Backpack+ Drive Manual

(inc Universal Backpack Drive)

Version 1.7

23 January 2025

Document Changes

Date	Version	Changes
10 August 2022	1.0	Original draft
18 August 2022	1.3	Added in Z88 and NT Dreamwriter user guides.
31 March 2024	1.4	Added in Sharp and Hexbus interfaces. Import-Export function for Z88.
12 July 2024	1.5	Added in commands for the Universal Backpack Drive.
20 October 2024	1.6	Clarified update instructions for BPD+ change from EPSON to TPDD Firmware
23 January 2025	1.7	Added some extra troubleshooting tips regarding low battery and file line endings.

Software Release Notes

- V1.13RC – First Released Version

IMPORTANT: Parts of the Backpack Drive+ (BPD+) and Universal Backpack drive (UBPD) firmware use Open Source software that were/are available on Github or other web sites. The license agreements for the Open Source software are reproduced with links to those relevant parts in the Annex. As always, the web pages should be consulted for more up-to-date and definitive information.

1. Although not used in the BPD+ the optiboot_dx software did help with the AVR boot loader. https://github.com/SpenceKonde/DxCore/tree/master/megaavr/bootloaders/optiboot_dx

2. Avr_boot: https://github.com/zevero/avr_boot bootloader for the BPD+.

3. The XMODEM software deployed on the BPD+ uses some of the ideas in https://github.com/Thuffir/xmodem

4. FatFS: http://elm-chan.org/fsw_e.html SD card file management software.

Welcome to the Backpack+ Drive User Manual

Introduction

The ability to store computer files on contemporary media such as Secure Digital (SD) cards has become an almost standard feature on modern computers. In general this benefit is somewhat lacking for older computers such as the Tandy™ Model 100, 102 and 200 series of laptops. There are, of course, a multitude of excellent modern solutions readily available for these vintage laptops, including smartphone storage and DOS/Linux-based software, but they are not always convenient.

The manual also covers the use of the Universal Backpack Drive (UBPD). Some commands listed may not be available of the BPD+.

The BPD+ is a simple, easy-to-use storage device that supports a micro SD card and serial port. It was designed to address the storage oversight for vintage computers. The BPD+ primarily mimics, as closely as possible, the capabilities of the original Tandy Portable Disk Drive 2 (TPDD2) thereby allowing the laptop to read and write files from/to the SD card on board the BPD+. The form factor of the BPD+ also complements the Tandy and NEC 8201a/8300 series of laptops in both color and connection method.

The BPD+ will work with the Tandy WP-2 Word Processor (WP-2) as it uses the same TPDD2 protocol, although there are some limitations on the features supported. All the file management applications listed in the Annex have been tested on these machines and work for those parts that do not rely on the behavior of magnetic media. For example, features such as bank (disk side) switching, formatting and sector access are not supported.

Although the BPD+ uses on-board firmware to implement the TPDD 2 ‘operation mode’ (a.k.a. M1 mode) which allows laptop to take advantage of SD card. The TPDD2 module does not currently support ‘FDC emulation mode’ (a.k.a. M0 mode) which would allow track or sector-based access. This mode is used by a number of other machines including most notably the Brother™ line of knitting machines, Pattern Programming devices e.g. PPD-100 and the FB-100 floppy disk drive used to store patterns. This mode is a planned addition in a future release when suitable test hardware can be acquired.

In addition to the Tandy and NEC family of machines the BPD+ can also support the Cambridge Z88™, Sharp CE-158/CE-158X, Hexbus Interface devices and the NT DreamWriter™. The use of the BPD+ with the Z88 and T-400 machines is described in the Annex.

Using This Manual

The “Quick Start” section contains the basic instructions to set up and use your TPDD 2 module. It is suitable for use with Tandy 100/102/200 and NEC machines, the Cambridge Z88 and NTS DreamWriter T 400. Reference should be made to the CE-158 Manual and CE-158X Addendum document for information on

how to use the BPD+ with the Sharp machines. The Hexbus Adapter User Guide provides informtion on how to use the Hexbus mode on the BPD+.

The “Command Line Interface” (CLI) section describes the use of the "CLI" mode and explains how to issue commands to the BPD+. Users should, at minimum, set the date and time so that file timestamps are correct when the SD card is used on a modern computer.

The “Theory of Operation” section describes the hardware and firmware operation in detail, including procedures for programming new firmware.

PART I: Quick Start Guides

This section provides a series of quick start guides for setting up and using the BPD+:

- Tandy and NEC laptops
- CP/M-100 and REXCPM
- Tandy Word Processor 2 (WP-2)
- Cambridge Z88
- NTS DreamWriter T 400
- Sharp CE-158 and CE-158X, refer to relevant Sharp Manual and the CE-159X Addendum
- Hexbus Interface for use with TI-74 and CC-40, refer to Hexbus Adapter User Guide
- Setting the time and date on the BPD+
- Updating the BPD+ firmware
- Simple troubleshooting

Depending on the source of the BPD+ and the configuration of your laptop, some of these steps might not be required. Loading of the firmware is only required for modules that you have constructed, complete units will come already loaded with firmware -- see Annex A.

Although a number of machines have been tested there may be other vintage machines that could use the XMODEM or upload features built into the BPD+ feel free the experiment. The firmware on the BPD+ can be changed to support the EPSON HX-20 and EPSON PX-8.

Use with the Tandy and NEC laptops

Step	Operation
1	Insert a CR1025 battery into the holder near the power switch.
2	Insert AA battery into holder. Alkaline batteries are preferred. Make sure the orientation is correct. TIP: Before inserting the battery wrap a piece of tape (e.g, masking tape) around the battery and form a small tab. This will simplify removing the battery in the future.
3	For use with Tandy 100/102/200 or NEC laptops, set the DTR-DSR and CTS-RTS switch on the BPD+ to loop-back mode. (Switch set toward the dot on the case.)
4	Prepare a micro SD card with the boot files. The required files can be downloaded from https://github.com/Jeff-Birt/uPDD/tree/main/SD_Card and extract the "sector0" directory (and all its files) to the root of the SD card. The "sector0" directory should now contain the following files: BOOT, TS-DOS.100, TS-DOS.200, TS-DOS.NEC as well as the "help" directory.
5	Insert the micro SD card into the BPD+. The card should be inserted label-side towards the DB25 connector.
6	Ensure the BPD+ is switched off, and plug it into the laptop serial port.
7	If your laptop has TS-DOS in ROM (ROM or REX based), simply install TS-DOS and start using the BPD+. No further steps are needed. (See the TS-DOS manual for instructions on installing TS-DOS from ROM.) If your laptop does not have TS-DOS in ROM continue following these instructions to load a RAM resident version of TS-DOS. Enter BASIC and type: `run "com:98n1enn"<Enter>` (for Tandy) `run "com:9n81xn"<Enter>` (for NEC)
8	Power on the BPD+. The Green and Yellow LEDs should blink briefly, indicating the start of the boot load process.
9	After a few seconds the text "INITIAL PROGRAM LOADER II" should appear on your laptop screen. The yellow LED will blink occasionally during the load process until "Installing TS-DOS" is displayed and dots begin to appear on the screen. *NOTE: Depending on the boot file used the text may differ slightly.*
10	Wait approximately 3 minutes for TS-DOS to load and follow the instructions on your laptop screen to complete the installation of TS-DOS. Please be patient. *Note: TS-DOS is resident in your laptop's RAM and will be erased by a cold-start or power loss. In such cases, repeat this process from step 6 to restore TS-DOS to your laptop.*
11	Optional: Set the real-time clock (See "Setting the Time and Date")

Use with the Tandy Word Processor 2 (WP-2)

The Tandy WP-2 machine is restricted to `.DO` text files and `.DA` dictionary files. The machine also requires 8.2 format filenames. In order to support these WP-2 specific features the BPD+ needs to be configured for WP-2 support. The configuration can be undertaken on a Tandy or NEC laptop using the TELECOM app or using a regular serial port on a computer with a suitable terminal program such as CoolTerm as described in the Command Line Interface section.

If the BPD+ enters sleep mode any attempt to read the *diskette* will result in '***no files***' in this case move back to the *memory* option and then return to the *diskette* option to read the files. There appears to be a problem with the WP-2 diskette mode that causes problems with out of sequence responses.

The screen on the WP-2 is very slow to update this may cause loss of characters when used with the BPD+ CLI as at even 9600bps it can out pace the screen.

Before starting

It is assumed the BPD+ is already configured with the CR1025 battery, an AA battery and suitable SD card. For use with Tandy Word Processor 2 laptops, set the DTR-DSR and CTS-RTS switch on the BPD+ to loop-back mode. (Switch set toward the dot on the case.)

Configuring the BPD+ for use with the WP-2 and using the FILES app on the WP-2

Step	Operation
1	Return to the system menu on: Tandy: Press F8 NEC: Press Shift+F5
2	Start the TELCOM application.
3	Set the serial port for 19200bps, 8bit, no parity, 1 stop bit Tandy: `STAT 98n1dnn <Enter>` NEC: `STAT 9n81xn <Enter>`
4	Enter terminal mode `TERM <Enter>`
5	Press `<Enter>` four more times until you see the '`C`' and a '`#`' prompt on your screen. You are now in CLI mode.
6	Use the set command to configure for use with the WP-2. `set mode wp2` This will configure the BPD+ to use 8.2 file formats and disable the boot options. *NOTE: This step must be completed before attempting to use the BPD+ on the WP-2.* To set the drive back for use with the Tandy or NEC laptops use: `set mode mt`
7	Plug the BPD+ into the WP-2 using a null modem adapter that has a 9-pin female to 25-pin female convertor. The pin connections are shown in the Annex. The BELKIN Pro Series DB9 Female/DB25 Female Adapter F2L089 seems to work well in this application. Make sure step 3 of 'Use with the Tandy and NEC' laptops guide is taken to set the loop-back mode.
8	On the WP-2 you can now use [F2]-[+] [F2-Files] option to access the file menu. Select the `diskette` option to bring up a list of available files from the SD Card. Files can then be copied to/from the WP-2 RAM Disk or Memory using the F1-C option. NOTE: Do not try to scroll too quickly through the list of files on the Diskette menu as the WP-2 is unable to keep up with scrolling this might result in selection of the wrong file.

The following operations have been tested with the WP-2.

- File copy to/from the BPD+.
- File rename and merge file on the BPD+.
- File delete on the BPD+.

Other options have not been tested but might work.

Using the TELECOM app on the WP-2

To use the TELECOM app on the WP-2 with the BPD+ the serial port must be configured as follows:

```
Device: RS232
Baud: 9600
Word: 8
Parity: None
Stop: 1
XON/OXOFF: Enable
Printer Echo: Off
Duplex: Full
```

To configure the serial port use the [F2]-[-] [Setup] option to open the menu. Then scroll down to Telecom option this will bring up another menu to allow the configuration of the RS232 parameters. The Telecom setup menu can be accessed directly using [F2]-[T] while in this screen.

The TELCOM app can be entered using [F2]-[9] [TELECOM] this should bring up "`RS232C is Ready`" on the LCD screen. The `<Enter>` key should be pressed this will then show "`Set to 9600bps`", this indicates that the BPD+ has now started to us 9600bps for communications. Now press `<Enter>` four times until you see the '`C`' and a '`#`' prompt on your screen. You are now in CLI mode. The mode will time out after 10s of inactivity.

Use with CP/M-100 and REXCPM

The BPD+ can be used with REXCPM and CP/M-100 by changing two settings.

To bootstrap the REXCPM:

1. Copy the "RXCINI.DO" file into the "sector0" directory on the SD Card. Copy the remaining REXCPM files to the root of the SD card.
2. Set the bootstrap file for sector 3 to "RXCINI.DO" with `boot 3 RXCINI.DO`. See "boot" command in the CLI reference.
3. Set the "mode" to "MT" with `set mode MT`. See the "set" command in the CLI reference.
4. Power off the BPD+
5. Start BASIC.
6. Type `RUN"COM:98N1ENN"<Enter>`
7. Power on the BPD+ and follow the on-screen instructions.

