Black Printing Enhancements Functional Specification
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Contents
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1. History
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1.00 MRC  21/3/95  Updated for Developer pack.

2. Outstanding Issues
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None.

3. Overview
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This document describes the changes proposed to be made to the printing
system by project 'Black'. There may be some bug fixes, and support of new
printers (where that does not entail much work). However, the changes
consist largely of those which track enhancements introduced by the Black
version of the SpriteExtend module. These changes divide broadly into two
classes: minor extensions, to more fully support new format Sprites; and a
more major extension, to support JPEG compressed images. The potential
advantage of JPEG support is that of reduced memory requirements for
applications such as DTP.

For bit image printers (dot matrix, ink jet), the minor extensions are not
expected to require any changes within the printer modules, since the output
is rendered via standard Sprite calls. For PostScript printers, the minor
extensions will require modified code to track the Sprite changes.

For both bit image and PostScript printers, the JPEG support requires new
code. This consists of:

1) intercepting the JPEG plot calls, when printer output is active;
2) handling JPEG plots in a fashion similar to equivalent Sprite plots (the
   JPEG plot types are a subset of the Sprite plot types).

4. Technical Background
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The printing software consists of the desktop applications and the printing
support modules. The desktop applications are: !FontPrint, !PrintEdit and
!Printers. The printing support modules are: PDriver (the printer sharer);
PDriverPS (the PostScript driver); PDriverDP (the bit image driver);
PDumperSpt (the dumper support module); and PDumperDM, PDumperIW, PDumperLJ
(the bit image dumpers).

The device dependent driver modules, PDriverPS and PDriverDP, will be most
affected by the proposed changes, since they contain all the code which
deals with rendering to printers. The PDriver module will be affected by the
addition of a new printer SWI (PDriver_JPEGSWI).

The proposed changes follow those to SpriteExtend, which are described in
the related document:

   1303/005/FS Black Video Software Functional Specification

These changes are itemised as 4.1 to 4.5, with consideration of their impact
on the printer drivers. Items 4.1 to 4.4 (minor extensions for new format
Sprites) are considered only for their impact on PDriverPS, since PDriverDP
renders Sprites via the Sprite system itself, and so will inherit the
changes. Section 4.6 considers additions to support specific printers.

## 4.1 Support for 1 bpp masks on new format Sprites
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The use of 1 bpp masks does not require changes to PDriverPS, since it has already been supported in the current version (version 4.16).

## 4.2 Palettes on new format Sprites
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Palettes will be allowed on new format Sprites of 8 bpp or less. This will not require significant changes to PDriverPS, since the palettes will be of the old format, which is already catered for.

## 4.3 Wide translation tables on new format Sprites
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Wide translation tables will be allowed by SpriteExtend, for plotting Sprites into 16 or 32 bits. This is controlled by R5 bit 5, in the PutSpriteScaled and PutSpriteTransformed SWI's. Minor changes to the printer drivers will ensure that this bit is monitored and passed on appropriately.

## 4.4 Plotting directly from the palette with 8 bpp full palette Sprites
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This is controlled by R5 bit 4, and is already supported in the current version of PDriverPS (version 4.16).

## 4.5 Plotting JPEG images
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### 4.5.1 Background
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Some background on JPEG images is given in the related document:

   1303/005/FS Black Video Software Functional Specification

For the purposes of printing, the important point is that JPEG images are a compressed form of either 8-bit grey-level or 24-bit true colour pixel values. The new SpriteExtend will support the following JPEG plotting SWI's:

   JPEG_PlotScaled
   JPEG_PlotFileScaled
   JPEG_PlotTransformed
   JPEG_PlotFileTransformed

The scaled plot SWI's support plotting of JPEG images with simple scaling (cf the SpriteOp PutSpriteScaled), either from memory or file. The transformed plot SWI's are intended to support plotting of JPEG images with transformations such as rotations (cf the SpriteOp PutSpriteTransformed).

The transformed JPEG plots will not be fully supported by SpriteExtend in Black; they will fault all transformations except simple scaling. In order to cater for more general transformations in the future, the printer drivers themselves will not fault transformations. Also, transformations will be passed to the PostScript output, in order to minimise changes required when SpriteExtend support is enhanced.

When printing is active, the printer drivers must intercept the JPEG plotting calls. This will be implemented by two SWI's. A SWI implemented by SpriteExtend will be called by the printer drivers to turn JPEG interception on or off. A SWI implemented by the printer drivers will receive intercepted calls from SpriteExtend. This is defined in section 6.

The task of JPEG plotting in the printer drivers is similar to that for Sprites, since both handle pixel-mapped image objects. As with SpriteExtend for video plotting, only simple scaled JPEG plots need be supported for now. There are some simplifications for JPEG images over Sprites, since the former have no masks or palettes. On the other hand, the nature of the JPEG data raises some questions, which are considered below.

