

JOYCE v2.5.5

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Abstract

JOYCE is an Amstrad PCW emulator for UNIX and Windows. It emulates the PCW 8000, 9000 and 10 series computers, but *not* the PCW 16; see ANNE for PCW16 emulation.

Contents

1	Introduction	5
1.1	Copyright	5
1.2	What JOYCE does	5
1.3	What's new?	5
1.4	Concepts	7
1.5	Compiling JOYCE	8
1.5.1	JOYCE on Mac OS X	8
1.6	Missing Features	9
1.7	Internet resources	9
2	Setting Up	9
2.1	Directory organisation	9
2.1.1	Under Windows	9
2.1.2	Under UNIX	9
2.2	Running JOYCE for the first time	9
2.2.1	You will need:	9
2.2.2	The JOYCE command	10
2.2.3	Adding boot discs	10
2.2.4	After copying boot discs	10
2.2.5	Reading in other discs	10
2.3	What if I haven't got 3.5" start-of-day discs?	10
2.4	What if I haven't got start-of-day discs at all?	11
3	In Use	11
3.1	What is emulated	11
3.2	How the disc drives are handled	12
3.2.1	Boot discs (also known as start-of-day discs)	12
3.2.2	Ejecting a disc	12
3.2.3	Command-line options	12
3.2.4	Non-floppy discs	13
3.3	What if the speed is wrong?	13
3.3.1	If JOYCE is too slow	13
3.3.2	If JOYCE is too fast	13
4	Peripherals in JOYCE	13
4.1	The keyboard	13
4.1.1	CTRL / ALT key swapping	16
4.1.2	Delete key swapping	16
4.2	The Mouse / other pointing device	16
4.2.1	AMX mouse	16
4.2.2	Kempston mouse	16
4.2.3	Electric Studio lightpen	17
4.2.4	Mouse auto-patch	17
4.3	The disc drives	17
4.4	The LocoLink interface	17
4.4.1	Internal LocoLink server	17
4.4.2	LocoLink to another emulator	17
4.4.3	LocoLink to a real computer (requires Linux)	17

4.4.4	Sockets and Shared Memory	18
4.5	The PCW-Linkit interface	18
5	The JOYCE Menu	18
5.1	The Action Menu	19
5.2	The Debug Menu	20
5.3	The Disks menu	20
5.3.1	The Disc Management menu	20
5.4	The Settings menu	21
5.4.1	General options	21
5.4.2	Memory	22
5.4.3	Disc drives	22
5.4.4	Extra drives	23
5.4.5	Matrix printer	23
5.4.6	Daisywheel printer	24
5.4.7	CEN port and PAR port	24
5.4.8	CPS8256	25
5.4.9	Joystick	25
5.4.10	Keyboard	26
5.4.11	Mouse / Lightpen	26
5.4.12	Video	26
5.4.13	Accelerated Display	27
5.4.14	LocoLink	27
5.4.15	PCW-Linkit	27
5.4.16	Guest systems	27
5.4.17	Save settings	27
6	JOYCE Utilites	27
6.1	CENPORT	28
6.2	DDJOYCE.PRL	28
6.3	DDJOYPCW.PRL	28
6.4	DDJOYPDF.PRL	28
6.5	DDJOYPNG.PRL	28
6.6	DOSDIR	29
6.7	EMULIOS.RSX	29
6.8	EXPORT	29
6.9	GUEST, GDUMP and ENDGUEST	30
6.10	IMPORT	30
6.11	JFASTCRT and JFASTUC1	30
6.12	JOYCEDRV	32
6.13	PCKEY	32
6.13.1	Notes:	33
6.14	QUIT	33
6.15	REDIR	33
6.16	RTC	34
6.17	VGA and VGACOM	34
6.18	XPALETTE	35

7	JOYCE utilities (PC hosted)	36
7.0.1	MD3 discs and Windows NT / 2000 / XP	36
7.0.2	Problems reading floppies on Windows 9x	37
8	Guest Sessions	37
8.0.1	Guest and Host Drives	38
8.0.2	Leaving a guest system	38
8.0.3	Viewing guest system memory	38
8.0.4	The CP/M 2 environment for programmers	39
8.0.5	The CP/M-86 environment for programmers	39
9	Recent Changes	40
A	For UNIX system administrators	45
B	Keyboard codes	46
C	Acknowledgements	49
C.1	Previous versions also owed much to:	49

1 Introduction

1.1 Copyright

- Copyright 1997,2001-7,2009-10,2012,2014,2016-7,2021-6 John Elliott.
- Copyright 1994, 1995 Ian Collier.
- Copyright 1991 Jim Hudgens.
- Copyright 1987, 1999 DRDOS Inc.

JOYCE can be distributed freely under the conditions of the GNU General Public License (sic) - see the file COPYING.

1.2 What JOYCE does

JOYCE emulates a PCW computer (8000, 9000 or 10 series). Run it, and your UNIX or Windows computer becomes a PCW.

1.3 What's new?

Since v2.4.0

- Corrected an issue with dot-matrix printer output going out of alignment.
- The built-in dot-matrix and daisywheel printers can now output in PDF format.
- New GSX drivers allow output in PNG and PDF format, and accelerated drawing on the PCW's native black and white screen.
- Corrected the colours used by the built-in 800x600 GSX driver.
- Added the ability for JOYCE to act as a terminal to the host system (Currently only in JOYCE for UNIX).
- The PCW-Linkit interface is emulated.
- A new experimental console driver for faster text output.
- The VGA screen now supports the CRTPLUS extra escape codes for bold, italic, grey etc.
- Added the option for an internal LocoLink server. This allows you to use LocoLink 1.3 or 1.4 to export files.
- Bug fixes to parallel printer port emulation in ANNE [Jacob Nevins].
- Finally fixed the annoying issue where, if you open an EDSK disc image from the file browser you had to specify manually that it was an EDSK and not a DSK.
- A new feature allows CP/M 2 and CP/M-86 sessions to be run within CP/M Plus. For more information, see section 8.

Since v2.2.0

- The keyboard mapping has been updated on Windows systems; the # and ½ keys should now be where expected.
- An option has been added for all emulated hard drives to use the same 8Mb disc format. This allows more than 6 drives under CP/M.
- JOYCE now emulates the Electric Studio light pen.
- JOYCE will now prompt you when a CP/M program attempts to access files outside the emulator (for example, the supplied IMPORT or EXPORT utilities). This warning can be controlled from f6=Settings | General | File Access...
- The Windows version is distributed with the latest SDL.DLL.
- Keyboard emulation has been made more accurate; the three keyboard option links are now emulated.
- The underlying libdisk and lib765 libraries have been updated.

Since v2.1.0

- A bug in the Z80 emulation which caused Starglider to hang has been corrected.
- The PCKEY utility (in JOYCE) did not work. It has been repaired.
- Initial support for compiling under MacOS X has been added.
- The ability to present a folder on the host computer as a PCW drive, without any additional PCW software. This is still a very new experimental feature – use it with caution!
- Native LOGO support has been corrected and should now work.
- Native GSX support has been restored, based on original Digital Research source code.
- Various bugfixes in the floppy drive emulation.
- JOYCE doesn't hang if Trivial Pursuit is run with the emulated CPS8256 interface attached.
- JOYCE now emulates several joystick models.
- The code has been updated to compile without modification on systems with GCC 3.x and SDL 1.2.6.
- A bug has been fixed in the creation of new .DSK files.
- Garbled text in the boot screen has been fixed.
- The utility .DSKs provided actually contain all the files they should.
- Windows GDI printing was printing at a third of the correct size; this has been corrected.
- Help text corrected if you press F1 on the boot screen.
- The Windows version now works if there are no printers set up on the system.

Since v2.0.0

- Some internal structural changes.
- LocoLink can be emulated using the parallel port (only under Linux 2.4 or later), UNIX domain sockets, or TCP/IP.
- The built-in printer emulations support direct printing under Windows.
- All the utility programs have been rewritten to cross-build under UNIX rather than natively under CP/M. This may introduce some instabilities.

Since earlier versions

See section 9.

1.4 Concepts

When moving from a PCW to an emulator, the biggest change you have to accustom yourself to is the way that JOYCE handles discs. Real PCWs (except the few with add-on hard drives) use real floppy discs; you use a start-of-day disc to use LocoScript or MicroDesign, a data disc to save your work on, and so on.

It is possible for JOYCE to use real disc drives in the same way that a PCW does. However this is pretty slow and awkward; since the PC's got a hard drive, you might as well use it.

Disc image files

PCW programs can't generally use the PC's hard drive directly. For one thing, it's too big; and for another, it's not in CP/M format¹. Instead, JOYCE creates one or more "disc image files". Each of these is the equivalent of one real PCW disc.

Disc image files have a number of advantages:

1. They are much faster than real floppy discs.
2. You don't have to be shuffling a stack of floppies every time you want to use JOYCE.
3. If you want more discs, you don't have to go to the shop to buy them. You just create more disc image files.

By convention, these have names ending in ".dsk". So instead of having a "manuscripts" disc, you would have a disc image file called "manuscripts.dsk". To normal UNIX or Windows software, "manuscripts.dsk" is just one file, but PCW programs see it as a disc with any number of PCW files on it.

One consequence of this is that the PCW's "A" and "B" drives have nothing to do with your PC's real floppy drives. The emulated PCW can be happily using a disc in its "B" drive even if your PC has only one drive.

Converting your PCW discs to disc image files is covered in section 2.

¹If you do happen to have a CP/M partition on your hard drive, I don't want to know. JOYCE still won't use it.

Disc image folders

JOYCE 2.1.8 and later can also use folders instead of disc image files. In this system, one PCW disc corresponds to one PC folder. This has the advantage that each PCW file corresponds exactly to one PC file. For example, you could instruct the PCW to make ASCII files, save them to such a disc/folder, and then read them directly with PC software.

1.5 Compiling JOYCE

If you have downloaded JOYCE as a binary for your platform (eg: the full Windows install, or an RPM), you can skip this section.

To compile JOYCE, you will need:

- SDL, the Simple DirectMedia Layer: <<http://www.libsdl.org>>. You need version 1.0.8 or later.
- libxml, the xml parser used by GNOME <<http://www.libxml.org/>>. JOYCE was tested with version 2.2.6.
- libpng, the image library. <<http://www.libpng.org/pub/png/>>. You need version 1.0.6 or later.