To install CP/M-100 on the REXCPM:

1. Set the "mode" to "GEN" with `set mode GEN.` See "set" command in the CLI reference. This will allow the BPD+ to access large CP/M files.
2. Start BASIC and type `CLEAR 0,60000<Enter>`
3. Run the "CPMUPD.CO" program, following the instructions on the CP/M-100 wiki page.

Use with the Cambridge Z88

The BPD+ can be used with the Cambridge Z88 (Z88) computer. It has been verified to work with OZ 3.0 and OZ 4.7.1. It may work with OZ 5.0, but as yet has not been tested.

To support the Cambridge Z88 (Z88) unique features, the BPD+ first needs to be configured. The BPD+ can be configured using the Z88's `TERMINAL` application or by using a regular serial port on a computer with a suitable terminal program such as CoolTerm™, as described in the Command Line Interface.

Before starting

It is assumed the BPD+ is already configured with the CR1025 battery, an AA battery and suitable SD card. For use with Z88 laptops, set the DTR-DSR and CTS-RTS switch on the BPD+ to loop-back mode. (Switch set toward the dot on the case.)

A serial port adapter that connects the female 9-pin serial port on the Z88 to the male 25-pin port on the BPD+ is required. The pin assignments information needed to make the correct serial port adapter is included in the Annex of this manual. Commercial adapters are also available and should work with the BPD+ however they have not been tested.

Step	Operation
1	Make sure the Z88 is turned off. Plug the BPD+ into the Z88 using the Z88-specific serial port adapter described above that has a 9-pin male to 25-pin female convertor. The pin connections for the Z88 adapter are shown in the Annex.
2	Once the BPD+ is connected to the Z88 with the serial port adapter turn on the BPD+ and then turn on the Z88. Next, press the Z88's `INDEX` key to see the list of Z88 Applications. Press the down arrow to select the `PANEL (□S)` Application. When in the `PANEL` Application, press the down arrow to move the cursor over the baud rate settings and change both the Transmit and Receive baud rates to 19200. This will set the serial port to 19200 bps, 8bit, no parity, 1 stop bit. Press `<Enter>` to save the setting changes. This should now return the Z88 to the `INDEX` page.
3	If not, press the `INDEX` key and then use the down arrow to select the `TERMINAL` Application.
4	Press `<Enter>` four more times until the '`C`' and a '`#`' prompt appears on the Z88 screen. This is the BPD+ CLI mode.
5	Use the set command to configure the BPD+ for use with the Z88. `set mode z88` This will configure the BPD+ to use 8.2 file formats and disable the boot options. *NOTE: This step must be completed before attempting to use the BPD+ on the Z88.* To, for example, set the drive back for use with the Tandy or NEC laptops use: `set mode mt`
7	The Z88 should now be ready for use with the DOS Application software (*DISKMGR* and *DISC-RPB*) or the BPD+ CLI commands.

The Cambridge Z88 DOS Applications - *DISKMGR* and *DISC-RPB*

There are two BBC™ BASIC programs, complete with manuals, which were written to allow a Tandy Portable Disk Drive (TPDD) (which the BPD+ emulates) to be used with the Z88. They are *DISKMGR* and *DISC-RPB*. While neither program is currently supported by their creators, they can be found and downloaded from the Rakewell Z88 Archive page located here http://www.rakewell.com/xob/xob.shtml or from the BPD+ support Page located here TBD.

In this guide the *DISC-RPB* program will be installed for use with the BPD+. The manual for *DISC-RPB* is also on the Rakewell Z88 Archive page. One of the main features of the *DISC-RPB* interface is that it allows for the convenient tagging of files. (*DISKMGR* does also work however *DISC-RPB* is the preferred choice and used to illustrate the technique.)

Both of the programs (*DISKMGR* and *DISC-RPB*) were written to support the original TPDD 1, this drive used magnetic media and had a very limited file storage capability therefore when using the BPD+ there are some limitations:

1. The number of files stored in the directory used by the Z88 should not exceed 40 files. This was the bank limit on the TPDD drives. Using the CLI on the BPD+ it is possible to create new directories and move to them (see `mkdir` and `pwd` in the CLI section). The BPD+ will remain in the selected directory until power cycled or changed to another directory. This can be used as a form of virtual TPPD floppy drive. Because the BPD+ does support directories on the Tandy/NEC machines there will be an extra file called 'UP' that will appear when in a subdirectory. No attempt should be made to delete or load the 'UP' file, nor should a file/directory be named 'UP'.

2. The *bank* selection menu item on `DISC-RPB` will have no effect as the BPD+ does not recognize banks

3. The *format* command will be ignored, the SD card on the BPD+ cannot be formatted it will not work on the drive.

Installing *DISC-RPB* on the Z88

Step	Operation
1	Download *DISC-RPB* from Rakewell or the BPD+ [TBD] support site to your computer from the links provided above. There are two options for moving the *DISC-RPB* application to the Z88: EZlink2 (step 2a) using a serial cable connection or via the `ImpExp` (step 2b) application with OZ 4.7.1 using the BPD+.
2a	Once the BASIC program "*DISC-RPB*" is downloaded to your Mac or PC computer, use EZLink2 or a preferred method to transfer it to the Z88 :RAM.? the RAM location is not important now. The serial cable will need to be connected between the Z88 and computer. After the program "*DISC-RPB*" has been copied to the Z88, exit EZLink2 on the computer and the Z88. Reconnect the BPD+ to the Z88 and turn it on.
2b	**Advanced Users** The BPD+ can be used to copy the "*DISC-RPB*" application to the Z88 using the XMODEM protocol built into OZ 4.7.1. (NOTE: It maybe available on earlier OZ versions but has not been tested). In order to do this first copy the "*DISC-RPB*" application to the BPD+ SD card in the top/root directory. Using the `TERMINAL` application on the Z88 as described above enter the following command at the CLI prompt: `xmodt DISC-RPB` Exit the `TERMINAL` (□V) application and move to the `ImpExp` (□X) application. In the `ImpExp` application select the `X)modem` option and then `R)eceive` file. In this case the file name will be `DISC-RPB`. Once the transfer has completed `DISC-RPB` should be stored on the Z88.
3	**Do not LOAD and RUN the BASIC program "*DISC-RPB*"- IT MUST BE CHAINED FIRST.** Return to the `INDEX` and press down arrow to select the BBC BASIC Application and press the <`ENTER`> key. At the BASIC > prompt, type: `CH.":*//DISC-RPB"` and press the ENTER key.
4	*DISC-RPB* should now be running and ready for you to use. Refer to the *DISC-RPB* manual on the Rakewell Z88 Archive page. *DISC-RPB* will remain in memory to be used as needed. It can be selected from the main screen by use of the cursor keys.
5	To exit *DISC-RPB*, select `Quit` in the Application. Then return to the Z88 `INDEX` and <>`KILL` the Application.

Use with the NTS DreamWriter T 400

The BPD+ can be used with the NTS DreamWriter T 400 (DW-T400). It may work with other versions of the NTS DreamWriter series, but they have not been tested.

The BPD+ can be connected to the DW-T400 using the BELKIN Pro Series DB9 Female/DB25 Female Adapter F2L089 or the WP-2 adapter (as described above). This connection provides the same configuration as the serial cable that came with the DW-T400 plus a null modem adapter, which can also be used to make the connection. More information on the DW-T400 serial communications port can be found in its Instruction Manual.

Make sure the DW-T400 and BPD+ are powered off. Plug the cables or adapter into the 9-pin female serial port connector on the DW-T400 and then plug the BPD+ in to the cable/adapter.

There may be other combinations of serial cables and null modem adapters that work. The setup above provides space to put your BPD+ to the side of the DW-T400 since the DW-T400 cable is about 3 feet in length.

Before starting

It is assumed the BPD+ is already configured with the CR1025 battery, an AA battery and suitable SD card. For use with DW-T400 laptops, set the DTR-DSR and CTS-RTS switch on the BPD+ to loop-back mode. (Switch set toward the dot on the case.)

General Operation of the DW-T400 with the BPD+.

The good news is that the DW-T400 has terminal communications built into its main applications. First find it in the *WP* or *Word Processing* menu, item 5, on your DW-T400.

Step	Operation
1	Turn your DW-T400 off. Plug the BPD+ into the DW-T400 using the process outlined above.
2	Next, press the DW-T400 *WP* key or use the *Word Processor* menu. Then, cursor over to menu item 5, *COMMUNICATE*. Press the *Return* key. Using the *SET UP* menu, select item 6. On the *RS-232C SET UP* page, enter the following setting: - `BAUD RATE: 19200` - `BIT LENGTH: 8` - `STOP BITS: 1` - `PARITY: NONE` - `X ON/OFF: DISABLE` Press the `Return` key to exit the *SET UP* page. This should return back to the DW-T400's *COMMUNICATE* menu page.
3	Select *TERMINAL* or item 5. Once in *Terminal Mode,* press the *Return* key four times to enter the BPD+ CLI mode where CLI commands can be entered. To exit, type *Bye* at the BPD+ prompt or simply hit the DW-T400's *CAN* key.
4	To send or receive a file from or to the BPD+, use the CLI commands `xmodt` to transmit and `xmodr` to receive file on the BPD+ first. Then start the *XMODEM SEND FILE* or *XMODEM RECEIVE FILE* application respectively on your DW-T400 *COMMUNICATE* page. The file transfer should begin.

Setting the Time and Date on the BPD+

The Time, Date and Day functions are controlled through the CLI mode of the BPD+. To access the CLI mode, a terminal program such as the TELECOM application on the Tandy/NEC machines or Z88 can be used. The time, date and day of week will need to be reset whenever the CR1025 RTC battery is removed or replaced.

This example uses the Tandy/NEC machines.

Step	Operation
1	Return to the system menu Tandy: Press F8 NEC: Press Shift+F5
2	Start the TELCOM application
3	Set the serial port for 19200bps, 8bit, no parity, 1 stop bit Tandy: `STAT 98n1dnn <Enter>` NEC: `STAT 9n81xn <Enter>`
4	Enter terminal mode `TERM <Enter>`
5	Press `<Enter>` four more times until you see the '`C`' and a '`#`' prompt on your screen. You are now in CLI mode.
6	Set the current date with the '`date`' command. August 10, 2022 is given as an example `date 10/08/2022<Enter>` The exact format will depend on how the date format has been configured. The factory default is dd/mm/yyyy.
7	Set the current time using the '`time`' command. 4:20 PM is given as an example `time 04:21:00 p<Enter>`
8	Set the day of the week using the '`day`' command. Friday is given as an example `day fri<Enter>`

Updating BPD+ Firmware using the SD card on the M100/102/200 family of devices

The firmware can also be update using CoolTerm and entering the commands as required.

1. Copy the new firmware file to the root of the SD card.
2. Start the TELCOM program and access the CLI (See "Command Line Interface"). See steps 1-5 above.
3. Enter command: `BOOT U <filename><Enter>` where `<filename>` is the name of the new firmware file.
4. Press `Y` to enable update
5. The boot status for sector "U" should show an asterisk next to the selected boot filename
6. Reboot the BPD+: `REBOOT<Enter>`
   The boot process should display the message "Normal Update" followed by "Processing File".
7. Once the install process is complete and before using the drive complete the following steps:
   a) use the `FACTORY` command to reset the drive to TPDD mode.
   b) set both loopback switches to LOOP. This setting will allow the BPD+ to function correctly with TS-DOS when it sleeps.
8. Verify the new firmware version: `INFO<Enter>`
9. Once the update is complete use the `set mode` command to select the desired machine. Refer to the command list below for all the possible settings.

The green and yellow LEDs will also flash to provide a visual indication of the update progress.

Troubleshooting

Yellow LED stays on continuously

Check that a properly formatted micro SD card has been inserted fully into the slot. The label side should face the serial connector.

TS-DOS hangs when accessing the disk

Is your micro-SD card installed correctly? You can verify this by entering CLI mode and issuing the `info` command. If you see the message "No card?" check that you have inserted a working micro-SD card with the required files (See "Quick Start Guide"). You can also check the SD card is present by using the `ls` command. This command should list the files on the SD card. It should show sector0 as one of the directories if you are at the root directory or the BPD+ has been power cycled.

Check the battery is good, replace it with a known good battery to check the files can be accessed. To protect the SD-Card the BPD+ will disable access to the SD-Card if the voltage is too low. If the battery is very low, then the BPD+ will shut down to protect the SD-Card completely.

