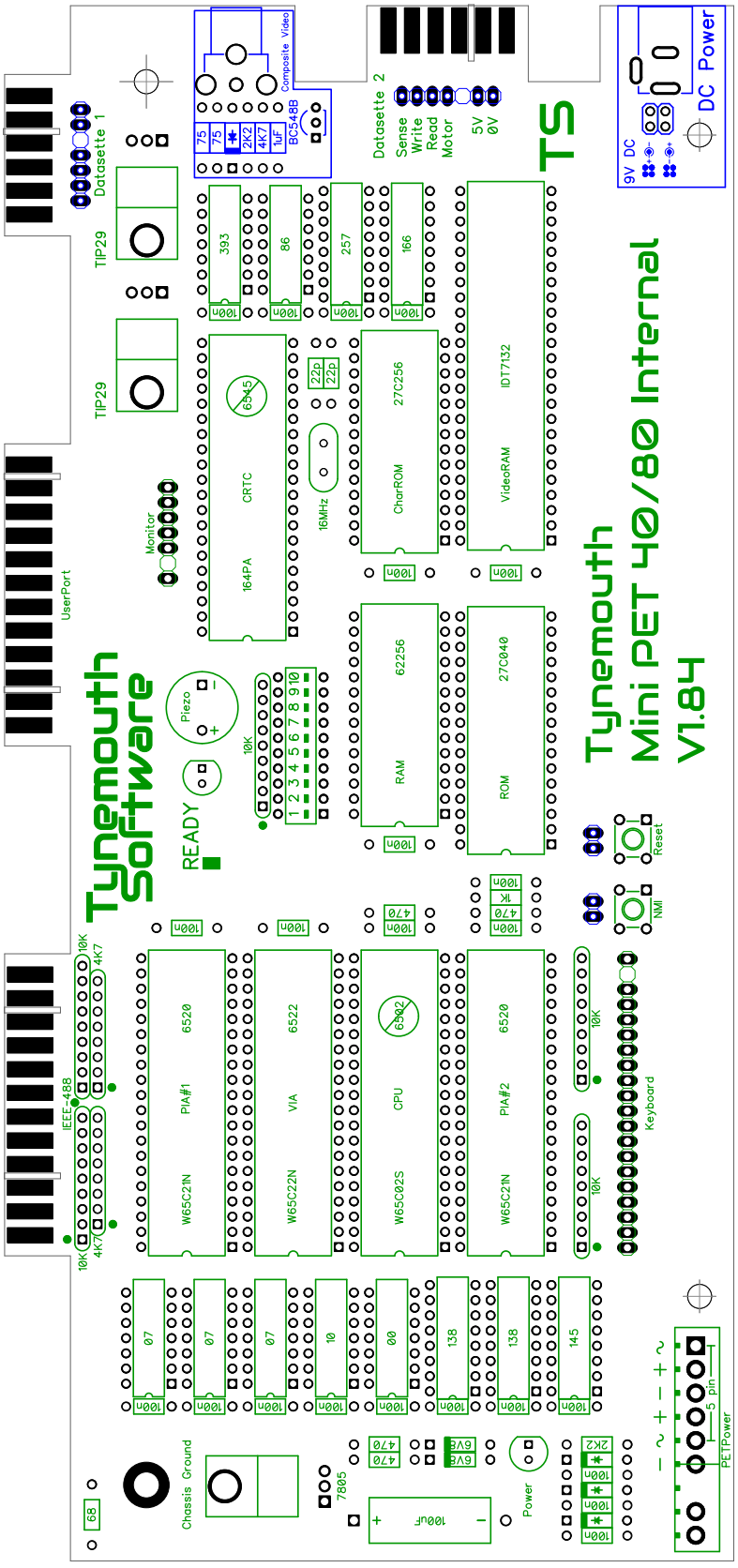
Assembly should follow standard procedures for this sort of kit. The following is offered as a guide to the order parts should be assembled:

1. Single resistors, small capacitors and diodes (*support board in a frame and solder from above can be easier than soldering from below and having to keep flipping the board over*)
2. Crystal and Logic ICs (*if not fitting sockets, noting orientation of pin 1 circles or indents, all pin 1's are to the left*)
3. IC sockets for remaining chips (*noting orientation of pin 1 indents, all pin 1's to the left hand side of the board*)
4. Resistor arrays (*noting the dot for pin 1 on the package and the board*)
5. Transistors / voltage regulator (*bend the legs at right angles at the point they get thin for perfect alignment. Can be left alone, or soldered, bolted or riveted to the board. Heatsinks should not be necessary*)
6. Large capacitor, LEDs, buzzer, switches, jumpers, connectors etc.