You should be able to compile with the following commands:

```
./configure
make
sudo make install
```

On systems with a GCC version earlier than 3.0, the first line should be `./configure --with-ministl`.

To cross-compile JOYCE for Windows, you need the XMINGW32 cross-compiler pack from <<http://www.libsdl.org>>, and MINGW32 versions of the above libraries.

1.5.1 JOYCE on Mac OS X

I have successfully compiled JOYCE on a Mac OS X (10.4.2) system. The process (and indeed MacOS X support in general) is pretty new and unpolished.

Firstly, the three libraries mentioned above (SDL, libxml and libpng) had to be compiled from source and installed using their “make install” commands; pre-packaged OS X versions didn’t seem to be suitable.

Secondly, the configure script needed to be told what the host system was:

```
./configure --host=powerpc-darwin-apple8.2.2
make
sudo make install
```

Thirdly, this builds a JOYCE that is still very much a UNIX application; there’s no application icon, no native OS X menu, and so on.

Finally, OS X uses the [f9] and [f10] keys for Exposé; so you will need to use [Command]+[F9] and [Command]+[F10] instead.

1.6 Missing Features

These features were present in JOYCE 1.36 but not in the current JOYCE:

- Built-in debugger.

1.7 Internet resources

The latest versions of JOYCE - and any future updates - will be downloadable from [<http://www.seasip.info/Unix/Joyce/>](http://www.seasip.info/Unix/Joyce/).

Announcements of new JOYCE releases, if any, will be made to the newsgroup [<news:comp.sys.amstrad.8bit>](mailto:news:comp.sys.amstrad.8bit). It is also on-topic to discuss JOYCE in this newsgroup.

2 Setting Up

2.1 Directory organisation

2.1.1 Under Windows

JOYCE uses two directories - a “system” directory common to all users (eg, “C:/Program Files/Joyce/lib” and a “user” directory (eg: “C:/My Documents/Joyce”). Each of these directories will have subdirectories called `Boot` (boot files and boot disc images) and `Disks` (all other disc images). In the remainder of this document you will see directory names which look like “~/Joyce/Boot”; you should take the “~” to stand for the “My Documents” directory.

If you don’t want JOYCE to put its files in “My Documents”, then you can override it. In JOYCE, press [f9] for the menu, [f6] for settings, and select “General”. Then enter the new directory name, and press RETURN. You will need to copy or move the “Joyce” directory from “My Documents” to the new directory you specified.

2.1.2 Under UNIX

JOYCE uses two directories - a “system” directory common to all users (by default, `/usr/local/share/Joyce` - see Appendix A) and a “user” directory for each user (by default, `~/Joyce`). Each of these directories will have subdirectories called `Boot` (boot files and boot disc images) and `Disks` (all other disc images).

2.2 Running JOYCE for the first time

2.2.1 You will need:

- A version of JOYCE that installed correctly.
- A screen capable of 800x600x256 graphics. JOYCE may well be faster in 256 colour mode than in (say) 16-bit mode.
- One of the following:
 - At least one 3.5” PCW start-of-day disc;
 - Disc images of PCW start-of-day discs, that you have previously generated;
 - A working JOYCE 1.3x installation.

2.2.2 The JOYCE command

Under Windows, JOYCE should be run from the Start Menu. Under UNIX, the command to use is either “xjoyce” (to run in a window) or “xjoyce -f” (to run full screen). Other command line options are given in section 3.2.3.

2.2.3 Adding boot discs

The first time JOYCE is started, it will detect that no boot discs have been read in. Unless you want to boot laboriously from a floppy every time you use JOYCE, you should choose the “set up boot discs properly” option.

If you had a previously working JOYCE installation, then this will be detected, and you will be given the option to copy boot discs from it. If you decide not to do this, you will have to provide start-of-day discs or disc image files.

The next menu that appears asks you for the location of the boot disc to use. If you are using real floppies, then select the correct drive (A: or B:). If you are using pre-prepared DSK files, choose the correct file.

If you are copying a MicroDesign program disc with copy protection (or other similar programs such as Tweak3), you will also need to click on “Advanced” at this point and select the “MicroDesign program disc” option. Note that this will not work on stock Windows NT, 2000 or XP; see section 7.0.1.

Next select “Continue”. You will be asked for a name to give to this boot disc (eg: “LocoScript” or “CP/M”).

Once you have entered the name, the disc is read in and converted to a JOYCE .DSK file. If you were copying from a real disc, you can put it away when the drive light goes out; JOYCE won’t need it again.

You can then repeat for as many boot discs as you like.

If you have trouble copying boot discs under Windows 95, 98 or ME, then see section 7.0.2 which describes a workaround using PCWTRANS.

2.2.4 After copying boot discs

The JOYCE opening screen will appear, with up to 9 boot discs listed on it. If you read in more than 9, press [f3] to see the others. Choose the disc you want to use, and the black stripes should start to march down the screen.

When you are ready to quit, press [f10].

2.2.5 Reading in other discs

The JOYCE automatic setup routine only covers start-of-day discs. To convert other discs (eg, data discs), press [f9] for the JOYCE menu, then [f2] for the Discs menu, and select “Disc Management”. From the menu that appears, choose “Convert floppy to JOYCE DSK file”. The rest of the procedure is similar to the one for boot discs, described in section 2.2.3.

2.3 What if I haven’t got 3.5” start-of-day discs?

If you have the ability to transfer files to and from your PCW (by a serial link or LocoLink, for example) and 1Mb of memory (512k for 8000 series PCWs) then you can use DU54 to make the disc images. Download DU54 from my website, and use its “Copy” option to copy from a disc to a file in CPCEMU format. Then transfer the

resulting file to your PC. These files will be bigger than the floppies they were copied from; so you need a big RAMdrive to put them in.

Once you have the files on the PC in CPCEMU format, proceed as described in section 2.2.3, with pre-prepared disc images.

2.4 What if I haven't got start-of-day discs at all?

Let me make this clear: I can not supply copies of start-of-day discs. My recommendation would be to buy new ones from SD Microsystems; contact sdmicro@aol.com.

3 In Use

3.1 What is emulated

- The Z80.
- 2MB of memory.
- The screen.
- The keyboard.
- The timer.
- The PCW8256/8512/9256/10 dot-matrix printer. Unless you have a printer that isn't supported by the PCW (eg: the HP Deskjet 720C) or you are using software such as LocoScript 1 that doesn't support external printers, I recommend that you use the CPS8256 printer interface instead.
- The PCW9512/9512+ daisywheel printer. The same caveats apply as for the dot-matrix printer.
- The CPS8256 parallel/serial interface. You can print to a disc file or a UNIX command (eg, "lpr" for direct printer output). Serial ports can be mapped to a file or a device node (eg "/dev/ttyS0" for direct connection to other computers).
- A Centronics-only printer interface. You can print to a disc file or a UNIX command (eg, "lpr" for direct printer output). Some CP/M versions cannot detect the Centronics interface; in this case, you should disable it and enable the CPS8256 interface instead.
- Most of the floppy disc controller. However, JOYCE has only limited access to the PC's real floppy drive.
- The mouse (in AMX or Kempston mode). You will need a three-button mouse to use the AMX mode properly - the Microsoft Intellimouse with the scroll wheel is fine.
- The Electric Studio light pen.
- The PCW9512 PAR port.
- The beeper.
- The LocoLink interface.

3.2 How the disc drives are handled

The basic concept of disc image files was described in section 1.4. There are several subtleties to be aware of:

3.2.1 Boot discs (also known as start-of-day discs)

When JOYCE is started, both disc drives are normally empty. As soon as you select which system to boot, the disc image you chose (normally named something like `~/Joyce/Boot/boot1.dsk`) will be inserted in the PCW's A drive. You can add, remove or rename boot discs using the Disc Management menu (press [f9] for the JOYCE menu, then [f2] (Disc) and choose "Disc Management").

3.2.2 Ejecting a disc

To eject a disc, press [f9] for the JOYCE menu, then [f2] (Disc). If there is a disc in the PCW's A or B drive, you can eject it by selecting the corresponding "eject" option. Remember that ejecting discs from JOYCE's emulated drives doesn't have anything to do with whatever floppy drives are actually fitted to the PC.

3.2.3 Command-line options

To start JOYCE and make it automatically boot from one of the discs on the boot menu, use:

```
xjoyce -A #n
```

for example

```
xjoyce -A #2
```

will choose option 2 from the boot menu.

If you want JOYCE automatically to run a boot disc file (not necessarily one of the ones on the menu), then use -A with a filename:

```
xjoyce -A locoscript3.dsk
```

will load "locoscript3.dsk".

If you want to start with a floppy disc in drive B:, then use the -B command-line option:

```
xjoyce -B /home/fred/Joyce/Disks/diskb.dsk
```

JOYCE can also start an EMS/EMT file directly. To do this, use -E:

```
xjoyce -E /tmp/j14cpm3.ems
```

You can add a memory-size option to any of the above commands - for example,

```
xjoyce -A locoscript140.dsk -m 256
```

will boot from "locoscript140.dsk" with 256k memory (LocoScript 1.40 malfunctions with the default 2Mb).

3.2.4 Non-floppy discs

- JOYCEDRV.FID gives the emulated PCW a hard drive, and/or direct access to PCW floppy discs. It requires a recent version of CP/M (BIOS 1.8 or later) or LocoScript 2.30 or later. It uses a similar "disc image file" system to the floppy drives, but the image files can be up to 8Mb in size.
- REDIR.COM allows you to use one or more UNIX directories as CP/M drives. It will run under any version of CP/M. This avoids the problem that the host PC can't see "inside" image files without extra software.
- IMPORT.COM and EXPORT.COM will copy single files into or out of the JOYCE environment. They will run under any version of CP/M.

All these utilities are on the file UTILS.DSK. You can get at them with a command something like:

```
xjoyce -B=/usr/local/lib/Joyce/Disks/utils.dsk
```

and they will appear on drive B:. REDIR.COM and its companion programs are in Group 1; the others are in Group 0.

3.3 What if the speed is wrong?

3.3.1 If JOYCE is too slow

One solution is to increase the CPU speed. Press [f9], then [f6] and select 'General'. Then enter the new speed; since my original PCW had a Sprinter, I prefer to run at 200% speed.

It may also be possible to improve the performance of JOYCE by changing the video refresh frequency. This is normally 12, but it can be reduced to improve performance. If it is reduced to 3.75, for example, then programs that use a mouse pointer may appear a little jerky, but JOYCE should run at its full speed.