TS-DOS does not load when bootstrapping (Quick-start procedure)

Make sure that the power switch on the BPD+ is set to off. Start the TELCOM program to access the CLI mode (See "Setting the Time and Date for the TELCOM STAT procedure"). Power on the BPD+ and look for startup output messages.

"*`DS? Error`*": When using the BPD+ to boot a file using, for example, `run "com:98n1e"` in BASIC, and this fails with *`DS? Error`* or similar make sure the file is using carriage-return (CR = 0x0D) and line feed (LF = 0x0A) as the line ending, also known as CR/LF format. If a file has been downloaded or edited the program used to download/edit the file might remove either the CR or LF for some obscure reasons. A quick way to check if this is the issue is to use the TELECOM program and observe the output data when preforming a boot procedure as described in the previous paragraph. If the lines do not return to the left side and simply continue one line below the previous line in a staggered manner, then the CR is missing. If the lines overlap, then the LF is missing. If possible, edit the file to create a new file that uses CR/LF line endings. Many good editors will allow a file to be saved with various line endings to support different operating systems, select the CR/LF option.

"No SD Card" - Check that a properly formatted micro-SD card has been inserted fully into the slot. The label side should face the serial connector. If the SD card is new, then it should already be formatted correctly. The BPD+can only support SD cards up to 16GB, however larger SD cards might work they could be unreliable.

"No Boot File" – Check that the SD card contains the "sector0" files. See "Quick Start Guide" step 5.

PART II: Command-Line Interface (CLI)

The BPD+ has two primary states: the TPDD state and CLI state (see above for description). In the TPDD state, the BPD+ will service TPDD Protocol Commands from e.g. TS-DOS on the laptop. To access the BPD+ CLI from the laptop the TELECOM application can be used. Set the serial port to 19200bps, 8bits, no parity and 1 stop bit (see "Quick Start" for STAT commands). See your laptop's manual for more information on the use of the TELECOM application. Once connected, the CLI state is accessed by pressing `<Enter>` (CR) four (4) times. This action should bring up the 'C' followed by the '`#`' prompt. You can now issue CLI commands to the BPD+.

If the SD card is not installed then the CLI commands associated with the file system on the SD card will not work. Check that the SD card is installed correctly if a CLI command returns an error.

If a command is successfully completed then generally the "`OK`" response will be returned. Other positive and negative responses are generated depending on the command and the particular CLI state.

If an unrecognized command is entered, the "`Unknown Command`" error will be generated. Check the spelling of the command to make sure the command is valid and that it is available in the version of firmware on the BPD+. It is anticipated that new commands might be added in future and existing ones might be enhanced or others might be removed.

If an unexpected or invalid parameter is entered for a command, the "`Bad Parameter`" error will be generated. Check that the parameters are valid for the command and that they are formatted correctly.

All the filenames used in the commands should follow the 8.3 format if the files are BPD+ system files or the 6.2 format if the file is to be used by the laptop (the WP-2 uses 8.2 format files). This will prevent issues with the various file types being confused by the laptop file management applications. For convenience the file types .BX and .BY used by REX to store ROM and RAM images are accessible via TS-DOS. These files should only be loaded by REXMGR, but they can be deleted and renamed in TS-DOS. The BPD+ does not support long filenames on the SD card.

Relevant commands can accept control keys to change their actions. The following control keys are recognized:

`Ctrl-C` : terminates any command in progress

`Ctrl-S` : resume listing

`Ctrl-Q` : pause listing -- make sure pause is ended as the module will not return to TPDD state

`Ctrl-Z` : close open file

`<space>` : continue

`<enter>` : continue

The example commands shown below use the following nomenclature:

<...> : Required field(s)

[...] : Optional field(s)

| : alternate options

All commands follow the same format: command, followed by a parameter list if required.

Using CoolTerm™ with the Backpack+ Drive from a Mac/PC

For convenience, the TPPD 2 module CLI can also be accessed from a Mac or PC through an RS232 connection using any serial terminal program. The program CoolTerm™ is tested and recommended. CoolTerm should be configured to access the correct *serial port* (e.g. USBSERIAL) associated with the serial cable plugged into the BPD+. Configure the Serial Port as: baud rate: 19200, Data Bits: 8, Parity: None and Stop Bit 1. The DTR and RTS can be set ON. Most of the Terminal default modes will work however *"Enter Key Emulation*" should be set to CR only, and the *"Convert Non-Printable characters*" and *"Handle BS and DEL characters*" should be checked.

Other serial terminal programs can be used, but configuration details will vary and are not covered here.

Command Summary

Command	Parameters	Description
backup	<filename>	Backup current flash firmware
boot	[0|3|4|5|U <filename>]	Set boot sector filenames
bye		Exit CLI State
cat	<filename>	List out filename to screen
cd	<directory name> | ..	Change directory
chk	<src filename> [dest filename]	Check the file format is valid
codo	<src filename> [dest filename]	Change .CO file to loadable .DO file
cp	<src filename> <dest filename>	Copy src to dest file
date	[d/m/y | m/d/y | y/m/d]	Print or sent date
day	[mon | tue | wed | thu | fri | sat | sun]	Set or print day.
dir	[*.<filetail>][-w | -d | -m]	Directory listing
download	<src filename.DO>	Download src file
factory		Reset to factory settings
help		Print list of commands
info		List information
ls	[*.<filetail>][-w | -d | -m]	Directory listing
mkdir	<directory name>	Make directory
mv	<src filename> <dest filename>	Copy src to dest file
pwd		Present directory name
ren	<src filename> <dest filename>	Rename src file to dest file
reboot		Reboot the module
reset		Reboot the module
rm	<filename> | <*.*>	Delete filename
rmdir	<directory name>	Delete directory
set	[time <24 | ampm> | date <mdy | dmy | ymd> | flow <ON | OFF> | lines <num 1-255> |	Set various configuration options on module.

Command	Parameters	Description
	update <OFF | ON> | sleep <0 – 60> | boot <ON | OFF> | echo <ON | OFF> | mode <WP2 | MT | Z88 | GEN | SHARP | SHARPX | HEX>]	
time	[hh:mm:ss | hh:mm:ss [a|p]]	Print of set time
type	<filename>	List out filename
upload	<src filename>	Upload src filename
uploadz	<src filename>	Upload src filename
xmodr[1]	[-c] <dest filename>	XMODEM receive to dest filename
xmodt[1]	<src filename>	XMODEM transmit src filename
xmodz[1]	[-c] <dest filename>	XMODEM receive to dest filename

[1]Note: xmodr, xmodz and xmodt have only been tested with TerraTerm™ and the Z88 running OZ 4.7.1. Before using you must verify they work in your application.

Alphabetical List of Commands with description

backup - Backup Command

```
backup <filename>
```

This command allows the user to backup the current firmware image stored in the flash memory of the Microchip AVR64DD32. The backup file generated can be used to restore the BPD+ should something fail during an upgrade or to revert to an earlier version (refer to Annex A for further details). In order to keep the SD card system files in line with the file structures it is recommended that the <filename> should use the 8.3 format with the file type being set to *.bin*. However there are no restrictions on the filename that can be used. While the file save is in operation progress dots are printed on the screen. Once the image has been saved to the SD card it will be verified and once again progress dots are used to indicate the verification is taking place. If the verification does not find any problems then *Success!* is printed on the screen. Note: the number of dots shown during the verify is less than the save as the first area of the Flash memory is used by the bootloader and is not saved (written as 0) or verified.

If the command is entered without a filename this will generate a Bad Parameter error.

Example:

```
# backup fred.bin
fred.bin
Saving Binary Image
.....
.....
Saved
Verifying
.....
.....
Success!
```

boot - Setting IPL Boot Sector Parameters

```
boot [0|3|4|5|U <filename>]
```

This command allows the BPD+ to be configured for different boot and update options.

When the BPD+ is powered on it will check the status of the RTS and DTR lines. If these two lines are ‘high’ then it will enter bootstrap mode and output the file located in the ‘sector0’ directory indicated in the boot parameter list. In the example below the boot command is entered without any parameters to display the contents of all the virtual boot sectors. In this case Sector 0 (labeled IPL) is linked with the file *boot*, Sector 3 (M100) is linked with *TS-DOS.100*, Sector 4 (T200) with *TS-DOS.200* and Sector 5 (NEC) with

TS-DOS.NEC. Each file associated with a sector must exist on the SD card in the "sector0" directory otherwise an error will be generated when an access is attempted. The *sector0* directory mimics the method provided by the real TPDD 2 drive to upload a file to a laptop that may have no other DOS access capability. The 'virtual' Sector 3, 4 and 5 files are accessed using the boot program or similar that sends another command to the BPD+ to select the file to download. For example if the serial port receives 'FF3' it will send the 'virtual' Sector 3 file. This approach uses the same file that is used on the system floppy of the TPDD 2 drive to perform the IPL operation. (see Annex for a more in depth description.)

The U sector, unique to the BPD+, stores the filename to be used when updating the drive firmware from SD card.

If the command is entered without any parameters then the current boot sector settings and update file are listed to the screen (as shown in the example below). To change a boot setting, the command is entered with the desired virtual sector to change and the new filename. If the virtual sector and/or filename are not valid this will result in a "`Bad Parameter`" error. (NOTE: No check is made on the existence of the file in the sector0 directory).

When changing the setting for the "U" (update) virtual sector, the filename will again be set to the selected file and it will also prompt with "`Enable Update [y/N]?`" (The default is no). If "Y" is entered, an update will be scheduled the next time the board is power cycled or the reboot/reset command is used. The boot sector list is again printed out and if the update has been enabled a `*` will printed next to the update sector filename. See Annex A for updating the firmware on the BPD+. The update file needs to be located at the top/root directory of the SD card -- it should not be in a sub-directory. (NOTE: No check is made on the existence of the file in the root directory.)

WARNING: The file that is selected with the new firmware image for the update Sector should be a valid firmware file for the module otherwise the module will be corrupted and a forced update will have to be initiated to recover the BPD+**, if the bootloader has not been corrupted. If the bootloader has been corrupted then it will need to be reloaded using an Atmel-ICE and Microchip virtual studio.**

Example:

```
# boot
Boot Sector Settings
0: IPL  boot
3: M100 TS-DOS.100
4: T200 TS-DOS.200
5: NEC  TS-DOS.NEC
TPDD Update File
U: Upd  TPDD2000.BIN
#
```

bye – Terminate CLI session

```
bye
```

This command is used to return to the TPDD state. Normally after 10s of inactivity the BPD+ will return to the TPDD state automatically, this prevents the BPD+ being locked in the CLI state. The automatic return will not happen if the output in the CLI has been paused.

cat – List contents of file

```
cat <filename>
```

This command lists the contents of a file to the screen. It is useful for reviewing file contents and making sure the data is correct. Ctrl-S and Ctrl-Q can be used to pause and resume the print out. Using Ctrl-C will terminate the listing. **NOTE:** The command must be allowed to complete, otherwise the BPD+ will never return to the TPDD state.

Example:

```
# cat boot
boot
10 CLS:?"---INITIAL PROGRAM LOADER II---
20 ?"     WAIT A MINUTE!":CLOSE
30 IF PEEK(1)=171 THEN M=4 ELSE M=3
40 OPEN"COM:98N1DNN" FOR OUTPUT AS #1
50 ?#1,"FF";CHR$(M);
60 FOR I=1 TO 10:NEXT:CLOSE
70 RUN"COM:98N1ENN
#
```

cd - Change Directory

`cd <directory name> | ..`

This command is used change to another directory. The command must be followed by a valid directory name or list. The '`..`' notation can be used to go up one level of directory. Directory names can be concatenated to move down the tree more quickly e.g. `cd dir1/dir2` will move to dir2.

In the example below the first command will enter directory xxd. A successful command will show the directory entered. The second *cd* command moves up one directory to the top directory shown by the /. The third command moves down two levels to the trial directory. The subsequent command then moves back to the top directory.

The cd command is very similar in operation to that found on other operating systems however it does have some limitations when running on a small-embedded MCU.