Clean the board after assembly and check for any shorts or dry joints before inserting the ICs. Check jumpers and DIP switches are set appropriately before powering on.

COMPONENT PLACEMENT

Optional components are highlighted in blue.



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DIP SWITCHES

Settings are controlled from a set of DIP switches. Recommended settings are highlighted in green.

ROM SETTINGS

Switch 1 controls 40/80 column mode, switches 2 and 3 select the ROM and switch 4 controls keyboard type.

BASIC 1 only supports Normal/Graphics keyboard and 40 columns; BASIC 2 only supports 40 column mode.

Switch 1	Switch 2	Switch 3	Switch 4	Columns	Keyboard	ROM set
OFF	**OFF**	**OFF**	**OFF**	40	Normal / Graphics	MINI PET BASIC 4.1
ON	**OFF**	**OFF**	**OFF**	80	Normal / Graphics	MINI PET BASIC 4.1
OFF	**ON**	**OFF**	**OFF**	40	Normal / Graphics	BASIC 4
ON	**ON**	**OFF**	**OFF**	80	Normal / Graphics	BASIC 4
OFF	**OFF**	**ON**	**OFF**	40	Normal / Graphics	BASIC 2
ON	**OFF**	**ON**	**OFF**	80	Normal / Graphics	Cheese and Chive
OFF	**ON**	**ON**	**OFF**	40	Normal / Graphics	BASIC 1
ON	**ON**	**ON**	**OFF**	80	-	Simple Tester
OFF	**OFF**	**OFF**	**ON**	40	Business	MINI PET BASIC 4.1
ON	**OFF**	**OFF**	**ON**	80	Business	MINI PET BASIC 4.1
OFF	**ON**	**OFF**	**ON**	40	Business	BASIC 4
ON	**ON**	**OFF**	**ON**	80	Business	BASIC 4
OFF	**OFF**	**ON**	**ON**	40	Business	BASIC 2
ON	**OFF**	**ON**	**ON**	80	Business	Cheese and Chive
OFF	**ON**	**ON**	**ON**	40	-	Full Self-Test
ON	**ON**	**ON**	**ON**	80	-	Full Self-Test

FONT SETTINGS

The character ROM can be changed using switches 5 and 6. The default character ROM font is that found on BASIC 2 and BASIC 4 PETs. The older BASIC 1 set, and two international sets are provided as alternatives. The BASIC 1 set can be useful if when running software written to use lowercase mode on the PET 2001, and you see tHE iNCORRECT cASE. *(the BASIC 1 set seems more logical, not sure why they changed it?, but the BASIC 2/4 set should be used in most cases for the compatibility)*

Switch 5	Switch 6	Character Set	Charset 1	Charset 2
OFF	**OFF**	**901447-10 (BASIC 2/4)**	Uppercase / Graphics	Lowercase / Uppercase
ON	**OFF**	**901447-08 (BASIC 1)**	Uppercase / Graphics	Uppercase / Lowercase
OFF	**ON**	**German DIN**	Uppercase / Graphics	Lowercase / Uppercase
ON	**ON**	**Japanese**	Uppercase / Graphics	Uppercase / Symbols

VIDEO OPTIONS

Video options are set using switches 7 to 10. These options are only read when the reset button is pressed.

The original PETs had a fixed output of 60Hz and 15.625KHz line, this is compatible with composite video inputs on most NTSC TVs and monitors. Later CRTCs PETs with 12" monitors changed that to 20KHz, which is not compatible with composite video. The Mini PET can generate both versions, but not at the same time, so you can select 9" or 12" only, or composite video.

Switch 7	Switch 8	Switch 9	Monitor
OFF	**OFF**	**OFF**	NTSC Composite Video
ON	**OFF**	**OFF**	PAL Composite Video
OFF	**ON**	**OFF**	-
ON	**ON**	**OFF**	-
OFF	**OFF**	**ON**	9” PET
ON	**OFF**	**ON**	-
OFF	**ON**	**ON**	12” PET/CBM 60 Hz
ON	**ON**	**ON**	12” PET/CBM 50 Hz

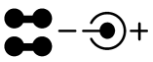
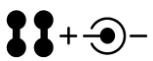
TEXT MODE LINE GAPS

Switch 10 is used to enable a two pixel gap between each line of characters, to match 80 column PETs in text mode. This is not available for NTSC / 60Hz modes of composite, and the 9” PET monitor (there are not enough lines available). When selected, there will be a 2 pixel gap between each line in text mode. Graphics mode remains without gaps in all cases.