To change the video refresh frequency, start JOYCE. At the opening screen, press [f9], then [f6] and select 'Video'. Then enter the new frequency and press RETURN.

3.3.2 If JOYCE is too fast

The built-in speed regulation in JOYCE should stop it running too fast. Possibly you could reduce the overall speed: press [f9], then [f6] and select 'General'. Then enter a new speed.

4 Peripherals in JOYCE

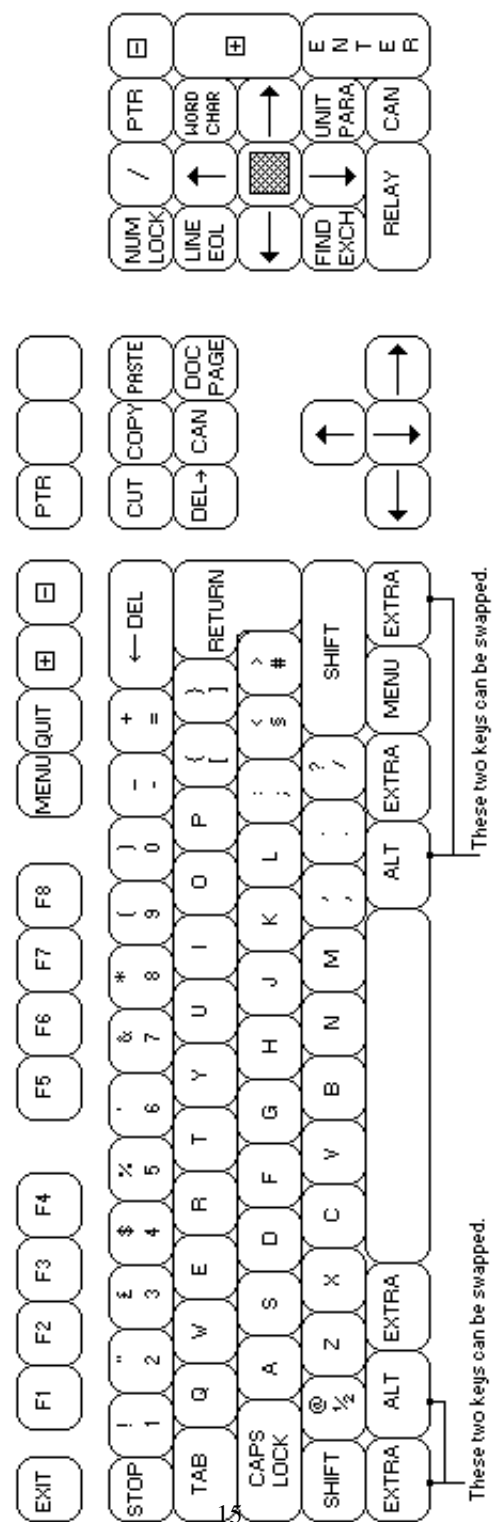
4.1 The keyboard

The PC keyboard is laid out a bit differently from the PCW keyboard. The following keys have non-obvious meanings:

[This is for a UK keyboard with XFree86. Other X servers may behave differently].

PC key	PCW key	Notes
ESC	EXIT	
' \neg	STOP	(top left hand corner, under ESC)
\	$\frac{1}{2}$ @	(down by the left-hand SHIFT)
' @	§ <	
# ~	# >	
CTRL	EXTRA	(can use ALT)
ALT	ALT	(can use CTRL)
WINDOWS	EXTRA	
F11	[+]	(Set)
F12	[-]	Clear
PrintScreen	PTR	
Keypad *	PTR	
Keypad -	[-]	Clear
Keypad +	[+]	Set
Delete	CAN	(numeric keypad ".")
Insert	RELAY	(numeric keypad "0")
End	FIND/EXCH	(numeric keypad "1")
PageDown	UNIT/PARA	(numeric keypad "3")
Home	LINE/EOL	(numeric keypad "7")
PageUp	WORD/CHAR	(numeric keypad "9")
Insert	CUT	(under PrintScreen)
Home	COPY	(under ScrollLock)
PageUp	PASTE	(under Pause/Break)
Delete	DEL->	(under Insert)
End	CAN	(under Home)
PageDown	DOC/PAGE	(under PageUp)

This is the full keyboard:



If you find these mappings inconvenient, you can use PCKEY (on the Utilities disc) to change keyboard mappings.

The keyboard has two user-configurable settings. To set them, press [f9] in JOYCE; then [f6] for Settings, and choose Keyboard.

4.1.1 CTRL / ALT key swapping

There are two ways the CTRL and ALT keys can be set up. These are:

1. The PC ALT key is used as the PCW ALT key. In this mode the key captions match better than the key positions.
2. The PC ALT key is used as the PCW CTRL key. This makes the positions of the keys match better than their captions.

PC key	PCW key (mode 1)	PCW key (mode 2)
ALT	ALT	EXTRA
CTRL	EXTRA	ALT

4.1.2 Delete key swapping

In the same way, the Backspace and Delete keys can be swapped. You may need to use this, depending how your X-Window system is configured.

4.2 The Mouse / other pointing device

There were three major types of PCW mouse:

- AMX
- Kempston
- KeyMouse

JOYCE emulates the first two of these; alternatively, it can emulate the Electric Studio lightpen. To choose which type is selected, press [f9] in JOYCE; then [f6] for Settings, and choose Mouse.

4.2.1 AMX mouse

The AMX mouse emulation is tuned for MicroDesign 3, with the mouse movement option set to “Slow”. Most programs support the AMX mouse, so this is probably the best choice. However, you will need a three-button mouse (or one with a scroll wheel) to use it successfully.

4.2.2 Kempston mouse

The Kempston mouse emulation is designed for Stop Press. Fewer programs support the Kempston mouse than the AMX, but it doesn’t need a three-button mouse.

4.2.3 Electric Studio lightpen

The lightpen emulation is designed for the programs supplied with the lightpen: NEWS-DESK, ART and DDESP.PRL. Since the original light pen had no switches, the mouse buttons do not do anything; you will need to use keys on the keyboard as directed.

4.2.4 Mouse auto-patch

The Mouse Auto-Patch feature (only available with the AMX mouse emulation) is used to improve mouse handling in PCW programs. When it is switched on, JOYCE will attempt to link Microdesign, Stop Press or Masterpaint directly to the PC's mouse, bypassing the normal mouse driver. If successful, this results in smoother mouse performance.

When you start the program that uses the mouse, you will see either "No mouse patch applied" (in which case, the link could not be established) or "Applied *program* mouse patch" (the link was established).

4.3 The disc drives

Instead of real disc drives, JOYCE works with "disc image files" on the computer's hard drive. These are fully described in sections 1.4 and 3.2.

4.4 The LocoLink interface

JOYCE allows three forms of LocoLink communication (only two under Windows, though). In each case, you must have suitable software (LocoLink or PCWLink).

4.4.1 Internal LocoLink server

- JOYCE will act as the master computer. Go into the settings for the LocoLink interface and set it to "Use internal LocoLink server". Then use the file chooser to select a directory. You can then use LLPCW.COM (from LocoLink 1.3 or 1.4) to export files; they will be written to that directory.

4.4.2 LocoLink to another emulator

- For JOYCE to act as the server computer, go into the settings for the LocoLink interface and set it to "output to Shared memory". On the screen that appears, enter a suitable name for the shared memory region (eg: "locolink") and ensure the "Server (eg LocoLink v2/v3)" option is ticked.
- For JOYCE to act as the client computer, go into the settings for the PAR port and set it to "output to Shared memory". On the screen that appears, enter a name for the shared memory region as above and ensure "Client (eg printer, PcW16)" is ticked.

4.4.3 LocoLink to a real computer (requires Linux)

- For JOYCE to act as the server computer, use a LapLink cable (not the original LocoLink cable) to connect the parallel ports of the two computers being linked. Go into the settings for the LocoLink interface, and set it to "Output to parallel port", specifying the name of the parallel port device (eg: /dev/parport0).

- For JOYCE to act as the client, connect the parallel port of your Linux box to the other computer (if it's another PC, use a LapLink cable; if it's a PCW, use the original LocoLink cable). Go into the settings for the PAR port, and set it to "Output to parallel port", as above.

4.4.4 Sockets and Shared Memory

Sockets and shared memory are two methods by which two emulators can communicate to each other – for example, emulating the scenario where a PcW16 and a PCW are connected by a LocoLink cable.

If you have a choice I recommend using shared memory as it is simpler to set up and can cope better with unexpected disconnections.

Shared memory can be used to communicate with other emulators on the same computer. They are described by a name (for example, "locolink") and a "client" or "server" indicator. When setting it up, you need to designate one computer as the client and the other as the server; if they're both set as client or both as server it doesn't work.

UNIX domain sockets (not supported on Windows) can be used to communicate with other emulators on the same computer. They work pretty much like normal files, and their names are normal filenames; so, for example, one might be called "/tmp/locolink.socket". When you are establishing a link, it is important that both ends are using the same socket name.

TCP/IP sockets can be used to communicate with other emulators not only on the same computer, but across a network or the Internet. However, JOYCE does not perform any security checks on socket connections, so I strongly recommend that you do not use TCP/IP sockets while connected to the Internet.

For a LocoLink client, the name of a TCP/IP socket is formed "host:port" - for example, "localhost:8256", "127.0.0.1:8512" or even "www.somewhere.com.invalid:8080".

For a LocoLink server, the name of the socket is formed "interface:port". The interface is usually either "127.0.0.1" (accept only connections from this computer) or "0.0.0.0" (accept connections from any computer).

The port has to be the same on both client and server sides of the connection, and the host/interface have to refer to the same computer. For two emulators on the same computer, use "127.0.0.1:port" for both client and server.

4.5 The PCW-Linkit interface

PCW-Linkit is a similar interface to LocoLink, except that it is only designed to operate between two PCWs. Consequently, an emulated PCW-Linkit connection can be set up between two instances of JOYCE. This can be done in the same way as for LocoLink, using sockets or shared memory. One machine must be set as the 'client' and one as the 'server', though once communication is established either can send files to the other.

5 The JOYCE Menu

If you press [f9] (or the Menu key on a Windows95 keyboard, or Command+F9 on a Mac OS X system) a menu will appear at the top of the screen. It offers the following

options:

- ESC=Back to JOYCE

Leaves the menu system.