Example:

```
# cd xxd
/XXD
OK
# cd ..
/
OK
# cd xxd/trial
/XXD/TRIAL
OK
#
# cd ../..
/
OK
#
```

chk – Check file contents

`chk <src filename> [dest filename]`

This command is used to check the validity of various files (only Tandy/NEC) on the SD card. When moving files from one media to another it is possible to acquire extra carriage returns, line feeds or in the case of the laptop extra ctrl-z's at the end of the file. If only the src filename is provided this command will review the file type and report any errors found. If errors are found then adding a destination filename will generate a file that has been cleaned up or at least attempted. The src filename and dest filename cannot be the same. If is not always successful and the file may remain damaged for use with the slabtop.

The examples below show the operation of the command. In the first case the *loadup.ba* file is not a real `.BA` file it is a `.DO` file so is reported as a Bad Parameter. The next example *ipl.ba* is a tokenized basic program that can be checked. In this case it reports the file size and bytes read, these values should be the same. It also looks for the two types of errors and reports none. The third example is a larger `.DO` file and in this case progress dots are displayed to show the operation is taking place.

Example:

```
# chk loadup.ba
loadup.ba
Bad Parameter
# chk ipl.ba
ipl.ba
.
BASIC Tokenized file.
File size: 18
Bytes read: 18
CR/LF Errors: 0
EOF Errors: 0
OK
# chk loadup.do
loadup.do
.....
File size: 2168
Bytes read: 2168
CR/LF Errors: 0
EOF Errors: 0
OK
#
```

codo – Convert .CO file to .DO file

`codo <src filename> [dest filename]`

This command is used to convert a `.CO` file (machine object) into a downloadable `.DO` file. This command can be used to aid in transferring `.CO` files to machines that do not have a DOS loaded. It is based on the method used by TSLOAD.DO. The src filename must have the `.CO` file type. The file type is checked during the read process and the routine will generate an error if it is the wrong type. If no dest filename is provided, it will be created from the src filename. If the dest filename exists it will abort and generate a "`File Exists`" error response. The command displays progress dots and reports the number of bytes read.

Example:

(The generated file has been listed using the "`cat`" command after conversion)

```
# codo testr.co
testr.co -> testr.do
.....
Created .do of 830 equivalent bytes
OK
# cat testr.do
testr.do
1 '.do Loader Version 0.3
2 'Method adapted from TSLOAD.DO
10 CLEAR824,61788
20 CLS:PRINT" Loading .co file..."
30 READP1:READP2:READP3
40 A=P1:FORI=0TOP2-1:P=P+2:IFP>LEN(D$)THENREADD$:P=1
50 B=(ASC(MID$(D$,P,1))-65)*16+ASC(MID$(D$,P+1,1))-65:POKEA+I,B:NEXT
60 SAVEM"testr",P1,P1+P2,P3:PRINT"Done":END
200 DATA 61788,824,61824
210 DATA
DOLPNDLBNLOAOGIAMCHAHCCBAAPDCCDBPDOBMJCBNLAICCCAPLCBCAPLBBCCPLAG
220 DATA AGMDECCFCBJJPBCCCAPLCBKNPBCCCCPLCBLIPBCCCEPLCBLBPBCCCGPLMJPBDOCE
230 DATA
DCDEPDKPDCDFPDDOCEDCDGPDDOABMDNNBEPBMDFJENPBCBDFPDMDMNBHPBCBDFPD
240 DATA
MNMHBIDKDEPDEPDKDGPDLJNKNBPBMNOAPBNKJEBEKPEPAGAADMDCDGPDCBAAPDAJ
250 DATA
HOMDIKEOMNDIPDNICKDBPDDGANCDDGAKCDDGAAHNDCDEPDKPMNGCHGKPMJKIDJAB

#
```

cp – Copy file

`cp <src filename> <dest filename>`

This command is used to copy the contents of the src filename to a dest filename. Progress dots are used to show the state of the copy. If the src filename does not exist then a "`Bad Parameter`" error will be generated. If the dest filename already exists, the option will be given to overwrite the file.

Example:

```
# cp testr.co test1.co
testr.co -> test1.co
..............
OK
#
```

date – Set or print date

`date [d/m/y | m/d/y | y/m/d]`

This command is used to print out the current date on the BPD+ or set the date. If no parameters are provided the date will be printed out. If a date in the correct format follows then the date will be reset to the new value.

In the example below the date is set to March 15, 2021 (set to `dmy` format).

See also `day`, `time` and `set` commands.

Example:

```
# date
15/03/2021
#
```

day – Set or print day of week

`day [mon | tue | wed | thu | fri | sat | sun]`

This command is used to either print out the current day of week or set the day of week. If no parameter is provided the day of week is printed. If a valid day is provided this will set the day to the new value.

The example below shows the commands used to display the current day, then change the day to 'sat' and then display the new day.

See also `date`, `time` and `set` commands.

Example:

```
# day
Fri
# day sat
OK
# day
Sat
#
```

dir – Directory Listing

`dir [*.<filetail>][-w | -d | -m]`

See `ls` command.

download – Download file

`download <src filename.DO>`

This command allows files to be downloaded to laptop serial port from the SD card. The src filename provided will be downloaded. The routine will wait until it receives an ENTER or for 10s before beginning to send characters. The download can be stopped using Ctrl-C. At the end of the download, the BPD+ will wait for an ENTER or for 2mins before closing the file. This should allow enough time to complete any actions on the host.

On the laptop the TELCOM application should be used to perform the download. Within TELECOM use F2 to start and stop downloads of the file. **Note:** TELCOM can only properly download .DO files.

factory – Factory reset Command

`factory`

This command is used to restore the BPD+ to a factory condition; it will set all the parameters back to their default condition.

help – Help Command

`help [cmd]`

This command is used to provide brief help information on the CLI commands available on the BPD+. If the `help` command is entered without a command name a complete list of the commands will be displayed. If the `help` command includes a command name then information on that command will be displayed. If the `help` files are not present on the BPD+ in `/sector0/help` then a very brief list of commands will be displayed as shown below. Reference should be made to this manual for a more detailed explanation of each command.

The help files can be edited using the TEXT app (Tandy/NEC) as they are .DO files so they can be tailored to your requirements if desired.

Example with no help files present:

```
# help
Commands (see manual for details)
backup boot bye cat cd chk codo cp
date day dir download factory help info
ls mkdir mv pwd ren reboot rm rmdir set
time type upload uploadz xmodr xmodt
#
```

info – Backpack+ Drive Information

`info`

This command is used to display information about the BPD+. The version and build date will vary depending on the firmware loaded onto the BPD+. The card type should reflect the type of SD card inserted into the BPD+. The U field shows the use time of the BPD+ in D:H:M, this timer only runs when the device is running and not asleep. The Hardware (HW) version is used to indicate the version of hardware being used.

The information for the BPD+ includes the board voltage; it should be close to 3.3V for the battery version. The Battery voltage can be used to gauge the status of the battery. A voltage below 1.4V will bring up a LOW warning.

NOTE: The firmware continually checks access to the SD Card to determine the capabilities of the battery; it may therefore appear ‘OK’ but actually ‘low’ in terms of available energy to run the BPD+.

Example:

```
# info
AVR BPD+ V1.10
Main = 3.29V Battery = 1.68V OK
Thu 11/08/2022  4:07:39P U 000:00:55
Card Type = SDHC & Size = 15.5GB
Built Aug 10 2022 15:38:34  HW V:01
Ser:42225361510046160154012200000000
```

impc - Import Conversion command routine (Z88)

```
impc <src filename> [dest filename]
```

This command will convert a regular file to a format suitable for sending to the Z88 imp-exp utility. The file is converted to an ESCaped file as per the Z88 User Guide.

ls - List Directory contents

```
ls [*.<filetail>][-w | -d | -m]
```

This command provides a listing of the current directory. This allows the maintenance of the SD card without the need to resort to another machine. It can use three modifiers to change the format of the output. In addition it has very limited wild card capabilities using the * option.

The file tails `.CO`, `.DO` and `.BA` are considered valid file types on the Tandy/NEC slabtop. Other file types are visible when used with the basic command.

The following modifiers are used by the `ls` command:

- `-w` lists the valid file types across the screen in four columns. This option provides a very easy to view list of files similar to the TS-DOS screens.
- `-d` lists the files with their creation dates. The files are time stamped using the time from the on board RTC.
- `-m` lists the valid file types is left justified column format.

The `-m` modifier is exclusive and will override the other modifiers. Examples of using these modifiers are shown below.

The wildcard option `*` can be used with various file tails to list those file types e.g. `ls *.ba` will list all the files with the `.BA` file tail in a particular directory. This option can be combined with the other modifiers.

The file tail `.<>` is used to indicate a directory in the `-w` and `-d` lists. The / is used to indicate a directory in the other lists. This is the same format expected by TS-DOS.

Example:

```
# ls -w
DOS100.DO DOS100.CO XXD   .<> DOS200.DO
TEENYX.DO LOADO .BA TSLD2 .DO OPLML3.DO
REMTST.DC FLO100.DO RAMFIX.BA RF249 .CO
FLO200.DO TEST  .DO TSLD2 .CO TSD200.BX
CRLF1 .DO IPLTST.BA CRLF1F.DO JUNS  .DO
DSKMGR.BA FRED  .<> FMT200.BA TEST  .BX
DOS200.CO DOSXMA.DO RF249 .DO SAR200.BX
OK
#
```

```
# ls -m
DOS100.DO 13940
DOS100.CO 5791
XXD   .<> /
DOS200.DO 13525
TEENYX.DO 2378
LOADO .BA 2521
TSLD2 .DO 1576
OPLML3.DO 945
REMTST.DC 1136
FLO100.DO 1052
RAMFIX.BA 1281
RF249 .CO 4934
FLO200.DO 1076
TEST  .DO 1
OK
#
```

```
# ls -d
SPOTLI~1 /
DOS100.DO 13940 22:48:28  10/05/2017
DOS100.CO 5791 22:05:06  10/06/2017
BOOT 223 21:47:15  09/19/2017
BASIC200.BIN 5376  9:11:07  03/09/2018
XXD /
DOS200.DO 13525 16:09:06  10/09/2017
break
OK
#
```

mkdir – Make directory

`mkdir <directory name>`

This command creates a new directory. A duplicate directory name will cause an error. **WARNING:** Do not name a directory "UP" as this is used for internal directory control.

mv - Move file

`mv <src filename> <dest filename>`

This command is used to rename a file from src filename to dest filename. If the dest filename already exits this will result in a *`Check filenames`* error and the command will not be completed. Similarly if the src filename does not exist then the *`Check filenames`* error will be generated.

The `mv` command can also take directory names to move files from one directory to another.

pwd – List present directory name

`pwd`

This command is used to indicate the present working directory.

ren - Rename file

`ren <src filename> <dest filename>`

This command is used to rename the src filename to dest filename. If the dest filename already exists this will generate a Check filenames error. If the src filename does not exist it will generate a Check filenames error.

reboot – Reboot BPD+ module

```
reboot
```

This command is used to reboot the BPD+. Generally this command is used to initiate an update procedure.

reset – reset Backpack+ Drive

```
reset
```

This command is used to reboot the BPD+. Generally this command is used to initiate an update procedure on the BPD+.

rm – Delete file

```
rm <filename> | <*.*>
```

This command is used to delete a file from the current directory. The filename must exist in the directory otherwise the *No Files found* error would be generated.

The `rm` command can also be used with the wildcard `*.*` to remove all the files in a directory. This operation requires a yes response to the `Sure [y/N]?` query. Use with caution it will delete everything in a directory!

rmdir – Remove/Delete Directory

```
rmdir <directory name>
```

This command is used to remove a directory. The directory must exist and be empty for the command to complete. If the directory does not exist the error '*Invalid directory*' will be generated. If the directory is not empty then the error '*Directory not empty*' will be generated, in this case all the files need to be removed from the directory before the operation can be completed. If the directory name supplied is not a directory then the error '*Not a Directory*' will be generated. **WARNING**: Do not try to delete the `UP. <>` directory this is used internally for navigating the directory structure.

set – Set Command options

```
set [time <24 | ampm> | Date <mdy | dmy | ymd> | Flow <ON | OFF> |
Lines <num 1-255> | update <OFF | ON> | sleep <0 - 60> |
boot <ON | OFF> | mode <MT | WP2 | GEN | Z88 | EPSON* | SHARP | SHARPX
| HEX>]
```

```
*UBPD ONLY
```

This command is used to set various configuration parameters on the BPD+. If the command is entered without any parameters, then the current settings are displayed. The various settings can be concatenated into one line if desired.