Switch 10	Graphics Mode	Text Mode 9” and NTSC	Text Mode 12” and PAL
OFF	**8 Lines**	**8 Lines**	**8 Lines**
ON	**8 Lines**	**8 Lines**	**8 Lines + 2 line Gap**

JUMPERS

The jumpers near the DC power connector set the polarity of the DC jack power input if fitted, and can be ignored if that connector is not used.

	Centre negative, used by optional TFW8b.com supply (also Spectrum and Commodore 16 computers)
	Centre positive, used by pretty much every other power supply

Power requirements are 9V DC. Current consumption is around 200mA for the board, more if using a datasette or powering an SD2PET. Currently heatsinks are not required on the 7805 or TIP29 transistors. Power can be connected via the DC jack or the 2 pin header for an alternate 9V DC source.

BASIC VERSIONS

*** COMMODORE BASIC ***

BASIC version 1 was supplied on the first 2001 PETs, and only supported the normal / graphics keyboard. It is provided for completeness, and would not be recommended for general use due to a number of bugs, particularly in the IEEE-488 support. The version here is usually referred to a 1r, which patched a few of those bugs.

COMMODORE BASIC

BASIC 2 was the standard version on the 2001N or 30xx machines, and has support for normal and business keyboards. *(You sometimes see these referred to as 1, 1r and 2, and other times as 1,2 and 3. None of these versions are numbered until 4.0, so use whichever numbers you prefer).*

*** COMMODORE BASIC 4.0 ***

BASIC 4 was supplied as an upgrade to 2001N and 30xx machines and also on the 40xx machines. It has additional disk commands over BASIC 2.

*** MINI PET BASIC 4.1 ***

Mini PET BASIC is a custom version of BASIC 4, specifically adapted for the Mini PET with help from Steve Gray's editor ROM project. This version has added support for the sounder (normally only found in later CRTC based PETs) and also there is a built in DOS Wedge (see later). This is the recommended ROM to use. It terms of hardware, the Mini PET is closest to the original 4032 with the 2001N-32 board, but with many of the tweaks from the later machines, so the BASIC also sits between the BASIC 4.0 used on the original 4032 with the 2001N-32 board and 9" monitor, and the later version of BASIC 4.0 used on the later 4032 with the 'universal dynamic' board and 12" monitor. *(yes, the naming schemes are confusing, and I haven't even mentioned PET/CBM)*

CHEESE AND CHIVE

Cheese and Chive is an 80 column game by Misfit, courtesy of The Future Was 8 bit.

- https://www.tfw8b.com/product/cheese-chive-pet-32k-80-column/

Control is by keyboard or a userport joystick.

SIMPLE TESTER

A simple test ROM, usually referred to as PET Tester is included in the ROM options. This is a simple test ROM which tests the first 1K of RAM and for each byte, display **b** for bad or **g** for good. It alternates this with a screen showing the full character set. This is useful for testing monitors as it gives you an easy way to get a screen full or characters. This version has been specially modified to respond to the NMI button to toggle between uppercase / graphics and lowercase / uppercase fonts.

BUILT IN SELF TEST

The Mini PET BASIC ROM sets and BASIC 4 ROM sets include a built in self-test in ROM at 0xA000.
To activate this, type **SYS 40960**.

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FILE BROWSER

A file browser is built into the MINI PET BASIC 4.1 ROM images. This is particularly suited to use with the SD2PET SD card disk drive.

This can be activated by pressing the NMI button (or a push switch wired to the adjacent pin header).

The standard BASIC 4 ROM sets also contain the file browser as an option ROM, at 0x9000. To activate those versions, type `SYS 36864` (or it can be easier to remember to type `SYS 9*4096`).

CONTROLS

- ***Up / down arrow keys*** – scroll through the list of files
- ***Left /right arrow keys*** – scroll up or down one page of files
- ***Return*** – load the select program change into the selected directory or mount the selected disk image
- ***Clr / Home*** – Move up one directory, out of a disk image
- ***S*** – Toggle sorting the list of files alphabetically
- ***D*** – Cycle through the available drives 8,9,10,11 (if present)
- ***Q*** – Quit and exit to BASIC
- ***=*** – toggle font uppercase / lowercase and uppercase / graphics

When a program is selected, the Mini PET will be reset and the program automatically loaded and run.