- f1 = Help

Display the keyboard layout onscreen.

- f2 = Discs

Options for floppy drives A: and B:. Use this to "insert" and "eject" discs, and to read floppy discs into the JOYCE environment. It brings up the Discs menu below.

- f4 = Printer

Control the built-in dot-matrix or daisywheel printer. You should not normally need to use this menu; the "printer control" state (obtained by pressing [*] on the numeric keypad or [PrintScreen]) should be able to perform the necessary functions.

- f5 = Reboot

Reboot the PCW; equivalent to SHIFT+EXTRA+EXIT. You will be asked for confirmation.

- f6 = Settings

Settings for all aspects of the emulator. The Settings menu will appear.

- f7 = Dbg

Display the Debug menu (5.2).

- f8 = Action

Display the Action menu (5.1).

- f10 = Quit

Leave JOYCE. You will be asked for confirmation. Under Mac OS X, [f10] is used by Exposé so use Command+F10.

5.1 The Action Menu

This menu has only two options:

- "Select PCW screen." This is intended for use with GSX programs (such as DR Graph) which exit without shutting GSX down properly. In such cases, the program will appear to hang, but selecting the PCW screen will display the A> prompt. It can also be used if you run DISCKIT while in the 800x600 screen mode; DISCKIT always sends its output to the original PCW screen.
- "Guest Emergency Stop". This should be used if a program within the CP/M-86 environment has locked up, and you need to terminate it. Select this option and if all goes well, you should be unceremoniously dropped back into PCW CP/M. This is however something of a last resort, and should be avoided if possible. If a CP/M-86 environment is not running this option will have no effect.

5.2 The Debug Menu

There are three options here, intended mainly for advanced users or JOYCE developers.

- “CPU state” displays the values of the Z80 registers and the memory paging.
- “Debug mode” displays the debug console, on which system messages will appear².
- “RAM dump” writes out the bottom 256k of memory to a file in the current directory called “joyce.ram”. This is not a full snapshot facility; memory dumps can’t be reloaded, and they don’t contain CPU state.

5.3 The Disks menu

The Disks menu displays the status of the floppy drives, and allows you to eject or insert discs. Each drive has three lines in the menu:

1. The first line reads either “Drive A: (Ejected)” or “Drive A: (*Filename*)”. This shows whether there is a “disc” (.DSK file) in the drive or not.
2. The second line reads either “Eject” or “Insert...” depending whether there’s a disc in the drive. “Eject” ejects the current disc (.DSK file); while “Insert...” brings up a window asking for the file to insert. You can also “insert” a real floppy drive; this allows the emulated PCW to access a real drive directly (if slowly). If you ask to “insert” a folder, and the folder you select has not previously been used in this way by JOYCE, then you will be asked what format the folder should pretend to be in.
3. The bottom line for each drive reads “Read only”. If there is a tick beside it then the write protect holes on the disc have been opened and it cannot be written to.
4. If you select “Disc management...” then a menu appears allowing you to read in extra floppy discs, or convert .DSK files back to real discs.

5.3.1 The Disc Management menu

There are five options:

1. Add a boot disc - Reads in a start-of-day disc and adds it to the opening menu.
2. Rename a boot disc - Allows you to change the caption associated with a start-of-day disc.
3. Delete a boot disc - Removes a start-of-day disc from the opening menu. Use this option with caution!
4. Convert floppy to JOYCE .DSK file - Read in a normal (data) disc, storing the new disc image file in the “user discs” directory.
5. Write .DSK file back out to floppy - Convert a disc image file (either normal or start-of-day) back to a floppy disc.

²In previous versions, JOYCE had a built-in debugger that ran in the debug console. This is not present in JOYCE v1.9.0.

5.4 The Settings menu

Choose the item of hardware for which you want to make changes. Note that if you make a change such as disconnecting or connecting an interface, the emulated PCW may not pick it up until the next reboot. It's safest to change JOYCE settings while the opening menu is on the screen - after all, you wouldn't plug an interface into a *real* PCW with the power on, would you?

5.4.1 General options

This screen allows you to choose which PCW model to emulate, and how fast it should appear to be. Some points to note are:

- JOYCE knows the difference between boot discs for dot-matrix PCWs (8256, 8512, 9256, 10) and daisywheel PCWs (9512, 9512+). If you have selected a PCW model that doesn't match the boot disc, JOYCE selects the closest equivalent when booting.
- JOYCE treats the PCW8256 and PCW8512 as one choice, since the only difference is the number of disc drives and the memory size, both of which can be configured in other menus.
- JOYCE also treats the PCW9256 and the PCW10 as one choice. The differences between these models are the memory size and the presence of a Centronics port, both of which are configurable in other menus.

This screen also allows you to control the warning that appears when a CP/M program attempts to access files outside the emulator (as, for example, the supplied IMPORT and EXPORT utilities do). Select "File Access..." and select one of three options:

Allow full access Programs running under CP/M will be able to read and write any file on your computer, without prompting. This is how JOYCE 2.2.6 and previous versions behaved.

Prompt for each file When a CP/M program attempts to read or write a file, JOYCE will display a prompt asking whether this should be allowed (see below).

No file access CP/M programs will not be able to access arbitrary files on your computer. The IMPORT and EXPORT utilities will not operate.

If 'Prompt for each file' is selected, then when a CP/M program attempts to open a file, the following warning will be displayed:

```
Confirm host file access
A CP/M program is attempting to access the file:
bank_passwords.txt
Do you want to allow access to this file?
No
No, and don't ask again
Yes
```

The prompt will offer three options:

No Access to the file will be blocked. You will be prompted again if the program attempts to read or write a different file.

No, and don't ask again Access to the file will be blocked, and the File Access settings screen will be switched to the "No file access" option, blocking all future file access. If you subsequently want to grant access again, this must be done through the File Access menu screen.

Yes Access to this file will be allowed. You will be prompted again if the program attempts to read or write a different file.

5.4.2 Memory

This allows you to set the memory size of your emulated PCW. If your computer is running very low on memory, the "Current memory size" may be less than requested.

If you are running a very old version of CP/M, you may need to reduce memory to 512k to get DISCKIT to run. Some LocoScript 1 versions also malfunction if there's more than 512k of memory.

5.4.3 Disc drives

Note: The menus in this section only allows you to create configurations that could exist on a real PCW. By manually editing `~/Joyce/joycehw.xml`, you can create "impossible" configurations, such as a system with three floppy drives (CP/M and LocoScript won't detect the third one.) If the configuration is "impossible", the menus will look different as they attempt to accommodate the changes.

The settings in this menu are:

Boot discs are read-write / read-only:

This sets whether JOYCE makes emulated boot discs write-protected. Note that early CP/M releases (such as the 1.4 BIOS issued with 8000 series PCWs) need to have a change made to SUBMIT.COM³ before they can boot from write-protected disc images.

To override this for a particular boot disc, press [f9] while the loading stripes are on the screen; then press [f2] and change the setting.

Controller type (8256/8512/9512 vs. 9256/9512+/10)

You should set the correct controller type to match your system discs. At least some versions of Locoscript 3 for the PCW9256 refuse to load unless the controller type is

³Here's a transcript of a SID session making the necessary change:

```
A>SID SUBMIT.COM
CP/M 3 SID - Version 3.0
NEXT MSZE PC END
1600 1600 0100 DAFF
#S3A6
03A6 CD 3E
03A7 E4 0D
03A8 03 00
03A9 32 .
#W
002Ah record(s) written.
#GO
```

also set to 9256. This option is also set by the “PCW model” setting in the general options screen.

Drive A: settings / Drive B: settings:

This brings up its own menu, allowing you to set what type of disc drive is attached to the PCW. The three standard types are those supplied as standard with PCWs. If you want to emulate 5.25” drives or anything else unusual, select “other” and manually enter the drive type, the number of cylinders⁴ it can access, and whether it’s single or double-sided.

To emulate a single-drive PCW, set the type of drive B: to “Not connected”.

5.4.4 Extra drives

This menu allows you to set up drives C: - L: and N: - P:. Obviously these drives don’t exist on real PCWs, but they can on a JOYCE system, provided you are using a recent version of CP/M (1.12 / 2.12 or later) or LocoScript (2.28 or later). You will need to have a copy of JOYCEDRV.FID on your start-of-day disc for these drives to become available - see section 6.12.

For each drive, you can set it up in three ways:

- As direct access to the PC’s floppy drives.
- As a floppy drive that accesses a standard disc image file, just like the emulated A: and B: drives.
- As a hard drive with 8Mb of storage. The hard drive will also be stored on a .DSK file (or in a folder, depending which option you chose), but this .DSK file will not be usable in emulated floppy drives.

There is one general option: “All drives use fixed 8Mb format”. If this is set, all drives will be hard drives using the same 8Mb format. This allows more than six emulated hard drives under CP/M.

To set up a drive, choose it from the list. Then choose or enter the filename and drive type, as listed below:

Type of drive to use	Choose file	Choose option
Floppy drive A: or B:	A: or B:	floppy drive
Floppy drive using standard image file or folder	.DSK file or folder	floppy drive
Hard drive using special image file or folder	.DSK file or folder	hard drive

5.4.5 Matrix printer

The dot-matrix printer menu offers the following settings:

- CONNECTED/DISCONNECTED: Is the printer plugged in or not?

⁴The drive documentation may call this figure the number of tracks rather than the number of cylinders. Either way, it’s usually 40 or 80.

- **PAPER SIZE:** There are a number of standard paper sizes; or you can enter your own using “Custom”.
- **OUTPUT FORMAT:** PostScript, PDF or PNG. PNG output produces a small graphic file (around 20k) per page, while PostScript or PDF output produces a single file containing all the output from a JOYCE session. PostScript files are uncompressed and so can be large (on the order of 6Mb per page) depending how much information is printed. PNG and PDF files are compressed. Note that although the PNG files produced are small in size, they are big in area. Under Windows, there is also a “Use Windows’ GDI” option, which sends output to the default Windows printer.
- **OUTPUT TO DIRECTORY:** PNG output goes to disc files called “matrix0.png”, “matrix1.png” etc., PostScript output goes to “matrix0.ps”, “matrix1.ps”, and PDF output to “matrix0.pdf”, “matrix1.pdf” etc. The directories used are ~/Joyce/Pngs, ~/Joyce/PS and ~/Joyce/PDF respectively.
- **OUTPUT TO UNIX COMMAND:** Output goes to a UNIX pipeline. You can use this to send output to the UNIX printing system. It is recommended to use PostScript output for this. Note that printing will usually only start when JOYCE shuts down.