- `time`: sets the time format to either `24` hour or `ampm`.
- `date`: sets the date format to either mon/day/year `mdy` or day/mon/year `dmy` or year/mon/day `ymd`.
- `flow`: sets up flow control on the serial port. Flow control `on` or flow control `off`. This should allow XON/XOFF to work on the serial port however the laptop does not implement this option robustly and it may not function as expected.
- `lines`: sets the number of lines to be displayed on the screen before pausing, the value can range from 1 to 255. The default value 7 allows the use of the full display on a Model 100/102. For use on a Model 200 it might be more useful to set the number of display lines higher.
- `update`: sets the update feature `on` or `off`. The update feature allows the updating of the firmware on the BPD+ see Annex A for further details.
- `sleep`: sets the inactivity time before sleeping, the value can range from 0 to 60 mins. The 0 setting will turn off the sleep mode. The default value is 2 mins. If the BPD+ sleeps then it might require a power cycle when used with some software. Generally it will wake when it receives a character on the serial interface.
- `boot`: sets the boot option `on` or `off`. When set `off` the power on boot option is disabled.
- `echo`: sets the echo option `on` or `off`. When set `off` the console characters are not echoed.
- `mode`: is used to set the filtering mode of the BPD+. There are currently 3 modes:
    - `MT`: Tandy 100/102/200 and NEC laptop support - Only common Tandy/NEC files (.BA, .DO, .CO) are shown. File sizes are limited to 64KB.
    - `WP2`: WP-2 word processor support - Disables the bootstrapping, and sets filename length to 8 characters. File types are limited to .DO and .DA. The WP-2 *diskette* option can be used to copy (F1-C) and save files from memory; a few other options also appear to work.
      If the BPD+ enters sleep mode any attempt to read the diskette will result in '***no files***' in this case move back to the *memory* option and then return to the *diskette* option to read the files. There appears to be a problem with the WP-2 diskette mode that causes problems with out of sequence responses.
    - `GEN`: Generic mode - No file filtering is implemented. This mode is suggested for use with CP/M-100 and is required for installing CP/M-100.

- `Z88`: Sinclair Z88 mode – this mode sets the file structure to be compatible with the Z88 DOS. Refer to the annex for use of this feature.
- `SHARP`: Sharp mode – this mode sets the file structure to be compatible with the Sharp CE-158 and CE-158X serial/parallel port. It also sets the maximum serial port speed to 2400bps as the default. Refer to the CE158X addendum for further information.
- `SHARPX`: Sharp eXtreme mode – this mode sets the file structure to be compatible with the Sharp CE-158X serial/parallel port. It also sets the maximum serial port speed to 19200bps as the default. Refer to the CE158X addendum for further information.
- `HEX`: Hexbus mode – this mode sets the file structure to be compatible with the TI CC-40 and TI-74 devices. It also sets the maximum serial port speed to 38400bps. Refer to the Hexbus user guide for information on support of this interface.

  In future other options might be added such as FB-100 support.

See also `date`, `time`, `boot` and `day` commands.

Example:

```
# set date dmy
OK
# date
05/03/2021
# set date myd
Bad Parameter
# set date mdy
OK
# date
03/05/2021
#
```

time – Set or print time

```
time [hh:mm:ss | hh:mm:ss [a|p]]
```

This command is used to set the real time clock on the BPD+. If the hours are >12 and <=23 then it will assume the 24-hour clock has been used and set the time accordingly. If the hours <= 12 it will then look for trailing `a` or `p` to determine am or pm, if neither are present it will assume am time.

The format of the printed time is determined by the set command.

See also `set`, `date` and `day` commands.

type – List the contents of the file

```
type <filename>
```

See `cat` command.

upload – Upload file to Backpack+ Drive

```
upload <src filename>
```

This command allows files to be uploaded on the serial port from the host to the SD card. The command waits for the first char before receiving the file. The upload terminates 3s after the last character is received. Once completed it will display the number of characters uploaded this should correspond to the size of the file. If the disk is full during the upload it will abort and save the partial file. If the src filename exists it will generate a '*File exists*' error.

On the laptop the TELCOM application should be used to perform the upload. Within TELECOM use F3 to configure upload. To exit use ctrl-c during the upload process.

uploadz – Upload file to Backpack+ Drive terminate with Ctrl-Z

```
uploadz <src filename>
```

This command allows files to be uploaded on the serial port from the host to the SD card. The command will be terminated and the file written to disk at the first ctrl-z received. If the disk is full during the upload it will abort and save the partial file. If the upload file exists it will abort.

On the laptop the TELCOM application should be used to perform the upload. Within TELECOM use F3 to configure upload. To exit use ctrl-z during the upload process.

xmodr – receive a file using the XMODEM protocol ignoring CTRL-Z

```
xmodr [-c] <dest filename>
```

This command allows files to be sent to the BPD+ using the XMODEM protocol. The xmodr command can take the `-c` qualifier to use the CRC option. The default is to use the checksum method.

This method ignores any CTRL-Z (0x1A) characters that might be embedded in the file allowing the transfer of files that use the full ASCII range. It does however mean that the standard XMODEM padding at the end of a file will remain and not be removed. This might be considered a none standard XMODEM implementation but it does allow the transfer of Z88 applications.

xmodt – transmit a file using the XMODEM protocol

```
xmodt <src filename>
```

This command allows files to be sent from the BPD+ using the XMODEM protocol. xmodt can only use the checksum method.

xmodz – receive a file using the XMODEM protocol

```
xmodz [-c] <dest filename>
```

This command allows files to be sent to the BPD+ using the XMODEM protocol. The xmodz command can take the `-c` qualifier to use the CRC option. The default is to use the checksum method.

This method will recognize the CTRL-Z (0x1A) characters that might be embedded at the end of a file and remove them. It does however mean it cannot be used with files that contain embedded CTRL-Z (0x1A) characters. This is the more standard XMODEM receive protocol method.

Part III: Understanding the Backpack+ Drive

This section of the document discusses the theory of operation BPD+ to provide further information if you want to build your own BPD+ or repurpose the module to support other devices. As the BPD+ features are provided entirely in firmware they should be easily updatable to correct problems or add new options. Alternative firmware could be developed to support a number of different serial to SD card interfaces as required.

NOTE: The Universal BPD uses the same hardware structure as the BPD+ and the following descriptions can be used to understand the new hardware platform.

The BPD+ uses a micro SD card (4GB, 8GB or 16GB recommended) to support the file system and provide storage for the laptop data. The SD card is removable to allow easier transfer of data to/from other PC/MAC computers. When copying files to or from modern computers, care should be taken not to introduce extra carriage return or line feed characters that might impact the ability of the laptop to read the transferred files successfully.

The BPD+ includes a battery-backed Real Time Clock (RTC) to timestamp the files created on the SD card by the laptop. Although the original TPDD2 units did not include a timestamp feature, this addition allows easier maintenance of the SD card file system when accessed by a modern computer. The RTC date and time are set using the built-in CLI (described above) accessible via the serial interface. The ability to timestamp files could also be applied to file data if a logging application was to be written for the BPD+.

The BPD+ can be constructed with two power supply options; both options are exclusive and cannot be combined. The first option uses a 1.5V AA alkaline battery to supply the power. This power source should provide about around 20 hours of active use or about 500 hours in sleep mode with a good quality AA battery. The delay before sleep can be set via the CLI. The second power supply option uses an external DC supply of 3.6 to 6.0 volts, which is fed to a 3.3V low drop out (LDO) regulator. Using the +5V sourced from the BCR port to BPD+ the BPD+ module makes for a compact system that draws power directly from the laptop. Of course an external battery pack could also be used on the LDO version of the BPD+ module.

The main processor board can be constructed without mounting the RS-232 connector, making it small enough to mount internally to the Model 100/102. In this scenario, the BPD+ module would be wired directly into the laptop motherboard. It would be necessary to modify the laptop case to provide access to the SD card, if desired. Be aware that the BPD+ module would still occupy the serial port electrically, unless steps were taken to power down the BPD+ module (via e.g. an external switch or jumper) when not in use. **NOTE:** ***This option has not been tested.***

The BPD+ module uses the Microchip AVR64DD32 this MCU has 64Kbyte Flash, 8K SRAM and 512B EEPROM. The BPD+ uses the UPDI pin for programming which should fit with most Microchip programming devices e.g. PIC 4 or Atmel – ICE.

References and Background Reading

This section provides some useful background reading to understand the TPPD 2 module as well as the genesis of the module. There are probably many other solutions and references that can be found to aid in understanding if required, as well as act as inspiration to build something of your own.

1. TRS-80 Model 100 Owners Manual
2. TRS-80 Model 102 Owners Manual, Catalog No. 26-3803
3. TRS-80 Model 200 Owners Manual
4. TRS-80 Model 100 Reference Manual, Catalog No. 26-3810
5. TRS-80 Model 102 Reference Manual, Catalog No. 26-3803
6. Tandy Portable Disk Drive 1 Operation Manual, Catalog No. 26-3814
7. Tandy Portable Disk Drive Service Manual, Catalog No. 26-3808 (appears to be for TPDD 1)
8. Tandy Portable Disk Drive 2 Operation Manual, Catalog No. 26-3814
9. TPDD Base Protocol: http://bitchin100.com/wiki/index.php?title=TPDD_Base_Protocol definition of the TPDD Base Protocol used on the TPDD 2 drive and partly on the TPDD 1 drive. Incomplete, the document references out to “dlplus” as an example. Expands on the information in the TPDD1 Service manual. Covers use of the various protocol messages. This is independently provided resource.
10. TPDD Directory Protocol: http://bitchin100.com/wiki/index.php?title=Desklink/TS-DOS_Directory_Access definition of the directory DME response for TS-DOS. When combined with the base protocol it covers the complete TPDD TS-DOS software. The extension covers the use of directories primarily used by TS-DOS. Fits into the base protocol and uses one message to signal directory support. This is an independently provided resource.
11. dl.c V1.3 (URL: http://m100.bbsdev.net/) helps to understand the TPDD Base protocol outlined in the Tandy Ref manual and TPDD base protocol web page. Also recommended reading on the protocol web page. Software later extended and enhanced to dlplus.c (URL: https://github.com/bkw777/dlplus). Both written for *nix’s but are nevertheless useful references to complement the protocol descriptions.
12. dlplus Github repository https://github.com/bkw777/dlplus download source for the various bootloader options and file management applications/manuals. Includes ‘how to’ guides for loading and using the various options. Some of the more pertinent text is provided in the Annex to keep the information together, however the repository is the best source for the information.
13. TS-DOS Manual: A Disk-Operating System for the Tandy 100, 102, 200 and the NEC PC-8201 and PC-8300.

14. CE-158X Serial / Parallel Interface for Sharp PC-1500, PC-1500A, PC-1600 and TRS-80 PC-2
15. HEXBUS Adapter Manual, Version 1.0
16. Microchip: AVR64DD32 Datasheet.
17. Maxim Integrated: DS1338 I2C RTC with 56-Byte NV RAM Datasheet. RTC clock.
18. Texas Instruments: TRS3243E 3- to 5.5-V multichannel 600kbps RS-232 line driver/receiver with +/-15-kV IEC-ESD protection datasheet. Serial port interface.
19. REX Wiki Page: http://bitchin100.com/wiki/index.php?title=Rex used to store OPTROMS on the laptop and NEC machines, includes TS-DOS.
20. https://www.duracell.com/wp-content/uploads/2020/02/MN15US11191.pdf performance data for Duracell AA battery.

Theory of Operation

This section describes the hardware and firmware of the BPD+ to assist with understanding the operational aspects of the device, especially if the unit is to be used in other applications beyond those outlined in this manual.

Hardware Operation

A block diagram of the BPD+ is shown in Fig 1. The module is designed to be as simple and low cost as possible while still providing useful and versatile functionality. As mentioned above the unit uses the Microchip AVR64DD32 set to run at 8MHz.