Alternatively, you can browser to the appropriate folder and / or disk image and then exit to BASIC and load the program as normal.

When you return to the file browser, the previously selected folder will be preserved or disk image will still be mounted, to save having to browser back there again.

DOS WEDGE

The DOS Wedge gives a number of additional shortcut commands to access a disk drive, and is particularly suited to use with the SD2PET SD card disk drive.

THIS IS BUILT IN TO THE MINI PET BASIC 4.1 ROMS, AND IS AUTOMATICALLY ACTIVATED AT POWER ON, THERE IS NO NEED TO LOAD FROM DISK OR USE A SYS COMMAND.

If you are not using Mini PET BASIC 4.1, the standard BASIC 2 and BASIC 4 ROM sets also include the wedge as an option ROM, starting at address 0xE900. To activate those versions, type `SYS 59648`

COMMANDS:

- /*filename* – load the program *filename*
- ↑*filename* – load and run the program *filename*
- `@` - Display drive status (at power on, this will show drive version information)
- `@$` - Display a directory of files (does not overwrite the current program like `LOAD"$",8` does)
- `@CD:` *folder* – change into a subdirectory on the SD card
- `@CD:` *name.d64* – mount a disk image
- `@CD←` – unmount a disk image (if mounted) or change to the parent folder
- `@C:` *new*=*source* – create a copy of '*source*' called '*new*' in the current folder
- `@R:` *new*=*old* – rename a file from '*old*' to '*new*' in the current folder
- `@S:` *filename* – scratch (delete) the file *filename* (you **will not** be asked for confirmation)

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MACHINE CODE MONITOR

All BASIC versions apart from 1 have a built in machine language monitor. This is activated by the break handler, so is called at any point the BRK instruction is executed. This is code **00**, so the monitor can be launched by jumping to anywhere there is a **00** stored in memory. There is usually a **00** at address 4, so you can launch the monitor by typing **SYS 4** (**SYS 1024** is also commonly used).
The monitor is fairly simple, but allows you to view, modify, load or save memory and also to run code.

- All addresses must be entered as four hex digits, including any leading zeroes (e.g. **M 0094,0095**).
- All drive IDs must be two hex digits (e.g. **L "TEST",08**)
- All data must be two hex digits (e.g. **: 0094 78 D4 00 0D 00 D3 01 FF**)
- Any errors will either do nothing, or a **?** will appear in the line you have typed to indicate the error.

COMMANDS:

- **M** *start,end* - display memory between these addresses, 8 bytes per row
- **:** *start data* – write 8 bytes to memory, all 8 bytes must be present (*hint: cursor up to the output from a previous* **M** *command and overwrite any values you want to change)*
- **R** - display register status
- **;** *pc irq sr ac xr yr sp* – pre set register status at exit (*hint: cursor up to output of previous* **R** *command and overwrite any values you want to change*)
- **L "***filename***",***deviceID* – load *filename* from the device into memory at it's saved load address
- **S "***filename***",***deviceID,start,end+1* - Save memory between addresses to disk
- **G** *address* – jump to *address*
- **X** – exit to BASIC

RESET BUTTON

The Mini PET reset button controls the video microcontroller. When reset, this provides a clean reset pulse to the 65C02S processor. The READY LED is off during reset to indicate this.

NMI BUTTON

The Mini PET has a button wired to the NMI line of the 65C02S processor. This can be used to run code when the button is pressed. It is level triggered, and when activated, will processor will jump to the address stored at address 0xFFFA. On the default ROM sets, this is set to 0xFD49. This in turn checks address 0x0094 and jumps to the address that points to. By default, this is 0xB3FF, which causes a BASIC warm reset and the READY prompt will appear. You can change the values at 0x0094 (and the higher byte at 0x0095) to run different code. In Mini PET BASIC 4.1, this activates the built-in file browser.

MEMORY MAP

The 64K address space is split as shown in the following table. The size of the video RAM and its mirrors changes between 40 and 80 column mode.