5.4.6 Daisywheel printer

The daisywheel printer menu offers the following settings:

- **CONNECTED/DISCONNECTED:** Is the printer plugged in or not? Note that unlike on a real PCW, disconnecting the daisywheel with the computer turned on does not damage the memory chips!
- **OUTPUT FORMAT:** PostScript or PDF. Under Windows you can also select “Use Windows’ GDI”, which sends output to the default Windows printer.
- **PAPER SIZE:** There are a number of standard paper sizes; or you can enter your own using “Custom”.
- **OUTPUT TO DIRECTORY:** PostScript output is sent to “daisy0.ps”, “daisy1.ps”, etc. in the directory ~/Joyce/PS. PDF output goes to “daisy0.pdf”, “daisy1.pdf”, etc. in the directory ~/Joyce/PDF
- **OUTPUT TO UNIX COMMAND:** Output goes to a UNIX pipeline. You can use this to send output to the UNIX printing system. Note that printing will usually only start when JOYCE shuts down.

5.4.7 CEN port and PAR port

The following settings are available for the CEN port and the PAR port:

- **CONNECTED/DISCONNECTED:** Is the appropriate interface connected to the PCW?
- **OUTPUT TO FILE:** Output goes to a disc file. When you select this option, you are asked for the filename to send the output to.

- **USE INTERNAL LOCOLINK SERVER:** Emulates the PC end of a LocoLink interface being connected to the parallel port. This would allow the port to act as a LocoLink server, reading / writing to a directory on the host PC; however this does not support PCWLink, and I'm not aware of any other PCW software that would work in this configuration.
- **OUTPUT TO UNIX COMMAND:** Output goes to a UNIX pipeline. You can use this to send output to the UNIX printing system (enter "lpr" here, with any appropriate options).
- **OUTPUT TO PARALLEL PORT :** The port is directly mapped to one of the computer's parallel ports (/dev/parport0, /dev/parport1, etc.) This allows the port to act as a LocoLink server when connected to a real PCW – probably only useful if you have a copy of PCWLink.
- **OUTPUT TO SHARED MEMORY :** Output is sent to another process, using shared memory. This allows the port to act as a LocoLink server in conjunction with another instance of JOYCE. Again, it's probably only useful if you have a copy of PCWLink.
- **OUTPUT TO SOCKET:** Output is sent to another process or computer, over a socket. This allows the port to act as a LocoLink server in conjunction with another instance of JOYCE. Again, it's probably only useful if you have a copy of PCWLink.
- Under Windows, you also get the option to send data directly to LPT ports.

5.4.8 CPS8256

There are three configuration screens available for the CPS8256. The first one has the following settings:

- **CONNECTED/DISCONNECTED:** Is the CPS8256 interface connected to the PCW?
- **PARALLEL PORT:** Brings up the same settings screen as for the standalone CEN port, to configure output.
- **SERIAL PORT:** Displays the filenames used for serial input and output. These can both be set to a device special file (eg: "/dev/ttyS0") for direct access to serial ports. Under Windows COM1: to COM4: can be chosen.

Under Linux it is possible to use the serial port as a terminal to the host system. To do this, set the serial input and output filenames to "/dev/ptmx". Then, when you run (for example) MAIL232, you should see the shell prompt and be able to issue UNIX commands.

Using this option would also mean that any CP/M program could execute commands on your host system, so I'd recommend only using this option with a trusted terminal emulator program.

5.4.9 Joystick

This allows a real joystick on the computer to simulate an add-on joystick for the PCW. The first part of the menu is used to select what PCW interface is being emulated -

Kempston, Spectravideo or Cascade. Note that the Spectravideo and Cascade interfaces conflict with the CPS8256 serial interface; don't try to use both at the same time.

Once you have set the joystick type, select the second option to choose which joystick on the host system should be connected to the emulated interface.

5.4.10 Keyboard

The keyboard settings screen has five options. The first two are related to swapping keys: One controls which way round the CTRL and ALT keys are mapped (see section 4.1.1) and the other controls which way round the DELETE keys are (see section 4.1.2).

The next three keyboard options relate to the option links. PCW keyboards have three option links, and by default none of these links are connected. To my knowledge no PCW software uses the links, but for completeness JOYCE allows you to connect them here. The only one with a noticeable effect is LK2; if it's connected, pressing the Shift key will not cancel Shift Lock. For details of what LK1 and LK3 do, see the PCW hardware guide.

There are also two joystick options. These relate to a curious little piece of history. The controllers in all PCW keyboards include joystick support; but there's no joystick socket for them to plug in to (compare the PC1512 keyboard, where there is a joystick socket). Strictly in the interests of completeness, JOYCE provides the joystick sockets. To activate one or the other, select "Joystick 1" or "Joystick 2". A menu appears listing the joysticks on the host computer; select the one to use. To the best of my knowledge no PCW software supports the keyboard joystick; use one of the other joystick models to get something useful done.

5.4.11 Mouse / Lightpen

Two pointing device settings are available here:

- Emulation mode: No mouse, AMX mouse, Kempston mouse or Electric Studio lightpen (see section 4.2.1).
- Auto patch on or off (see section 4.2.4).

5.4.12 Video

The Video settings allow you to change:

- "Video refresh" - the number of times per second that the screen is redrawn. You can go up to 50Hz (ie, the screen is redrawn 50 times a second) or down to 0.01Hz (the screen is drawn once every 10 seconds). The default setting in JOYCE is 12Hz, which is fine for nearly all programs; even at 3.75Hz CP/M and LocoScript work fine.
- The beeper is usually emulated using the PC's sound card. You can also have it manifest as a red flash of the screen ("Visual Beeper") or silence ("Disable beeper").
- You can also choose whether to have a green screen (8000 series), white screen (9000 series) or any other screen colours here.

5.4.13 Accelerated Display

There is only one option here - when using the accelerated screen display (see section 6.11), are programs allowed to change the screen colour?

- When enabled, programs like PALETTE can change the screen text and background to any of the 64 colours supported.
- When disabled, PALETTE acts like on an original PCW and just swaps the foreground and background colours.

5.4.14 LocoLink

The LocoLink settings allow you to set whether or not a LocoLink interface is connected. If it is, then you get the same options as for a parallel port. However, only “Output to Parallel port”, “Use internal LocoLink server”, “Output to shared memory” and “Output to socket” can be used for a LocoLink connection.

- Use “Use internal LocoLink server” to act as the “master” computer, with files being sent to a directory on the host PC.
- Use “Output to Parallel port” to act as the LocoLink server when the client computer is a real PC or PcW16. Connect the parallel ports together with a LapLink cable.
- Use “Output to shared memory” or “Output to socket” to act as the LocoLink server when the client system is an emulated PcW16 (or PC).

5.4.15 PCW-Linkit

The PCW-Linkit interface is similar to LocoLink, except that there is no option to connect through a real parallel port, only to another emulator. Consequently only the “shared memory” and “socket” options are available.

One end of the link needs to be set as ‘client’ and the other as ‘server’ - since this is saved with the JOYCE hardware settings, you will need to change it manually on one of the two emulators before running the PCW-Linkit software.

5.4.16 Guest systems

This allows the drives available in a CP/M-86 session to be configured - see section 8.0.1 for more information.

5.4.17 Save settings

If you do not save the settings, they will remain in force only for the duration of your current JOYCE session. The settings will be saved to the file `Joyce/joycehw.xml` in your home directory.

6 JOYCE Utilites

The following utility programs are supplied with JOYCE. They are designed to access features of the emulator which have no equivalent on a real PCW. You will find them on the disc image “utils.dsk”.

6.1 CENPORT

CENPORT is a fast driver for the standalone Centronics printer port. Just type:

```
CENPORT
```

and printer output will be sent to the destination defined for that port. Any DEVICE setting for the printer will be ignored.

CENPORT only works under CP/M. LocoScript 1 cannot print from JOYCE (except using the emulated dot-matrix printer). If LocoScript 2 and later do not detect the Centronics port, use the CPS8256 printer port instead.

6.2 DDJOYCE.PRL

DDJOYCE is a GSX driver for the host PC's graphics screen, allowing high-resolution colour graphics to be used from CP/M. It requires JOYCE 2.1.7 or later.

To use it, edit your ASSIGN.SYS file. Remove the entry which reads

```
01 @:DDSCREEN
```

and replace it by

```
01 @:DDJOYCE
```

DDJOYCE has been tested with the Digital Research programs DR Draw and DR Graph, with the following issues:

- DR Graph works correctly, but when it shuts down the screen goes blank. This is because DR Graph does not make a proper 'close workstation' call when it closes. Use the Action menu (section 5.1) to switch back to the PCW screen.
- DR Draw works correctly, though text rendering is rather ugly.

6.3 DDJOYPCW.PRL

DDJOYPCW is an accelerated GSX driver for the PCW's normal (monochrome) display. Rather than take over the screen altogether, it attempts to do just what the original PCW driver (DDSCREEN) does - except faster and with more optional features (arc, filled pie slice, filled circle, two extra display fonts).

As with DDJOYCE, it can act as a drop-in replacement for DDSCREEN. It has been tested with DR Draw and DR Graph, with no apparent issues.

6.4 DDJOYPDF.PRL

DDJOYPDF is a GSX driver that outputs .PDF files in the JOYCE PDF directory (~ /Joyce/PDF). The intention is that you'd set it up as a printer or plotter driver in ASSIGN.SYS, replacing the Epson printer driver (DDFXHR8.PRL / DDFXLR8.PRL). By sending the output of the GSX program directly to PDF, rather than through a GSX printer driver and then the emulated printer, output is considerably faster and it's possible to use features such as colour which the emulated printer doesn't support.

6.5 DDJOYPNG.PRL

DDJOYPNG works similarly to DDJOYPDF, except it outputs .PNG bitmaps rather than .PDF files.

6.6 DOSDIR

DOSDIR displays the contents of a directory in the host filesystem (the name DOSDIR is for compatibility with MYZ80). Syntax is:

```
DOSDIR
or DOSDIR {x:/path/}filespec
```

Note that if you include a path you must include a filename. The command

```
DOSDIR C:/IMAGES/      is invalid, but
DOSDIR C:/IMAGES/*. *   is valid.
```

To get lower-case commands, use:

```
A>DOSDIR \
DOSDIR>/usr/local/bin/*
```

6.7 EMULIOS.RSX

EMULIOS allows Digital Research Logo to use the 800x600 screen. This was buggy in JOYCE 2.0.0-2.1.6, but has now been corrected.