### 4.5.2 Landscape printing of JPEGs
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For Black, there will be no support of rotated JPEG plotting in SpriteExtend. However, printing a page containing a JPEG image in Landscape mode would seem to require rotation of the JPEG by 90 degrees.

Fortunately, this problem does not arise in either the bitmap or PostScript printer cases. In the bitmap case, the driver code implements Landscape by plotting to an unrotated internal Sprite first, then copying with rotation to the output buffer Sprite. In the PostScript case, the rotations can be specified by matrices in the output.

### 4.5.3 Bitmap printers - Speed of JPEG printing
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The speed question arises because the bitmap printer drivers will often plot images in several chunks (multiple plots with appropriate clipping) in order to operate within available memory. For Sprites, this is relatively efficient, because the pixel values are readily accessible at random. For JPEG's, the data is a linear stream compressed from a raster scan, so that only raster order access would seem to be cheap.

Fortunately, the SpriteExtend implementation for JPEG plotting is already organised to minimise overheads in partial plotting, by maintaining pointers into the JPEG data. Hence, the JPEG plotting is not expected to add significant time to printing (above that required for a single decompression), provided that it handles JPEG's via SpriteExtend plot calls.

### 4.5.4 PostScript printers - direct access to JPEG pixels
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For PostScript printers, image data is typically passed inline in the PostScript file, and this requires direct access to pixel values. This is not supported by the SpriteExtend JPEG SWI's. However, this can be circumvented by plotting JPEG's into internal Sprites, which can then be used for direct pixel access. Clearly, large JPEG's will have to be split into chunks in order to fit within reasonable memory requirements. This should not cause significant speed problems, for the reasons discussed in section 4.5.3.

The memory required for the internal Sprite chunk buffer would ideally only be allocated if and when required. This should be practical since, unlike the bitmap drivers, the PostScript driver will not typically have claimed most of available memory on job start.

## 4.6 Support for specific printers

### 4.6.1 Support for new printers

The new printers currently seen as worthwhile to support are:

    Hewlett Packard Desk Jet 560C
    Canon BJC 4000 (forthcoming printer)
    Epson Stylus Colour
    Olivetti JP360

These all fall into the bit image class.

The DJ560C offers no gains over the DJ550C in colour graphics mode. Although
this means the current DJ550C driver and Printer Definition File (PDF) would
suffice, it is proposed to add a PDF for the DJ560C, which is merely a copy
of that for the DJ550C. This is to assure the user that the printer is
properly supported.

Similarly, the Canon printer can be driven by taking a copy of the BJC-600
PDF. However, better Canon support is potentially available with an enhanced
or extra dumper module - a possible future enhancement.

The Stylus requires ESC/P2 printer language support in order to access its
high quality graphics modes. An extra dumper module to achieve this will be
developed by a third party. This will then be purchased by Acorn and
incorporated in the Black release.

The Olivetti JP360 may be sold by Acorn. It uses an HP PCL III emulation,
and should operate with a PDF based on that for the HP DJ500C.

### 4.6.2 Improved support for current printers

The printing system allows different printer palette files to be assigned to
different printers, via the PDF. Currently, there is only one palette, tuned
to give good results on four-ink (CMYK) printers. Typically, three-ink (CMY)
printers could produce better approximations to black with a different
palette file. A second palette file, for CMY printers, will be included;
this is likely to be tuned to HP engines. The provision of individual
palettes for individual printers is considered uneconomic.

## 5. User Interface

Black effectively promotes JPEG files to a native type, known to RISC OS.
Hence, the user may reasonably expect sensible behaviour if a JPEG file is
double- clicked, or dropped onto the printer icon. The former is catered for
by !ChangeFSI (the JPEG will be converted to a Sprite). The latter should
cause the JPEG file to be printed, but would currently give the confusing
error message:

    Don't know how to print JPEG files - print XXXX as plain or fancy text ?

This will be remedied by developing a simple JPEG printing program, which
will print the JPEG to fit the current page margins, and then quit. This
will be placed within the !ChangeFSI folder, and an appropriate definition
of the Alias$@PrintType for JPEG files will be set in !ChangeFSI.!Boot, to
trigger printing of JPEG's.

## 6. Programmer Interface

Black printing enhancements will introduce two new SWI's, which are defined
here. These SWI's form an internal mechanism for JPEG interception, between
SpriteExtend and the printer drivers. Hence, they should both be marked in
the PRM as 'Applications must not use this SWI'.