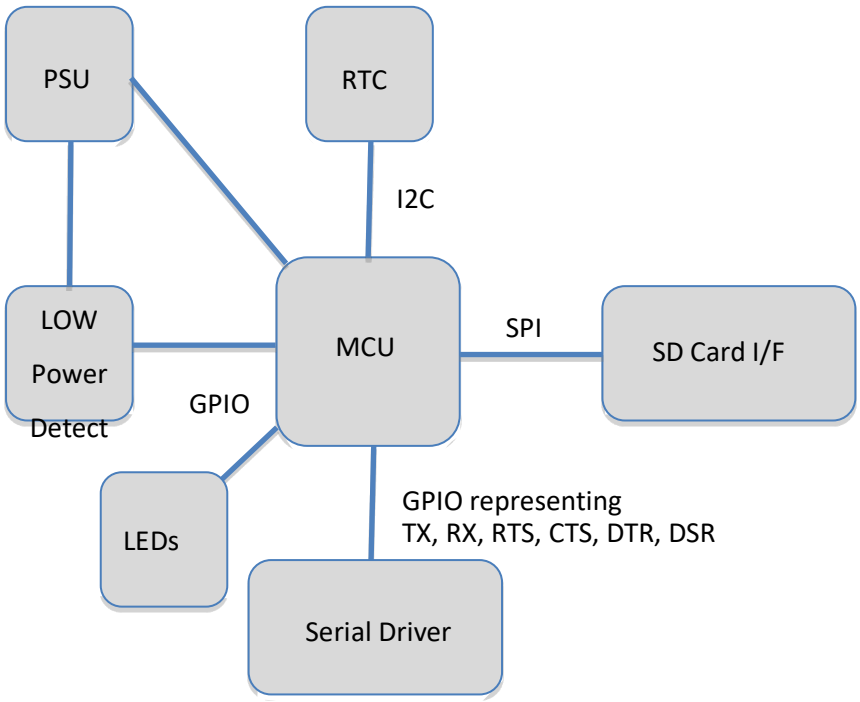


Figure 1: Backpack+ Drive Block Diagram

The MCU interfaces to 4 separate sections: SD Card interface, Serial Driver interface, RTC and LEDs. The BPD+ can be powered either by a 1.5V AA battery or an external supply depending on the power ICs populated during construction.

The hardware interface to the micro SD card is via the SPI bus which takes care of hardware aspects of reading and writing data to/from the SD card. The yellow LED is used to indicate the status of the SD Card, although not exclusively. A short blink of the yellow LED indicates that the SD Card is being accessed. A solid yellow LED indicates a problem with the SD card, either it is missing, improperly inserted, badly formatted or corrupt. The SD Card should not be removed while the unit is powered on as this will potentially corrupt the SD Card or damage the card/processor. If the SD card is accidently

removed the MCU will reset and wait for it to be re-inserted. The unit has been tested with 4GB, 8GB and 16GB micro SD cards other larger cards could work but their behavior might be unreliable. In particular with larger SD Cards the directory structure can become unwieldy and slow down the operation of the MCU.

The MCU interfaces to the RTC (DS1338) via the I2C bus to reduce the number of GPIO lines used. The RTC supports both time, date and day functionality although it only stores the lower two digits of the century. Currently the upper two digits are hardcoded into the MCU, unfortunately usage is limited to the 21st Century. The RTC is battery backed up using a 3V 30mAh CR1025, with an 800nA standby current this should give anywhere from 3-5 years of time retention depending on the quality of the battery and storage conditions of the unit. If the unit is to be stored for any length of time it is recommended that all batteries be removed to prevent leaks or corrosion of the board traces. If the RTC fails then an "RTC Failure" message will be printed on power up, the message could mean either a low voltage on the backup battery or an improperly fitted backup battery.

The serial interface uses the TX/RX pins of UART0 on the MCU and 4 GPIO pins to provide the control lines RTS, CTS, DTS and DSR lines. The control pins currently provide no hardware flow control although software flow control can be enabled via the CLI. The control pins are there to allow compatibility between the laptop software and BPD+ as well as future upgrades to support other machines. A Texas Instruments TRS3243E IC provides the serial voltages and interface. In sleep mode the serial interface is shutdown to save power. A rapidly blinking green LED indicates activity on the serial port, however the LED is also used to indicate other states (see below). The sleeping MCU is taken out of sleep mode when a character is received on the serial line. On the Tandy 100/102 at least the DSR/DTR (and CTS/RTS line on the 200) line need to be active for TS-DOS to work correctly. To provide this continued access, the LOOP switch on the line needs to be set to LOOP such that TS-DOS will send characters to wake up the BPD+. If any file management application reports a failure to communicate with the BPD+ then power cycling the BPD+ should solve the problem, after which you can retry the operation. This problem is present when using the REX to save files to the BPD+. It can also cause problems with the Model 200, which has inconsistent serial port behaviors.

There are two options to build the power supply. The first option uses a Torex XC9142D32DMR boost converter to provide 3.3V from a 1.5V AA battery. The second option uses a regular LDO to provide 3.3V from a wide input range of 3.6-6.0V. This allows flexibility when using the BPD+ in different roles. When using TS-DOS a low volt condition is flagged in the directory area to indicate a problem. To increase battery life, the MCU can go to sleep after a set number of minutes of no activity. This feature can be controlled using the CLI. It is also possible to turn off sleep mode if desired. Blinking yellow and green LEDs (see table below) are used to indicate entry into the sleep state. The MCU will remain sleeping until a new character is received on the serial port at which point it will begin normal activity. As mentioned above while in sleep mode all the pins on the serial port are disconnected and will float to almost 0V. If the serial port requires control lines to be active for operation then the loop back switches should be set to

LOOP mode so the serial port appears active. This is the case with the Model 100/102 and 200. Alternatively, if the loop back is insufficient and the unit has entered sleep then it can be power cycled when it is once again needed. A sleep time from 3 – 10mins is recommended. When the MCU is in the sleep state the current drain decreases to <1mA. During normal operation the average current drain is ~30mA depending on the precise activity, this can increase to a brief peak of 140mA when the SD Card is being accessed.

Two LEDs (Green and Yellow) are driven directly from GPIO pins on the MCU. The LEDs are used to visually signal various states of the BPD+. Their primary use is to indicate activity on the serial port with a blinking Green LED and activity on the micro SD Card with a blinking Yellow LED, as described above. On power up the Green and Yellow LEDs will blink alternatively to indicate successful power on. If the Yellow LED remains illuminated then a problem exists with the micro SD Card. The table below lists some of the states indicated by the LEDs.

Green LED	Yellow LED	Comment
blinking	X	Serial port activity
X	blinking	SD card Activity
off	steady	SD card problem
on on off	on off off	Entering sleep mode
on ~2s off ~2s	on ~2s off ~2s	Cycle repeats for 15s. Fatal error Possible low battery or SD card issue
During Update procedures		
on blink	on off	Update failed, file not found
on off	on blink	Update succeeded
rapid blink	off	Error occurred during update. Repeat.

The serial port daughter board provides the interface to the laptop. This board includes two small switches that allow the DSR & DTR and CTS & RTS lines to be looped together or connected straight through. This loopback is required to support some slabtop software. They should be left in LOOP mode when used with the Model 100/102/200. The through connection is provided to allow the use of the board with other serial ports. The daughter card could be modified to support other serial interface connectors if desired, for example a female DB-9 for use with the WP-2. The upper connector on the serial board is connected to the programming pins of the MCU. The programming pins also terminate on unused pins on the RS232 connector. This feature could be used to reprogram the MCU even if it was located internally to the laptop.

The programming pin header can be used to reprogram the MCU on the BPD+ using either the Microchip PIC 4 or Atmel ICE. Pin 2 is used by the bootloader to determine whether or not an update should be forced. When pin 1 and 2 are shorted using a shorting header no action will be taken on reboot or power cycle. If pin 1 and 2 are not shorted then an attempt will be made to update the firmware from the SD card (see Annex A). A shorting pin is required at all times to make sure it is available when needed. If the shorting header were not required for normal operation then finding one would be impossible when required.

Pin Number	Description	Comment
1	GND	DB-25 pin 7
2	Update	N/C
3	UPDI	DB-25 pin 10
4	Vcc	DB-25 pin 9
5	NC	DB-25 pin 11
6	NC	DB-25 pin 12
7	RESET	DB-25 pin 13
8	GND	DB-25 pin 7

Table 1: Programming header pin descriptions

The following table lists the serial port pins available on the header from the laptop perspective. These pins use +/-5V and are not TTL level compatible. This information could be used to redesign the serial port daughter board to support other formats of serial interface.

Pin Number	Description	Comment
9	GND	DB-25 pin 7
10	DSR	DB-25 pin 6
11	CTS	DB-25 pin 5
12	Tx	DB-25 pin 3
13	DTR	DB-25 pin 20
14	RTS	DB-25 pin 4
15	Rx	DB-25 pin 2
16	Reserved	DB-25 pin 14

Table 1: Serial port header pin descriptions from laptop

Figures 2 and 3 show the completed boards for reference. Note the board color and parts might vary dependending on supplier.

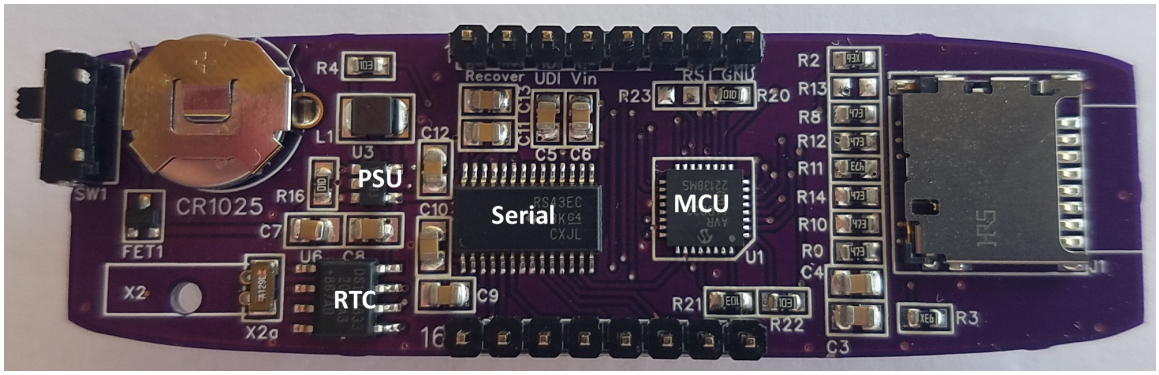


Figure 2: Annotated Backpack+ Drive without Serial Port

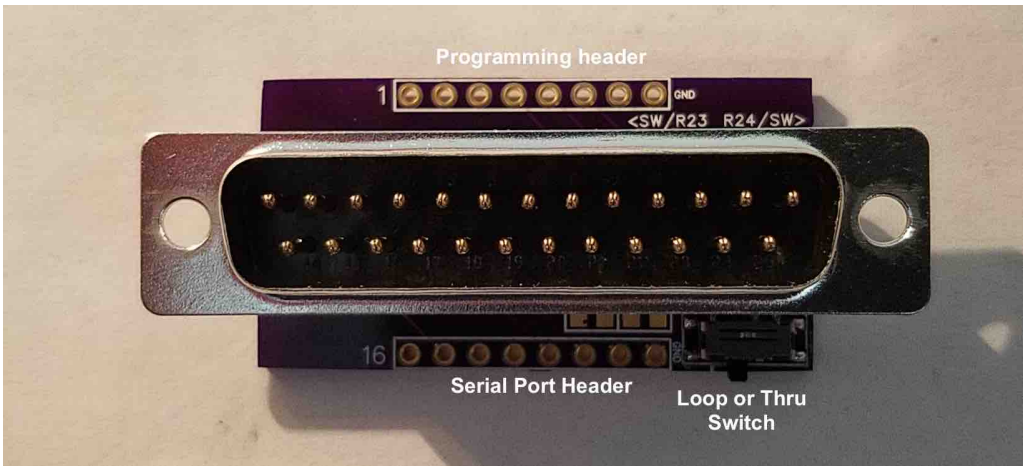


Figure 3: Annotated Serial Port Connector

Firmware Operation

The firmware can operate in three separate states: TPDD state, CLI state and Sleep state. The TPDD state is the default state of operation that is used to provide the TPDD services to the laptop. While in the TPDD state, the serial port is continuously monitored for TPDD Commands (e.g. from TS-DOS), original TPDD2 IPL commands ('FF?') for particular sectors or ENTER/RETURN keys (CR) to potentially start entry to the CLI state. The TPDD Protocol Commands generally start with "ZZ" making them easy to detect. The Boot Loader Commands (See Annex) start with "FF" and will cause the TPDD service to dump the file indicated in the desired Boot Sector (see CLI Boot command). If 4 ENTERs in sequence are received then the CLI state will be entered. The TPDD state is used to service TS-DOS or similarly based file management applications on the laptop.