To set it up, use the following commands (under CP/M):

```
PIP EMULOGO.COM=LOGO.COM
GENCOM EMULOGO
GENCOM EMULOGO EMULIOS
```

- Then EMULOGO.COM will behave as LOGO.COM, but using the 800x600 screen.

The following commands will behave differently:

setpc Allows a number from 0 to 255

setbg Allows a number from 0 to 255

savepic The .PIC file saved is in Windows BMP format, and can be exported, renamed to .BMP, and loaded by paint programs.

loadpic The .PIC file loaded must be in Windows BMP format and have 256 colours, but its size does not have to be 800x600.

6.8 EXPORT

EXPORT will write CP/M files out as UNIX files. It respects exact file sizes.

The syntax is:

```
EXPORT cpmfile           { [0] }
EXPORT unixfile=du:cpmfile { [0] }
```

The first form of the command produce a UNIX file with the same name as the CP/M file.

The second form creates a UNIX file with a name that may be different from the CP/M name.

Beware: because the CP/M CCP renders all filenames into uppercase, it's very unlikely you'll be able to pass directory names to EXPORT; if you say

```
EXPORT /home/fred/cpmfile
```

EXPORT.COM will see "/HOME/FRED/CPMFILE", which probably won't exist. To get round this, use:

```
A>EXPORT \  
EXPORT>/home/fred/cpmfile
```

6.9 GUEST, GDUMP and ENDGUEST

These files are used to control the guest subsystem, described in section 8.

6.10 IMPORT

IMPORT will read UNIX files into the CP/M filesystem. It sets exact file sizes.

The syntax is:

```
IMPORT {/path/}hostfile          { [O] }  
IMPORT du:=/path/hostfile        { [O] }  
IMPORT du:cpmfile=x:/path/hostfile { [O] }
```

The first form imports the named file (or files) to the current drive and user area.

The second form imports the file (or files) to the specified drive and user area, keeping the original name(s).

The third form imports the files, changing their name(s) to match the provided CP/M filename(s).

If the [O] option is present, existing CP/M files with the same name as an imported file will be overwritten without asking. Otherwise you are asked for confirmation.

Both filenames may include wildcards, and the second and third forms can include CP/M driveletters and user numbers:

```
A: IMPORT \  
IMPORT>2F:*.ASC=/usr/doc/*.txt
```

will import all the .txt files in /usr/doc to drive F, group 2.

Filenames are expanded case-sensitively, so you will normally need to use the backslash, as above, to get lower-case letters into the command line.

6.11 JFASTCRT and JFASTUC1

JFASTCRT is a driver which attempts to improve the speed of screen drawing, by implementing it within the emulator rather than as Z80 code. Where VGA.FID (see section 6.17) is a standalone screen that completely takes over from the normal PCW display (which can lead to possible compatibility issues), JFASTCRT attempts to do exactly what the normal driver does, just faster.

You can choose between two variants of the driver:

JFASTUC1.FID makes the new device optionally available as a device called UC1.

You can switch to the new driver with `DEVICE CONOUT:=UC1` and back to the original one with `DEVICE CONOUT:=CRT`

JFASTCRT.FID completely takes over from the existing CRT device, so the new driver is in use all the time and you can't switch back.

If enabled within the Setting menu, this driver supports changing the screen colours with ESC b and ESC c, as on the CPC6128.

It is also possible to use the accelerated driver from within a GUEST session, even if neither FID file has been loaded. Use STAT CON:=UC1: to send output directly to the new driver, and STAT CON:=CRT: to go back to whatever the host PCW is using.

Both drivers support some extra escape codes, from my PCW utility CRTPLUS.FID. JFASTCRT.FID can thus be used within the emulator instead of CRTPLUS.FID if desired.

ESC + a <mask> Set character AND mask.

ESC + b Bold on

ESC + d Double width on

ESC + g Grey text

ESC + h Double height on

ESC + i Italic on

ESC + o <mask> Set character OR mask.

ESC + u <pattern> Set underline pattern.

ESC + x <mask> Set character XOR mask.

ESC + Y <row> <col> Set cursor position, not making any adjustments for double-size characters.

ESC - a Remove character AND mask.

ESC - b Bold off

ESC - d Double width off

ESC - g Grey text off

ESC - h Double height off

ESC - i Italic off

ESC - o Remove character OR mask.

ESC - u Underline off

ESC - x Remove character XOR mask.

ESC s Bold on

ESC t Bold off

The character AND / OR / XOR mask may require a little explanation. Once the mask is set, the pattern of the specified character will be combined with all characters output, using the logical operation in question. This may come in useful for combining graphical characters, or for adding accents to letters.

6.12 JOYCEDRV

JOYCEDRV.FID is a file which is used to add one or more extra disc drives to CP/M (v1.9/2.9+) or LocoScript (v2.30+) running within JOYCE. The first of these drives will usually be drive C:.

Unless the settings are changed (see section 5.4.4) the drives will be set up as 8Mb hard drives, called `~/Joyce/Disks/c.dsk`, `~/Joyce/Disks/d.dsk`, etc.

How many drives you get depends on your environment, but on my system I get five under CP/M (C:,D:,E:,F:,and G:), and thirteen under LocoScript (C: to L: and N: to P:). If you set the option for all hard drives to use the same 8Mb format, than all thirteen extra drives will be available under CP/M too.

To enable JOYCEDRV, copy the file JOYCEDRV.FID to your start-of-day disc image. For example:

- Start JOYCE.
- Select CP/M from the boot menu.
- When the A> prompt appears, press [f9], then [f2] (Disc), then choose the “Insert” option for drive B:. Click on “disc file”.
- In the file chooser that appears, click “System disc files”, then “utils.dsk”. Then click OK.
- Back in the f2=Disc menu, choose “EXIT”. Then press ESC to leave the menu system.
- Back at the CP/M prompt, type `PIP A:=B:JOYCEDRV.FID`
- Press [f9], then [f5] to reboot, and confirm this.
- Select CP/M from the boot menu.
- JOYCEDRV should now list available drives. If not, then your version of CP/M is too old.

If you try to use a disc image that JOYCEDRV cannot understand, you will not be able to access it. Under CP/M, you will get an "invalid drive" error; under LocoScript, you will get a "FID error".

6.13 PCKEY

Syntax:

```
PCKEY keyfile
```

or:

```
PCKEY keyfile fidfile
```

PCKEY is used to alter the mapping of PC keys to PCW keys. You may need to use this utility if your keyboard does not have a UK layout, or you are using a laptop where some keys are difficult to get at. This was buggy in JOYCE 2.0.0-2.1.9, but has now been corrected.

When PCKEY is given one parameter, it will read the keyfile and make the changes immediately. When it is given two, it will compile the keyfile into a .FID file, which can then be put on a start-of-day disc and which will make the necessary assignments every time JOYCE is started.

The format of the keyfile is a series of lines; each line reads:

```
pc-number  modifier  pcw-number  {comment}
```

pc-number is the number of the key. For a full listing, see Appendix B.

NOTE: These numbers changed between SDL 0.8 and SDL 0.10; so if you are upgrading JOYCE from a version which used SDL 0.8, you need to rewrite your PCKEY files.

modifier must be N, for compatibility with the old DOS version of JOYCE.

pcw-number is the PCW key number. These are listed in the PCW manual.

So, a typical line might read:

```
27 N 8  ESC goes to EXIT
```

6.13.1 Notes:

1. The key mapping you have set remains until you exit JOYCE.
2. The option in the Settings menu to swap CTRL/ALT and Backspace/Delete uses the same method as PCKEY. It is probably best not to map these four keys.
3. Key 256 brings up the JOYCE menu. Key 257 brings up the Exit Confirmation screen.
4. If you use VGACOM to switch into VGA mode, note that keys set up by PCKEY don't affect the keyboard in VGA mode.

6.14 QUIT

Syntax:

```
QUIT { number } { [O] }
```

QUIT will exit JOYCE. With no parameters, it will check whether there are files on drive M: which may need saving, and if there are it will ask for confirmation.

The number parameter is the error level which JOYCE should return. If there is no number parameter, JOYCE returns 98.

The [O] option disables the M: drive check and quits immediately.

6.15 REDIR

REDIR allows you to use one or more PC directories as drives under CP/M. See the separate file REDIR.DOC for more information.

6.16 RTC

Syntax:

RTC

or

RTC [C]

RTC reads the PC's built-in clock. It can be used in two ways.

RTC by itself will set the PCW's clock from the PC's clock. The timing of the PCW's clock will then depend on the speed of emulation, which is another way of saying that it will gradually diverge from the PC's clock.

RTC [C] links the PCW's clock to the PC's clock; it will be set to the correct time whenever CP/M reads it.

6.17 VGA and VGACOM

VGA.FID allows CP/M programs to make direct use of the PC screen and keyboard. This gives more text on the screen and faster output.

Once VGA.FID has loaded, type VGACOM ON to activate it, and VGACOM OFF to deactivate it.

Your PCW screen will now be 100 columns x 36 lines. Nearly all the normal PCW escape codes are supported, which should enable character-based programs to be run. Since screen output is now being done by the host PC's processor, you should notice an improvement in speed.

If you run DISCKIT or a graphical program like Stop Press, you will find that no output is visible; use the Action menu (section 5.1) to switch back to the native PCW screen.

The following escape codes work differently in the 800x600 VGA mode:

ESC b / ESC c set colours (so the numbers in the PALETTE command actually have meaning).

ESC y sets 32x90 mode.

ESC z sets 36x100 mode.

ESC + a <mask> Set character AND mask.

ESC + b Bold on

ESC + d Double width on

ESC + g Grey text

ESC + h Double height on

ESC + i Italic on

ESC + o <mask> Set character OR mask.

ESC + u <pattern> Set underline pattern.

ESC + x <mask> Set character XOR mask.

ESC + Y <row> <col> Set cursor position, not making any adjustments for double-size characters.

ESC - a Remove character AND mask.

ESC - b Bold off

ESC - d Double width off

ESC - g Grey text off

ESC - h Double height off

ESC - i Italic off

ESC - o Remove character OR mask.