### 6.1 SWI JPEG_PDriverIntercept

The new SWI, JPEG_PDriverIntercept, will be added to SpriteExtend. This will
be called by the printer drivers in order to inform SpriteExtend whether
JPEG plotting calls should be handed on (via the SWI PDriver_JPEGSWI; see
below). JPEG calls are to be handed on when the intercept state is defined
as on. The printer drivers will set the intercept state appropriately, both
to handle JPEG plot calls from an application and also (if appropriate) to
re-enable JPEG plotting by SpriteExtend, into internal Sprites. The
definition of the SWI is as follows:

    JPEG_PDriverIntercept

    Entry:
      R0 bit 0    intercept state; 0 = off, 1 = on
      R0 bits 1-31 reserved (set to 0)

    Exit:
      R0 bit 0 = previous intercept state
      All other registers preserved

Calling this SWI repeatedly with the same intercept state will not cause any
errors. The only JPEG calls which are affected by the intercept state are
the plotting calls; namely:

    JPEG_PlotScaled
    JPEG_PlotFileScaled
    JPEG_PlotTransformed
    JPEG_PlotFileTransformed

### 6.2 SWI PDriver_JPEGSWI

The new SWI, PDriver_JPEGSWI, will be added to the PDriver module. This is
to be called by SpriteExtend in order to hand on the JPEG plotting calls,
when JPEG printing intercept is active. The definition of the SWI is as
follows:

    PDriver_JPEGSWI

    Entry:
      R8 = reason code (JPEG SWI number modulo 64) - this should be a copy of
           the code passed in R11 to the SpriteExtend SWI handler
      all other registers as defined for the original JPEG SWI

    All registers preserved on exit

This definition is analogous to the PDriver_FontSWI interface. The only JPEG
calls which have to be passed through this call (when intercept is active)

are the plotting calls; namely:

```
JPEG_PlotScaled
JPEG_PlotFileScaled
JPEG_PlotTransformed
JPEG_PlotFileTransformed
```

## 7. Standards

The printer driver modules will continue to be implemented as Aasm files.


## 8. Data Interchange

The printing enhancements are required to operate via Sprite and JPEG SWI calls. These are defined in this document and in the document:

    1303/005/FS Black Video Software Functional Specification


## 9. Data Formats

No new data formats are introduced by the printing enhancements.


## 10. External Dependencies

Liaison will be required with the work on Black SpriteExtend, particularly for the provision of the JPEG interception mechanism.

The development tests will be made on a RISC PC. They will require the Black version of SpriteExtend (with JPEG intercept mechanism implemented), and a JPEG-capable application (eg. Black version of !Draw).


## 11. Acceptance Test

### 11.1 Platforms

The printing enhancements will be available to all supported printers. Code will be suitable for placement in ROM wherever necessary.

The printing enhancements will not operate under RISC OS 3.5 or earlier, since they require the SpriteExtend enhancements. However, efforts will be made to ease the possible retrofit of printing enhancements to earlier OS versions; for example by dealing sensibly with errors caused by non-implemented JPEG SWI's.


### 11.2 Performance

There will be no impact on latency from the printing enhancements. The speed of printing without using new features such as JPEG's will be unchanged.

The speed of printing a page which includes a JPEG image will be somewhat worse than the speed for an equivalent print with the image held a Sprite. The best that can be expected is that an additional time equal to the time for a decompression of the JPEG image by SpriteExtend will be required. As an indication, this is of the order of 3 seconds for a 768x512 pixel colour JPEG on a Risc PC (30 MHz ARM 610).

Printing a 768x512 pixel colour JPEG image from !Draw to a file on hard disc will take no more than 55 seconds on a 9 Mb Risc PC, under the following conditions:

```
!Draw scale:     1:1
Paper size:      A4 landscape
Printer driver:  Canon BJC 600
Colour quality:  16 million, large halftone
Resolution:      180x180 dpi
```

The same test for an equivalent 32 bit Sprite takes about 45 seconds.


### 11.3 Memory requirements

The total code-size increase is expected to be no more than 20K, affecting the modules PDriver, PDriverDP and PDriverPS, and including the new dumper module for the Epson Stylus Colour printer.

Workspace requirements during printing will not be significantly increased, except for PostScript printing of JPEG images. The latter will require an extra buffer of typically 32K.


## 12. Development Test Strategy

The printing enhancements will be tested where possible with images which exercise the supported new features:

    1) New format Sprites with 1 bpp masks
    2) New format Sprites with Palettes
    3) Sprites plotted with wide translation tables
    4) Sprites plotted directly from the palette
    5) Colour and grey-level JPEG's

These items will be tested with appropriate versions of !Paint or !Draw where possible. (Items 3 and 4 may require test code to invoke the required features.)

The tests will cover at least one example of each of the following target printers: monochrome bit image, colour bit image, monochrome PostScript and colour PostScript.

The tests will include printing with low memory remaining, looking for sensible messages and tidy job cancellation where appropriate.

Directed tests will be undertaken for the new SWI's, to ensure they change registers only as documented.


## 13. Product Organisation

The deliverables of the printer enhancements will be a new dumper module, and also new versions of the printer driver modules, which will replace

those in the standard printing support. The modules selected (excluding any bug fixes or new printer support handed to Black) are expected to be: PDriver, PDriverDP and PDriverPS.

The disposition of printing support to disc or ROM is defined by the related functional specification:

Black ROM and Disc Structures Functional Specification - 1303,006/FS

Note that, if !Printers is placed in ROM, some work may be needed to separate out configuration data, which must be updatable.