Address Range	40 Column Mode	80 Column Mode	Function
0000 - 7FFF	32K		Main RAM
8000 - 83FF	1K	2K	Video RAM
8400 - 8FFF	3K	2K	Mirrors of video RAM
9000 - AFFF	8K		Options ROMs
B000 - DFFF	12K		BASIC ROMs
E000 - E7FF	2K		Editor ROM
E800 - E8FF	256 bytes		IO Range
E900 - EFFF	1792 bytes		Editor Extension ROM

IO MEMORY MAP

The IO space from E800-E8FF is decoded in the same way as the PET, using address lines A4, A5 and A6 as select lines. That means that chips will be active anywhere in the E800-E8FF range that their address line is low, so there are multiple duplicates of each of the IO chips in the range, and addresses that will select multiple chips. These are the recommended address ranges:

Address Range	Chip	Main Function
E810 - E813	PIA #2	Keyboard
E820 - E823	PIA #1	IEEE-488
E840 - E84F	VIA	Userport

PINOUTS

All connectors are viewed from what would be the outside of the PET, pin 1 to the right as you look from the keyboard. The grey lines indicate the slots in the edge connector or pin gaps in the pin headers.

IEEE-488 EDGE CONNECTOR

The IEEE-488 connector provides a fast parallel databus to connect an external disk drive or printer.

Top		Bottom	
1	DIO 1	**A**	DIO 5
2	DIO 2	**B**	DIO 6
-	-	**-**	-
3	DIO 3	**C**	DIO 7
4	DIO 4	**D**	DIO 8
5	EOI	**E**	REN*
6	DAV	**F**	GND
7	NRFD	**H**	GND
8	NDAC	**J**	GND
9	IFC	**K**	GND
-	-	**-**	-
10	SRQ	**L**	GND
11	ATN	**M**	GND
12	Chassis GND	**N**	GND

* REN is connected directly to ground on all PET models

USER PORT

The user port provides general user IO functionality, video and datasette signals. There is a full 8 bit parallel IO port driven from the 6522 VIA. This is not compatible with VIC20 or C64 userports.

No power is available. **DO NOT USE USER PORT DEVICES WHICH TAP POWER FROM PIN 2**

Top		Bottom	
1	GND	**A**	GND
-	-	**-**	-
2	Video	**B**	CA1
3	SRQ In	**C**	PA0
4	EOI	**D**	PA1
5	Diag *[1,5]	**E**	PA2
6	Cassette Read #2	**F**	PA3
7	Cassette Write *[2]	**H**	PA4
8	Cassette Read #1	**J**	PA5
9	Vertical Sync	**K**	PA6
10	Horizontal Sync*[3]	**L**	PA7
-	-	**-**	-
11	Graphic *[4]	**M**	CB2 *[5]
12	GND	**N**	GND

*[1] Tie to ground to start the Mini PET in machine code monitor mode

*[2] The same write signal is fed to both datasette ports

*[3] The signal polarity depends on the monitor selection (the same is true of the original PET motherboards)

*[4] This is low for the normal uppercase / graphic character set, high for lowercase / uppercase

*[5] The piezo sounder is driven from CB2 NANDed with Diag (as it is on later PETs). Diag is pulled high via a 10K resistor to ensure a valid signal.

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DATASETTES

The datasette connector is the same as that used on the VIC20 and Commodore 64, so you can use a C2N or 1530 datasette to load or save programs. The PET supports two datasettes. The rear edge connector is drive 1, and the side is drive 2. An internal drive can be connected via the 7 pin headers near the drive 1 or 2 connectors.

Top	Bottom	Internal Header	Signal
1	**A**	**1**	GND
2	**B**	**2**	+5V
-	**-**	**-**	-
3	**C**	**4**	Motor
4	**D**	**5**	Read
5	**E**	**6**	Write
6	**F**	**7**	Switch

MONITOR

The monitor connector is used to drive the PETs internal monitor. The pinout is the same for both 9" and 12" monitors, but the signal polarity is different. This is automatically set when selecting 9" or 12" monitor via the DIP switches (which also sets the appropriate frame rate).

Pin	Signal	9" Monitor Polarity	12" Monitor Polarity
1	Video	Inverted	Normal
2	GND	-	-
3	Vertical Sync	Active Low	Active Low
4	GND	-	-
5	Horizontal Sync	Active High	Active Low
-	-	-	-
7	GND	-	-

The timing of PET monitors is quite unusual. On the 9" PET, the HSync pulse ends part way through the video signal. On the 12" PET, HSync starts before the end of the previous line. It is therefore unlikely any other type of monitor could be driven from this output, use the composite video output instead.

POWER CONNECTOR

Power is fed to the Mini PET using the original 5 pin or 9 pin power connector. If fitting a 5 pin connector, align it to the right as shown on the silkscreen. The 5 pin connector can be oriented either way as the connections are symmetrical. 9V DC is generated in the same way as the on the PET, using the 9V centre tapped winding and the large capacitor mounted in the PET. The second 16V winding on later PETs is not used. The LED indicates 9V is present. The actual value may be from 8V to 12V, depending on load.