ESC - u Underline off

ESC - x Remove character XOR mask.

6.18 XPALETTE

Syntax:

`XPALETTE b f`

or:

`XPALETTE br bg bb fr fg fb`

XPALETTE takes advantage of the colours on a VGA screen to allow the PCW to display in any colour scheme, not just black and white.

The version with two parameters works the same way as on a CPC or a Spectrum +3 (though neither of these has as many colours as JOYCE has). For example, on a CPC you might type:

`PALETTE 2 63`

to get white text on a blue background. So, in JOYCE, type

`XPALETTE 2 63`

and the screen colours obediently change.

The version with six parameters allows any colour in the 24-bit range to be selected, rather than just 64. Instead of a colour being represented by one number, it is represented by three:

`XPALETTE 0 0 32 255 255 251`

will give you a very dark blue background and a foreground with the slightest tinge of yellow.

XPALETTE does not mind how the numbers are separated (with commas, spaces, *s or whatever) and accepts Hex numbers preceded with & (128 = &80 etc.).

Note! Unlike `PALETTE 0 0`, `XPALETTE 0 0` really does select black on black. This is not recommended.

7 JOYCE utilities (PC hosted)

If you don't want to use JOYCE's own methods for converting between disc files and image files, you can also use the DSKTRANS program, which is installed with JOYCE.

The command to use is either:

```
dsktrans /dev/fd $n$  dskfile  
- Floppy disc to image file
```

or

```
dsktrans dskfile /dev/fd $n$  -otype floppy  
- Image to floppy disc.
```

DSKTRANS isn't as versatile as CPCTRANS (for example, it can only handle discs in recognisable PCW or +3DOS formats) but it doesn't need telling what sort of disc it is using, and it is a native (not DOS-hosted) program.

To copy a MicroDesign 3 protected disc with DSKTRANS, add "-md3" to the end of the command line.

7.0.1 MD3 discs and Windows NT / 2000 / XP

Windows NT, 2000 and XP will flat-out refuse to read MicroDesign 3 program discs, owing to the copy protection used on them. If you are using Windows 2000 or XP, then it is possible to install Simon Owen's floppy disc driver <<http://simonowen.com/fdrawcmd/>>. In this case, select the "Alternative floppy" option as well as choosing "MicroDesign program disc".

If you are using Windows NT, or if you don't have the correct driver installed, there is no way to make JOYCE capable of reading MD3 discs. You will need to:

- Create a bootable DOS floppy disc. If you're on a system which can't do this, then you may be able to get hold of one at www.bootdisk.com. If you only have one floppy drive, the boot disc needs to include a RAM drive at least 1Mb in size.
- Copy MD3TRANS.EXE to the DOS disc.
- Boot from the DOS disc.
- If you have two drives: Insert the MD3 disc in drive B: and type

```
MD3TRANS B: A:dskfile
```

- If you have one drive: Copy MD3TRANS to the RAM drive

```
COPY MD3TRANS.EXE C:  
then insert your MD3 disc and run MD3TRANS  
C:MD3TRANS A: C:dskfile  
then insert your boot disc and copy the resulting file back.  
COPY C:dskfile A:
```

Either way, MD3TRANS will produce some error messages when copying the protected track. Answer 'I'gnore to any error messages that might appear.

7.0.2 Problems reading floppies on Windows 9x

On some versions of Windows 95, 98 or ME, JOYCE has trouble creating disc image files. The transfer appears to work, but runs very very slowly; and the resulting .DSK file is blank.

To get round this:

- Open a DOS prompt.
- Change to the drive and directory holding JOYCE - eg:

```
C:\WINDOWS>CD "\Program Files\JOYCE"  
C:\Program Files\JOYCE>
```

- Use a PCWTRANS command to read the discs:

```
PCWTRANS x: dskfile
```

- When adding the disks to JOYCE, browse to the .DSK file that was just created rather than choosing a real drive.

8 Guest Sessions

The Guest system allows a second copy of CP/M to be run. Currently two versions are supported: CP/M 2 and CP/M-86.

To start it, type

```
GUEST CPM2 { optional command to run }
```

or

```
GUEST CPM86 { optional command to run }
```

If GUEST launches successfully, you will see a message similar to:

```
JOYCE CP/M-86 guest BIOS 879K TPA  
Boot drive is A:  
Host drives: A: B: M:  
Guest drives:  
[CP/M-86] A>
```

At this point, you are inside the second CP/M system and have left the normal world of PCW CP/M behind. If you try to run one of the .COM files supplied with PCW CP/M, it may well fail to run (saying that it requires CP/M 3) or be plain ignored (if you are trying to use it under CP/M-86).

Two disc image files have been supplied to help you over this hurdle: cpm2.dsk contains the standard utilities for CP/M 2 (PIP, STAT, DDT etc.) and cpm86.dsk contains the corresponding utilities for CP/M-86 (PIP, STAT, DDT86...)

Both .DSK files also include a couple of example programs: SAVEPIC2.COM / SAVEPIC.COM will save the current screen display, in the .PIC format used by Digital Research Logo. LOADPIC2.COM / LOADPIC.COM will load a file saved by the corresponding SAVEPIC (or Logo itself).

Also supplied is ENDGUEST.COM / ENDGUEST.COM, which when run will close down the guest CP/M session and return you to original PCW CP/M.

8.0.1 Guest and Host Drives

The default for a guest CP/M session is to use the same disc drives as the PCW CP/M environment that started it. On a stock PCW CP/M this will be drives A:, B: and M:. If you are using JOYCEDRV.FID to add emulated hard drives, there may be more letters (C: D: etc.). So you can create a file in PCW CP/M, switch to CP/M 2 or CP/M-86 and edit it, then switch back to PCW CP/M and examine the changes. These drives are referred to in the boot message as 'Host drives'.

It is also possible to have 'Guest drives' which are exclusively for the use of the guest system and are not visible to PCW CP/M. These are configured through the JOYCE menu: Select f6=Settings, Guest systems, CP/M 2 or CP/M-86. It is then possible to configure for each drive letter whether it is a shared host drive or an independent guest drive (and, if the latter, what filename to use for it).

One use for guest drives might be to store programs and data files which are only meaningful to the guest CP/M system, so that they don't get mixed up with PCW CP/M files. They also have a speed advantage over host drives.

Guest drives are always 8Mb hard drives.

Host drives that are not supported at a BIOS level (for example, folders mapped using REDIR or CP/Net network drives) will not be made available to the guest CP/M system.

8.0.2 Leaving a guest system

The best way to return to PCW CP/M is to use the ENDGUEST command.

If the guest system has crashed, or you don't have a copy of ENDGUEST.CMD to hand, it's also possible to try to return to PCW CP/M by doing an 'emergency stop' - from the JOYCE menu, select 'f8=Action' and select 'Guest Emergency Stop'. If all goes well, you should be unceremoniously dropped back at the original A> prompt. This is however something of a last resort, and should be avoided if possible.

It's also possible that a crash of the CP/M-86 system will return you to PCW CP/M without asking - for example, if a CP/M-86 program calls an unexpected interrupt, or tries to divide by zero.

8.0.3 Viewing guest system memory

When you have finished a CP/M 2 or CP/M-86 session, its memory is retained. The GDUMP utility can be used to view it. The intention is that if you are using the guest environment for software development / testing, GDUMP can be used to examine memory after a crash and possibly determine what went wrong.

At its simplest, type

```
GDUMP CPM2 *
```

or

```
GDUMP CPM86 *
```

You will see the beginning of the guest CP/M system's memory. If you have run a session this will contain valid data; otherwise, it will be blank. Press STOP / Control-C to return to CP/M when the [More] prompt appears.

It is also possible to specify which part of memory should be viewed:

```
GDUMP CPM86 * [FIRST=510, LAST=57f]
```

will display 112 bytes from the start of the CP/M-86 CCP.

If the * is replaced with a filename, the contents of memory will be saved to that file. So

```
GDUMP CPM86 SAVED.MEM [FIRST=510, LAST=57f]
```

will save those same 112 bytes to the file SAVED.MEM.

8.0.4 The CP/M 2 environment for programmers

The CP/M 2 environment is a fairly standard CP/M 2 system. There is a signature 69h bytes from the start of the BIOS (so 66h bytes from the WBOOT entry point) which can be used to detect this particular environment:

```
DB 'JOYCE', 1, 0
```

There is also an entry point three bytes before (66h bytes from BIOS start, 63h bytes from WBOOT) which can be called with:

A=0 terminates the CP/M guest system, as ENDGUEST would.

A=0E3h is a version of the PCW system call CD VERSION. It returns A = host system type (1 for PCW, 41h for PcW16); BC = BIOS version; HL = hardware detected.

Currently the CP/M 2 system runs with interrupts disabled, so it's not a good idea to execute a HALT.

Character device reassignment (using STAT) is not supported, with one exception. Switching the console to device to UC1: sends output to JOYCE's built-in console driver. Switching it back to CRT: passes it to whatever device PCW CP/M is using. Otherwise, devices should be assigned with DEVICE under PCW CP/M before launching GUEST.

The CP/M 3 BIOS calls MOVE and XMOVE are implemented, at the same locations and with the same parameters as on a genuine CP/M 3 system. These are used to move memory between the guest system (bank 1) and the host system (bank 0FFh) or its video RAM (bank 0FEh). Other CP/M 3 calls (eg CONOST, MULTIO, TIME) are not implemented.

8.0.5 The CP/M-86 environment for programmers

If you are used to CP/M-86 for the IBM PC, the CP/M-86 environment here may feel rather stripped-down. There are no PC BIOS facilities available (for example, no screen services on INT 10h). You should use only the documented CP/M BIOS and BDOS services.

If you need to detect this particular environment, find the address of the INT 0D0h handler. Two bytes after that will be a 7-byte signature:

```
DB 'JOYCE', 1, 0
```

INT 0D0h itself provides only a couple of minimal services:

AH=0 terminates the CP/M guest system, as ENDGUEST would.

AH=0E3h is a version of the PCW system call CD VERSION. It returns AL = host system type (1 for PCW, 41h for PcW16); BX = hardware detected; CX = BIOS version.

The TOD command will display the current clock time (if set under PCW CP/M) but cannot change it.