If the BPD+ is powered on with the RTS and DTR line set 'high' then the module will dump the file indicated in Boot Sector 0 to the serial port. This allows the BPD+ to automatically upload a file to the laptop without any action required by the user (apart from configuring the boot files – see "Quick Start

Guide"). This mimics the behavior of the original TPDD 2 drive in sending boot sector software to the laptop to allow the TPDD software to be bootstrapped onto the machine.

Using TS-DOS (version 4 or above) in Option ROM is highly advised, as this will make accessing the BPD+ much easier and more reliable. The firmware has been tested with REX Classic and REX# models.

Entering four CRs in sequence will move the BPD+ to the CLI state from the TPDD state. This can be done from any terminal program or from TELECOM on the laptop. Once in the CLI state a 'C' and '#' prompt will be displayed, at this point a number of commands can be used to configure the BPD+ and perform SD card management. See the Command Line Interface (CLI) section for a description of the commands that can be used. If no activity is detected on the serial port for 10s while in the CLI state then the TPDD State will be re-entered. Typing '`bye`' on the terminal will enter the TPDD State immediately.

The Sleep state is entered when no activity has been detected on the serial port for a set length of time. On the BPD+ the inactivity time before sleep can be set via the CLI. There is also an option to turn off the sleep mode if required. As described above in the hardware section in the Sleep state the processor, serial interface and SD Card are all put into a low power mode to conserve the battery. The Sleep state is exited either when a character is received on the serial interface or the unit is power cycled/reset.

NOTE: The REX uses built-in TPDD access routines to save RAM or ROM images to the BPD+. However the REX TPDD client software is not as robust as TS-DOS. When saving such images, please save to a directory that does not contain many files in order to avoid REXMGR timing out while waiting for a response from the BPD+. The BPD+ checks for conflicting file names prior to writing any file to ensure that files are not overwritten. It is generally seen as good housekeeping to save images in a separate directory to simplify SD Card maintenance.

Annex A: Firmware Updates

The BPD+ employs a bootloader to permit field upgrades without the need to use a device programmer - once the bootloader has been installed. The BPD+ is updated using the SD card. Suitable *.bin* files for the bootloader can be found on the support page for the BPD+.

Installing the Backpack+ Drive Bootloader

The bootloader is based on the zevero/avrboot (github: https://github.com/zevero/avr_boot) software it uses a stand-alone MMC boot loader by ChaN and can be used on any device that has about 4Kbytes of boot flash memory. Installing the bootloader will require an AVR programmer such as the Microchip PIC 4 or Atmel-ICE and the Microchip visual studio to load the .bin file. The bootsize should be confirmed to be 0x0B. Once programmed the bootloader will search for the default file BPDP3000.BIN on the SD card. If the file is found this will be programmed into the flash memory and the BPD+ should be operational. If the file/SD card is not found then the bootloader will continue to loop until an SD card with the file is found. The update file BPDP3000.BIN should be located in the root directory of the SD card.

The shorting plug should be removed when programming the bootloader, see the hardware description above for the location of the pin.

Updating Backpack+ Drive Firmware using the SD card

10. Copy the new firmware file to the root of the SD card.
11. Start the TELCOM program and access the CLI (See “Command Line Interface”)
12. Enter command: `BOOT U <filename><Enter>`
13. Press `Y` to enable update
14. The boot status for sector “U” should show an asterisk next to the selected boot filename
15. Reboot the BPD+: `REBOOT<Enter>`
    The boot process should display the message “Normal Update” followed by “Processing FIle”.
16. Verify the new firmware version: `INFO<Enter>`

The programming pins can remain shorted during this operation. Once the BIN file has been loaded into memory the BPD+ should reboot with the new firmware. The green and yellow LEDs will flash to provide a visual indication of the update progress.

Example using reboot command: (The version shown might be different)

```
reboot
AVR BPD+ BOOT V1.1
Normal Update
Processing File
Update ran
```

Recovering a 'bricked' Backpack+ Drive.

If after an update or due to other reasons the BPD+ stops responding to TPDD or CLI commands then it is possible to perform a hard recovery provided the bootloader has not been corrupted. If the bootloader has been corrupted then it will be necessary to start the bootloader installation operation assuming a blank MCU as described earlier.

To perform a hard recovery first power down the BPD+ and remove the shorting header from the programming pins. The SD card shall be inserted with a copy of a known good firmware image and titled BPDP3000.BIN – this is the default image, at the root level of the directories. The unit can then be powered up to reprogram the firmware. If the serial port is connected the text below should be visible, if it is not displayed on power up then it is very likely the bootloader is corrupt. A successful read of the SD card should result in a recovered BPD+.

```
AVR BPD+ BOOT V1.1
Recovery mode using: BPDP3000.BIN
Processing File
Update ran
```

Annex B: SD card Format

Outline structure of SD card for use with the BPD+. The SD card should be no larger than 16GB as larger sizes may cause file-handling issues.

/ <update files>
BPDP3000.BIN

etc etc

/Sector0
<boot files>
BOOT
BOOTN
TS-DOS.100
TS-DOS.200
TS-DOS.NEC

/help
<help files>
MANCLI.DO
etc etc.

Annex C: Using the Laptop IPL Boot loading option on the Tandy/NEC computers

The Tandy 100/102/200 and NEC PC-8201a/PC-8300 laptops have no 'built-in' disk management software. Therefore, in order to deal with a floppy disk-based file system the laptop has to load a file management application (a.k.a. DOS). The real Tandy Portable Disk Drive 2 (TPDD2) uses a very simple method to load in this application software. When the TPDD2 is powered on if it detects the serial port is active (i.e. DTR is active) then it writes an Initial Program Loader (IPL) program (example shown below) located in sector 0 of the floppy disk onto the serial port. The laptop is set up to read and run the program received on the serial port by first entering `run "com:98N1ENN"` in BASIC prior to powering on the BPD+. Using this BASIC command also sets the serial port to the active state. This IPL program when completely loaded is run under BASIC. The IPL program then makes a request for the full File Management Application to the BPD+. In the case of the real TPDD 2 drive the application would normally be called *floppy*. As the BPD+ can support the Model 100, 102 and 200 the IPL program first checks to see which version of *floppy* should be requested. Once loaded the file management program then installs itself as an application that can be used to access the files on the floppy disk. Over time many different versions of file management software have been written for the laptop these range from the sophisticated TS-DOS to the very simple and small Tiny. All the alternate file management applications load in a very similar manner, the IPL when run makes the same request but the application provided is the alternate software.

The BPD+ mimics the method used by the real TPDD 2 drive by providing an option to boot a file management application. First the SD card needs to contain a directory called *sector0* located in the root directory where all the alternate file management applications and the IPL program can be stored. The BPD+ then maintains a 'sector 0' boot record in flash memory to point to the required application program. The default case is to use the standard IPL program shown below but to then use the, for example, TS-DOS file management applications for the 100/102, 200 and NEC machines. The IPL program and file management application can be changed using the *boot* CLI command (see the CLI command section). Although it is possible to boot directly into the required file management application by setting it as the IPL file this might cause performance issues as every time the unit is powered on with an active serial port this large file will be dumped to the serial port.

IPL file contents for Model 100/102/200 (BOOT):

```
10 CLS:?"---INITIAL PROGRAM LOADER II---
20 ?"     WAIT A MINUTE!":CLOSE
30 IF PEEK(1)=171 THEN M=4 ELSE M=3
40 OPEN"COM:98N1DNN" FOR OUTPUT AS #1
50 ?#1,"FF";CHR$(M);
60 FOR I=1 TO 10:NEXT:CLOSE
70 RUN"COM:98N1ENN
```

IPL file contents for Model 100/102/200/NEC (BOOTN):

```
10 CLS:PRINT"---INITIAL PROGRAM LOADER III---"
20 PRINT"     WAIT A MINUTE!":CLOSE
25 A$="COM:98N1ENN"
30 IF PEEK(1)=171 THEN M=4 ELSE M=3
35 IF PEEK(1)=148 THEN M=5:A$="COM:9N81XN"
40 OPENA$ FOR OUTPUT AS #1
50 PRINT#1,"FF";CHR$(M);
60 FOR I=1 TO 10:NEXT:CLOSE
70 RUNA$
```

The various different file management applications can be found on Github https://github.com/bkw777/dlplus having been collated by enthusiastic laptop users. Some of the details are reproduced below to highlight areas applicable to the BPD+ **however** reference should be made to the Github repository for more up to date information and any manuals etc.

The Easter egg - a reward for getting this far: The RTC on the BPD module has a battery backup that should last a few years under normal operation. An exclusive extension to the boot feature allows a query for the time, date and day to be extracted that can be used to set the time, date and day on the laptop should it have to be cold reset. The BASIC file below performs the action of requesting the data by sending 'FF7' to the module. It should respond with the current date, time and day. The date and time have to be set to `mdy` and `24` respectively for the laptop. International machines might require setting to the local format for this data.

Example laptop and BPD+ RTC management for 100/102 (SYNC.DO):

```
1MAXFILES=2:DEFSTRAF:F="COM:98N1E":OPENFFOROUTPUTAS1:OPENFFORINPUTAS2:C=CHR$
(13):PRINT#1,"FF";CHR$(7)
5INPUT#2,A,B,C:PRINTA,B,C
10DATE$=LEFT$(A,9)
15TIME$=LEFT$(B,8)
20DAY$=LEFT$(C,3)
```

IPL run options

There are a few different versions of the run command that can be used to start the IPL download on the family member machines:

- Tandy TRS-80 Model 100/102: *run "com:98n1e"*
- Tandy TRS-80 Model 200: *run "com:98n1enn"*
- NEC PC-8201, 8201a & 8300: *run "com:9n81xn"*
- Olivetti M-10: *run "com:98n1e"*
- Kytronic KC-85: *run "com:98n1e"*

All except the NEC machines can use: *run "com:98n1enn"*

File Management Application options

It should be noted that some commands available in the File Management Applications listed below such as format, bank etc. are not available on the BPD+ as they either do not exist or are not appropriate. In addition, the free space available will generally always be at the maximum as the SD card is much larger than the floppy disks the application was designed to use. All the Tandy and NEC versions of file management software available on the GitHub repository have been tested and work with the BPD+. The BPD+ also supports directory access but that is only available with TS-DOS.

All the file management files should be in the *sector0* directory on the SD card

File management options are listed below for convenience however reference should be made to the Github repository to retrieve manuals and resolve any issues.

Although the file management software can be loaded onto a laptop a better option is to use the TS-DOS OPTROM so as to avoid using RAM and to speed up operations should the RAM be corrupted. The OPTROM is available online as a binary or hex download for programming into a user created ROM or to load into a REX Classic. The use of OPTROMs and REX is beyond the scope of this manual.

The BPD+ does not support FDC Emulation mode (M0) i.e. track/sector access. File management programs that require FDC Emulation mode will not work.

TS-DOS

TS-DOS is the most sophisticated and complete file management application however it is also quite large when used as the RAM version. The application does support directories as used on the BPD+. There are 3 version of TS-DOS for the Model 100/102, Model 200 and NEC machines. They all use the run commands described above to load the IPL and then the application. The boot CLI command should be used to set up the files as required. The options below set up TS-DOS for all three machines.

3: TS-DOS.100
4: TS-DOS.200
5: TS-DOS.NEC

For all 3 versions when the installation has completed, which will take several minutes, while still in BASIC type *SAVE "TS-DOS"* this will produce TS-DOS.BA in the main menu. To run TS-DOS simply use the .BA program. The TMP.DO file created in the process can be deleted it is no longer required.