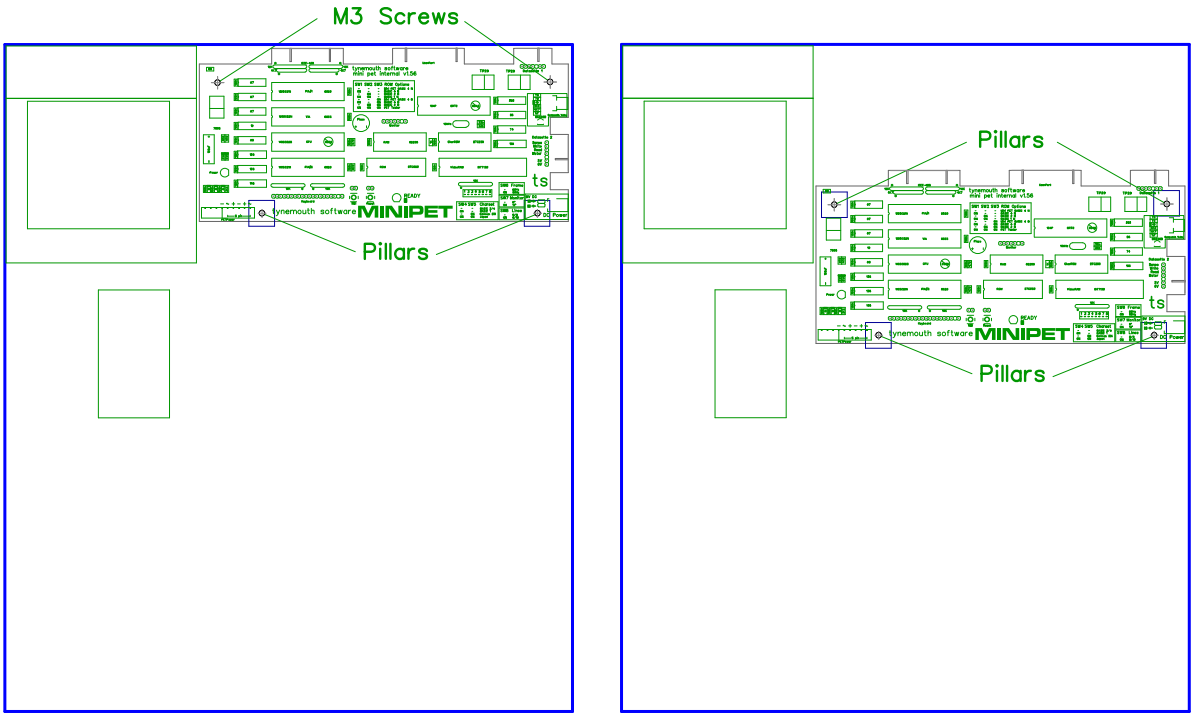
9 Pin	5 pin	Wire colours	Signal
1	**1**	**Brown**	9V AC
2	**2**	**Red**	9V DC from capacitor
3	**3**	**Black**	0V (AC centre tap)
4	**4**	**Red**	9V DC to capacitor
5	**5**	**Brown**	9V AC
6	-	**Black**	0V
-	-	**-**	-
8	-	**Blue**	16V AC (not used)
9	-	**Blue**	16V AC (not used)

MOUNTING

The board should be suitable to be installed in high or low profile cases used from the 2001 to the 8032. The board can be installed in one of two positions inside the PET case.

REAR MOUNT

This mounts the board at the back of the case with the edge connectors accessible through the holes in the rear as the original board would have had. Two M3 pillars should be present at the back of the case, and the two holes in the board should line up with those. Self-adhesive mounting pillars should be used for the two at the front. It is not necessary to remove the backing and stick the board down unless you want this to be a permanent fixture. The screw hole on the left hand side of the board is used to attach to chassis ground. The screw hole on the right is insulated.



MID MOUNT

The alternative is to mount the board further into the case. The side datasette port should still be accessible via the slot in the side of the case, but the rear ports will only be accessible internally. This can be useful to install an SD2PET SD card drive inside the case.

8032-SK / 8092-SK

The Mini PET board can be mounted in these cases, either with the two rear mounting screws as with the original board, or can be mounted centrally in the case, which would allow an SD2PET to be installed within the case.