Character device reassignment (using STAT) is not supported, with one exception. Switching the console to device to UC1: sends output to JOYCE's built-in console driver. Switching it back to CRT: passes it to whatever device PCW CP/M is using. Otherwise, devices should be assigned with DEVICE under PCW CP/M before launching GUEST.

CP/M-86 has the use of memory up to 0E0000h.

The 0E0000h-0FFFFFFh contains the host PCW's 64k TPA. For example, you will see the PCW BDOS at E000:F600, and the running GUEST.COM at E000:0100. Writes are only permitted to an area marked by GUEST.COM as writeable, so it is not possible to overwrite the PCW's zero page or BDOS from CP/M-86.

The 0F0000h-0FFFFEF range contains the PCW screen, mapped as a linear array of 256 rows each containing 90 bytes (rather than the more complicated memory layout seen when accessing the screen memory from PCW CP/M). It also contains the PCW font (at F000:7800-F000:7FFF).

Further information may be gleaned from the source code of ENDGUEST, LOADPIC and SAVEPIC.

9 Recent Changes

New in v2.5.5:

- Bug corrected with emulated dot-matrix printer: bidirectional printing could lead to misaligned output.
- The emulated daisywheel and dot-matrix printers can now output in PDF format.
- Added support for three new GSX drivers: DDJOYPCW (accelerated drawing on PCW screen), DDJOYPDF (output to PDF) and DDJOYPNG (output to PNG).

New in v2.5.4:

- Corrected the default colour mapping in DDJOYCE GSX driver.

New in v2.5.3:

- Added the ability for JOYCE to act as a terminal to the host system (Currently only in JOYCE for UNIX).

New in v2.5.2:

- Added support for the PCW-Linkit interface.
- Created an accelerated screen driver, accessed via JFASTCRT.FID / JFASTUC1.FID.
- Added an internal LocoLink server, allowing a directory on the host system to be accessed by LocoLink 1.x running within JOYCE.

New in v2.5.0:

- Added CP/M 2 and CP/M-86 guest subsystems, allowing programs for these versions of CP/M to be run within JOYCE.
- When inserting an existing disc image file, default its type to 'Autodetect' rather than 'DSK' - this should make it easier to access disc images in EDSK format.
- Compilation fix: rename 'byte' type to 'zbyte' to avoid clashing with native C++ byte type.

New in v2.4.0:

- Bug fix: PIP could hang copying files larger than 16k from folders mapped as drives.
- Compilation fix: int versus unsigned in PcKeyboard.cxx

New in v2.2.15:

- JOYCE now correctly handles CPC disk images with unformatted tracks.

New in v2.2.14:

- Fix display artefacts when colours are changed while video is disabled.
- Fix Rosanne checksum when the ROM is patched by Rosanne acceleration
- Fix autodetection of EDSK files.

New in v2.2.13:

- Updated to the latest GNU Autotools.

New in v2.2.12:

- Altered the default keyboard mapping on Windows systems; this should result in the # and ½ keys showing up where you expect them to.

New in v2.2.11:

- Fixed a problem in the install process that required LyX to be installed.
- Added an option to use a single DPB for all drives provided by JOYCEDRV.FID; this allows all 13 extra drives to be present in CP/M.

New in v2.2.9:

- Added support for the Electric Studio light pen.

New in v2.2.7:

- External file access by CP/M programs now prompts for each file being read / written.

New in v2.2.5:

- Compilation fixes for recent versions of libpng.
- Fix for a crash when the cursor was moved offscreen in the VGA terminal.

New in v2.2.4:

- Improvements to keyboard emulation.
- In the Windows version, updated to the latest stable SDL.DLL.

New in v2.2.3:

- More compilation fixes.

New in v2.2.2:

- Compilation fixes for Linux version.

New in v2.2.1:

- Updated to the latest LibDsk and Lib765.

New in v2.2.0:

- Minor code cleanups only.

New in v2.1.11:

- Corrected a Z80 emulation bug that caused Starglider to hang.
- The CPU state shown in the debugger now includes memory paging status.
- The JOYCE memory dump saves 256k rather than 160k.
- In the file browser you can choose 'Current directory' as well as JOYCE's default directories.

New in v2.1.10:

- Restored the functioning of the PCKEY utility.

New in v2.1.9:

- Various changes to improve performance and allow building on Mac OS X.
- Updated LibDsk to 1.1.9, fixing a bug in rcpmfs for files saved as User 1.

New in v2.1.8:

- Exposed the 'rcpmfs' functionality in LibDsk, allowing folders to be used as disc images.

New in v2.1.7:

- Finally reinstated the native GSX driver, using Digital Research GEM code released under the GPL.
- Got the native LOGO driver working again; it hadn't worked properly since the port from DOS.
- Added 'Select PCW screen' command.
- Added "Extended .DSK" and "Alternative floppy" to the Drive Type menu.

New in v2.1.6:

- Bug fix: JOYCE does not crash if run on a Windows system with no printers set up.
- Fixed a bug where writes to DSK files would fail with mysterious errors.
- Added compatibility for DSK files which have both 512 byte and 1k sectors.
- JOYCE doesn't hang if Trivial Pursuit is run with the emulated CPS8256 interface attached.

New in v2.1.5:

- Joystick support.
- Compiles under SDL 1.2.6

New in v2.1.3, 2.1.4:

- Minor bug fixes.

New in v2.1.2:

- Bug fix in creation of hard drive .DSK files.
- Compiles without modification under gcc 3.2 (if configured with the `--with-stl` option).

New in v2.1.1:

- Bug fixes in the 2.1.x boot ROM and utilities.
- Scale of the Windows GDI output corrected for PCW9512 printing.

New in v2.1.0:

- Internal restructuring - part of the creation of ANNE.
- LocoLink emulation.
- Support for printing to a Windows GDI printer.

New in v2.0.1:

- Fixed a bug parsing JOYCEHW.XML.

New in v1.9.9:

- Windows serial port emulation is now usable.

New in v1.9.5:

- Windows serial port emulation improved, though it still isn't very good.
- Custom screen colours can be set through the menu system.

New in v1.9.4:

- Dot-matrix printer output can now be in PostScript format rather than PNG.
- Daisywheel emulation added.
- Bug fixes in the 100x36 text screen (as provided by VGA.FID / VGACOM.COM)
- Partial and buggy serial port support under Windows.
- Floppy controller emulation changed so that .DSK files can be created and formatted.

New in v1.9.3:

- JOYCE can now read MicroDesign 3 discs (except on Windows NT / 2000 / XP).
- It is possible to map the PCW's floppy drives directly to the PC's floppy drives.
- Bug fix: The keypad minus key now correctly maps to the PCW "[-]" key.
- Bug fix: No DirectSound crash when JOYCE terminates on Win95.

New in v1.9.2:

- It is now possible to set the PCW memory size at startup with the "-m" option.
- Sound output added.

Bug fixes:

- Fix for incorrect colours on some Windows systems.
- The file chooser now works properly in the Windows version.

New in v1.9.1:

Windows version created.

New in v1.9.0:

- JOYCE has been thoroughly overhauled and rewritten in C++.
- TIMINGS.COM is no longer necessary. The speed of JOYCE is now set using the “General” option from the [f6] settings menu.
- The menu system is entirely new.
- CPS8256 emulation has been added.
- Dot-matrix printer emulation has been added.
- The disc controller emulation has been rewritten from scratch. It should support disc image files in the CPCEMU “extended” format.
- The Z80 emulation is now Ian Collier’s code from xz80.
- The AMX and Kempston mouse emulation are now much more usable, even without the auto-patch mode.

A For UNIX system administrators

First and foremost, *don’t run JOYCE as the root user!* JOYCE gives the PCW programs within it various methods to access the host filesystem; it is entirely possible that a malicious PCW program running within JOYCE could damage important UNIX files.

It is possible to set up a system-wide installation of JOYCE with default settings, boot discs and other discs. To do this, first set up the desired configuration as a normal user. Then copy the following files:

- From `~user/Joyce` to `/usr/local/share/Joyce`: `joycehw.xml`
- From `~user/Joyce/Boot` to `/usr/local/share/Joyce/Boot`: `boot*.dsk` and `joycebt.xml`
- From `~user/Joyce/Disks` to `/usr/local/share/Joyce/Disks`: Any other `.dsk` files that should be common.

This will then become the default configuration on your system. Users will still be able to change settings or add additional discs; these will be saved to their local configuration directories.

B Keyboard codes

Note that many of these keys don't exist in a standard PC keyboard. For example, the PC keyboard has no "\$" key (it uses SHIFT + 4 instead) so assigning codes to that key will have no effect.

Code	Key
8	Backspace
9	Tab
12	Clear
13	Return
19	Pause
27	Escape
32	Space
33	!
34	“
35	# (Linux only)
36	\$
38	&
39	,
40	(
41)
42	*
43	+
44	,
45	-
46	.
47	/
48	0
49	1
50	2
51	3
52	4
53	5
54	6
55	7
56	8
57	9
58	:
59	;
60	Linux: < Windows: \
61	=
62	>
63	?
64	@
91	[
92	Linux: \ Windows: #
93]

94	^
95	_
96	,
97	A
98	B
99	C
100	D
101	E
102	F
103	G
104	H
105	I
106	J
107	K
108	L
109	M
110	N
111	O
112	P
113	Q
114	R
115	S
116	T
117	U
118	V
119	W
120	X
121	Y
122	Z
127	Del
256	Keypad 0
257	Keypad 1
258	Keypad 2
259	Keypad 3
260	Keypad 4
261	Keypad 5
262	Keypad 6
263	Keypad 7
264	Keypad 8
265	Keypad 9
266	Keypad .
267	Keypad /
268	Keypad *
269	Keypad -
270	Keypad +
271	Keypad ENTER
272	Keypad =

273	Up arrow
274	Down arrow
275	Right arrow
276	Left arrow
277	Insert
278	Home
279	End
280	Page up
281	Page down
282	F1
283	F2
284	F3
285	F4
286	F5
287	F6
288	F7
289	F8
290	F9
291	F10
292	F11
293	F12
294	F13
295	F14
296	F15
300	Num lock
301	Caps lock
302	Scroll lock
303	Right shift
304	Left shift
305	Right control
306	Left control
307	Right Alt
308	Left Alt
309	Right Meta (OS X: Command)
310	Left Meta (OS X: Command)
311	Left Windows
312	Right Windows
313	Mode / Alt Gr
315	Help
316	Print screen
317	SysRq
318	Break
319	Menu
320	Power
321	Euro

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