The manual for TS-DOS can be found on the Github repository.

DSKMGR

The DSKMGR file management application has a smaller footprint than TS-DOS and provides similar functionality without some of the ease of use, it does not support directories. There are 2 version of DSKMGR for the Model 100/102 and Model 200. They all use the run commands described above to load the IPL and then the application. The boot command should be used to set up the files as:

3: DSKMGR.100
4: DSKMGR.200

The installers can take several minutes to run.

On the M100/102 the progress is indicated by the PC = xxxx text. When complete this will ask a few questions expecting *Y* or *N* responses. The Self-Clearing and High-Speed should be Y. The sound option is a personal preference. Once returned to the BASIC prompt type *NEW*. The DSKMGR then needs to be loaded to the directory by first using *LOAD "DRIVER.DO"*, then *SAVE "DSKMGR"*. The DRIVER.DO file can be removed with KILL "DRIVER.DO". Then use NEW to clean up the BASIC area. Use DSKMG.BA in the menu to run the application, not DSKMGR.CO.

On the Model 200 simply type NEW and exit BASIC.

The GitHub repository contains versions for other family members however these have not been tested but should be easy to configure on the BPD+. The repository also contains the manual for using the DSKMGR application.

TEENY

Teeny is the simplest file management application with a very rudimentary CLI to save and load files. It does not support directories. It is also perhaps the hardest to load onto the machine although it has a very small footprint.

There are 3 versions of Teeny for the Model 100/102, Model 200 and NEC machines. They all use the run commands described above to load the IPL and then the application. The boot command should be used to set up the files as

```
3: TEENY.100
4: TEENY.200
5: TEENY.NEC
```

Loading the application can take a few minutes although it is relatively quick due to its small size. Once loaded the actions taken are different for all 3 machines:

On the Model 100 use *NEW* followed by *CALL 9643* this should generate a list starting with TOP:xxxx. The value xxxx from TOP is then used with *CLEAR 0,xxxx* to set up space for *TEENY.CO*. Teeny can then be used from the main menu.

On the Model 200 use *NEW* followed by *CALL 13072* this should generate a list starting with TOP:xxxx. The value xxxx from TOP is then used with *CLEAR 0,xxxx* to set up space for *TEENY.CO*. Teeny can then be used from the main menu.

On the NEC machine in BASIC type:

```
NEW
L=747
P=PEEK(-3196)+PEEK(-3195)*256
CLEARFREE(""),P-L
```

Teeny can then be used from the main menu.

TINY

Tiny is similar to Teeny in operation however it only occupies 760 bytes of memory making it the smallest footprint. There is only a Model 100/102 version of this file management system and it does not support directories. The boot command should be used to set up the files as:

```
3: TINY.100
```

Once loaded enter NEW and then CLEAR 0,62200. Tiny can then be run from the main menu.

Annex D: WP-2 Cable Configuration

The BPD+ can be used with the Tandy WP-2 however an adapter cable is required. The Tandy WP-2 has to use a null cable with a DB-25 Female to DB-9 Female connector. The BELKIN Pro Series DB9 Female/DB25 Female Adapters F2L089 is one possible option. The pin connections are listed in the table below.

DB-9 Female	DB-25 Female	Comment
2	3	RX
3	2	TX
4	20	DTR
5	7	GND
6	6	DSR
7	4	RTS
8	5	CTS

Annex E: Cambridge Z88 Cable Configuration

The BPD+ can be used with the Cambridge Z88 however an adapter cable is required. The Cambridge Z88 has to use a null cable with a DB-25 Female to DB-9 male connector. The pin connections are listed in the table below.

DB-9 Male	DB-25 Female	Comment
1	-	-
2	2	RX
3	3	TX
4	5	RTS/CTS
5	4	CTS/RTS
6	-	-
7	7	GND
8	20	DCD/DTR
9	6,8	DTR

Further information can be found on the Z88 wiki pages.

https://cambridgez88.jira.com/wiki/spaces/ZP/pages/120887895/Z88+Serial+Cable

Annex F: AVR port usage

The following tables lists the ports used by the BPD+ the information is provided to allow the reuse of the BPD+ in other applications.

Backpack+ Drive port usage

```
* PA0 = Unused
* PA1 = Unused
* PA2 = SDA
* PA3 = SCL
* PA4 = MOSI - out
* PA5 = MISO - in
* PA6 = SCK  - out
* PA7 = SS   - out
* DDRA  = 11011100 = 0xDC
* PORTA = 11011100 = 0xDC

* PC0 = INT_UART_RX Interrupt from UART
* PC1 = RS232_SHDN RS232 Shutdown pin - OUT
* PC2 = RS232 EN RS232 Enable pin - OUT
* PC3 = SDDET - IN
* PC4 = unused
* PC5 = unused
* PC6 = unused
* PC7 = Unused
* DDRC  = 00000110 = 0x06
* PORTC = 00000010 = 0x02

* PD0 = unused
* PD1 = LED2 - OUT
* PD2 = LED1 - OUT
* PD3 = RTC_INT RTC Interrupt
* PD4 = UART_TX - OUT
* PD5 = UART_RX - IN
* PD6 = SEL2 - IN
* PD7 = VBATT - IN
* DDRD  = 00010110 = 0x16
* PORTD = 00010110 = 0x16
```

```
* PF0 = unused
* PF1 = unused
* PF2 = DTR - IN
* PF3 = RTS - IN
* PF4 = DSR - OUT
* PF5 = CTS - OUT
* PF6 = RESET- - IN
* PF7 = UDI    - IN
* DDRF  = 00110000 = 0x30
* PORTF = 00110000 = 0x30
```

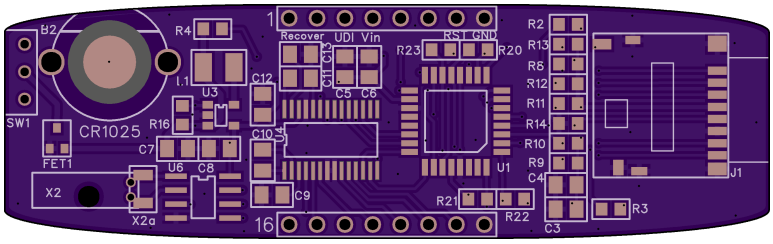
Annex H: Backpack+ Drive Part List

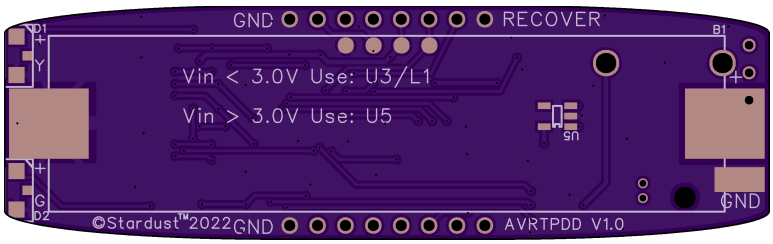
Manufacturer Part Number	Digi-Key Part Number	Ref	Qty	Description
SPC02SYAN	S9001-ND		1	CONN JUMPER SHORTING GOLD FLASH
PH1-08-UA	2057-PH1-08-UA-ND		2	CONN HEADER VERT 8POS 2.54MM
1024TR	36-1024CT-ND	B1	1	BATTERY HOLDER AA SMD TAB
3031	36-3031-ND	B2	1	BATTERY RETAINER COIN PC PIN
CL21B104KBCNFNC	1276-2444-1-ND	C4, C5, C11, C12	4	CAP CER 0.1UF 50V X7R 0805
CL21B105KOFNNNG	1276-6471-1-ND	C3, C6	2	CAP CER 1UF 16V X7R 0805
GRM21BR71A106KA73K	490-14381-1-ND	C7,C8	2	CAP CER 10UF 10V X7R 0805
CL21B474KOFNNNG	1276-6483-1-ND	C9, C10, C13	3	CAP CER 0.47UF 16V X7R 0805
APA3010YC-GX	754-1576-1-ND	D1	1	LED YELLOW CLEAR SMD R/A
APA3010SGC-GX	754-1586-1-ND	D2	1	LED GREEN CLEAR SMD R/A
DMP2240UW-7	DMP2240UWDICT-ND	FET1	1	MOSFET P-CH 20V 1.5A SOT323
DM3D-SF	HR1941CT-ND	J1	1	CONN MICRO SD CARD PUSH-PULL
DB25-PT-1	2057-DB25-PT-1-ND	K1	1	CONN D-SUB PLUG 25POS VERT SLDR

Manufacturer Part Number	Digi-Key Part Number	Ref	Qty	Description
LQH32CN4R7M53L	490-4057-1-ND	L1	1	FIXED IND 4.7UH 650MA 195 MOHM
RC0603FR-0790R9L	311-90.9HRCT-ND	R2, R3	2	RES SMD 90.9 OHM 1% 1/10W 0603
RC0603JR-0710KL	311-10KGRCT-ND	R4, R21, R22	3	RES SMD 10K OHM 5% 1/10W 0603
RC0603FR-07100KL	311-100KHRCT-ND	R16, R20	2	RES SMD 100K OHM 1% 1/10W 0603
RC0603JR-0747KL	311-47KGRCT-ND	R8, R9, R10, R11, R12, R14	6	RES SMD 47K OHM 5% 1/10W 0603
MHSS1105	679-1849-ND	SW1	1	SWITCH SLIDE SPDT 300MA 6V
EG1257	EG2586CT-ND	SW2	2	SWITCH SLIDE SPDT 300MA 4V
AVR64DD32-I/PT	150-AVR64DD32-I/PT-ND	U1	1	64KB, 8KB RAM, 32P, 24MHZ, MVIO
XC9142B33DMR-G	865-XC9142B33DMR-G	U3	1	IC REG BOOST ADJ 350MA SOT23-6
TRS3243ECPW	TRS3243ECPW-ND	U4	1	IC TRANSCEIVER FULL 3/5 28TSSOP
DS1338Z-33T&R	DS1338Z-33+CT-ND	U6	1	IC RTC CLK/CALENDAR I2C 8-SOIC
AB38T-32.768KHZ	535-9034-ND	X2	1	CRYSTAL 32.7680KHZ 12.5PF TH
VMK3-9001-32K7680000	150-VMK3-9001-32K7680000TR-ND	X2a Alternate	1	CRYSTAL 32.7680KHZ 12.5PF TH

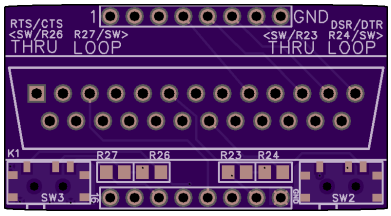
Annex I: PCBs

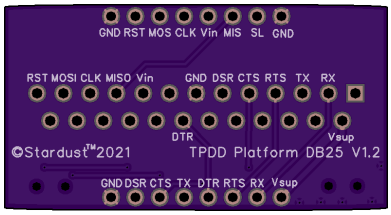
Backpack+ Drive PCB





DB25 PCB





Annex J: Open-source license reproductions

Licenses for the various open source software used in the project are reproduced below. Reference should be made to the relevant Github pages for up to date copies.

Bootloader for Backpack+ Drive

Github: https://github.com/zevero/avr_boot

License from Github:

SD card management firmware for the Backpack+ Drive

url: http://elm-chan.org/fsw/ff/doc/appnote.html#license

General license statement

```
/*----------------------------------------------------------------------------/
/  FatFs - Generic FAT Filesystem Module  Rx.xx                                /
/-----------------------------------------------------------------------------/
// Copyright (C) 20xx, ChaN, all right reserved.
// FatFs module is an open source software. Redistribution and use of FatFs in
// source and binary forms, with or without modification, are permitted
// provided that the following condition is met:
// 1. Redistributions of source code must retain the above copyright notice,
//    this condition and the following disclaimer.
// This software is provided by the copyright holder and contributors "AS IS"
// and any warranties related to this software are DISCLAIMED.
// The copyright owner or contributors be NOT LIABLE for any damages caused
// by use of this software.
/----------------------------------------------------------------------------*/
```