

# Technical Note TN1021

## Creating Off-Screen Bitmaps When Speed is Critical

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This Technote provides an example of creating an off-screen bitmap by hand, drawing to it, and then copying from it to the screen. Apple encourages the use of GWorlds for your off-screen needs. In some cases, however, creating your own off-screens can be beneficial. The resulting off-screen bitmaps can be used like a 1-bit GWorld, but with improved performance.

This technique is useful for the creation of regions when OpenRgn is not an option. For example, in making a region from a line, draw the line in an offscreen and call `BitMapToRegion` to convert the offscreen's bitmap to a region. These offscreen bitmaps can be also be substituted for pixmaps in routines such as `CopyMask`, where the mask is black and white, and speed is of great importance.

This Technote is written primarily for those involved in speed-critical projects, such as game developers and graphics applications developers.

### **Note:**

This technique for creating off-screen bitmaps is intended for black and white uses only. If your needs include only color ports, you should review Macintosh Technical Note [QD 13 - "Principia Off-Screen Graphics Environments."](#)

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## Drawing Off-Screen Bitmaps

The following is an example of creating and drawing to an off-screen bitmap, then copying from it to an on-screen window. The example is supplied in both a C and Pascal versions, and will work with all compilers.

### Creating an Off-Screen Bitmap in C

Let's look at a general purpose function to create an off-screen bitmap. This function creates the GrafPort on the heap. You can also create it on the stack and pass the uninitialized structure to a function similar to this one.

```
Boolean CreateOffscreenBitMap(GrafPtr *newOffscreen, Rect *inBounds)
{
    GrafPtr savePort;
    GrafPtr newPort;

    GetPort(&savePort);    /* need this to restore thePort after OpenPort */

    newPort = (GrafPtr) NewPtr(sizeof(GrafPort));    /* allocate the grafPort */
    if (MemError() != noErr)
        return false;    /* failed to allocate the off-screen port */
    /*
    the call to OpenPort does the following . . .
        allocates space for visRgn (set to screenBits.bounds) and
        clipRgn (set wide open)
        sets portBits to screenBits
        sets portRect to screenBits.bounds
        (See Inside Mac: Imaging with QuickDraw,
        pages 2-38 to 2-39)
        side effect: does a SetPort(&offScreen)
    */
    OpenPort(newPort);
    /* make bitmap the size of the bounds that caller supplied */
    newPort->portRect = *inBounds;
    newPort->portBits.bounds = *inBounds;
    RectRgn(newPort->clipRgn, inBounds);    /* avoid wide-open clipRgn, be safe */
    RectRgn(newPort->visRgn, inBounds);    /* in case newBounds is screen bounds */

    /* rowBytes is size of row, it must be rounded up to an even number of bytes */
    newPort->portBits.rowBytes = ((inBounds->right - inBounds->left +
                                   15) >> 4) << 1;

    /* number of bytes in BitMap is rowBytes * number of rows */
    /* see notes at end of Technote about using _NewHandle rather than _NewPtr*/
    newPort->portBits.baseAddr =
        NewPtr(newPort->portBits.rowBytes * (long) (inBounds->bottom
                                                    - inBounds->top));
    if (newPort->portBits.baseAddr == nil) { /* check to see if we had
        enough room for the bits */
        SetPort(savePort);
        ClosePort(newPort);    /* dump the visRgn and clipRgn */
        DisposPtr((Ptr)newPort); /* dump the GrafPort */
        return false;    /* tell caller we failed */
    }
    /* since the bits are just memory, let's clear them before we start*/
```

```
EraseRect(inBounds);          /* OpenPort did a SetPort(newPort) so we are ok */
*newOffscreen = newPort;
SetPort(savePort);
return true;                   /* tell caller we succeeded! */
}
```

## Eliminating an Off-Screen Bitmap in C

To eliminate an off-screen bitmap created by the previous function, use this function:

```
void DestroyOffscreenBitMap(GrafPtr oldOffscreen)
{
    ClosePort(oldOffscreen);          /* dump the visRgn and clipRgn */
    DisposPtr(oldOffscreen->portBits.baseAddr); /* dump the bits */
    DisposPtr((Ptr)oldOffscreen);     /* dump the port */
}
```

## Using an Off-Screen Bitmap in C

Now that you know how to create and destroy an off-screen bitmap, let's go through the motions of using one. First, let's define a few things to make the NewWindow call a little clearer.

```
#define kIsVisible true
#define kNoGoAway false
#define kNoWindowStorage 0L
#define kFrontWindow ((WindowPtr) -1L)
```

Here's the body of the test code:

```

main()
{
    char* myString = "\pThe EYE"; /* string to display */

    GrafPtr    offscreen;          /* our off-screen bitmap */
    Rect        ovalRect;          /* used for example drawing */
    Rect        myWBounds;         /* for creating window */
    Rect        OSRect;            /* portRect and bounds for off-screen bitmap*/
    WindowPtr   myWindow;

    InitToolbox();                 /* exercise for the reader */
    myWBounds = qd.screenBits.bounds; /* size of main screen */
    InsetRect(&myWBounds, 50,50); /* make it fit better */
    myWindow = NewWindow(kNoWindowStorage, &myWBounds, "\pTest Window",
                        kIsVisible, noGrowDocProc, kFrontWindow,
                        kNoGoAway, 0);
    if (!CreateOffscreenBitMap(&offscreen, &myWindow->portRect)) {
        SysBeep(1);
        ExitToShell();
    }
    /* Example drawing to our off-screen bitmap*/
    SetPort(offscreen);
    OSRect = offscreen->portRect; /* offscreen bitmap's local coordinate rect */
    ovalRect = OSRect;
    FillOval(&ovalRect, qd.black);
    InsetRect(&ovalRect, 1, 20);
    FillOval(&ovalRect, qd.white);
    InsetRect(&ovalRect, 40, 1);
    FillOval(&ovalRect, qd.black);
    MoveTo((ovalRect.left + ovalRect.right - StringWidth(myString)) >> 1,
           (ovalRect.top + ovalRect.bottom - 12) >> 1);
    TextMode(srcXor);
    DrawString(myString);

    /* copy from the off-screen bitmap to the on-screen window. Note
    that in this case the source and destination rects are the same size
    and both cover the entire area. These rects are allowed to be
    portions of the source and/or destination and do not have to be the
    same size. If they are not the same size then _CopyBits scales the
    image accordingly.
    */
    SetPort(myWindow);
    CopyBits(&offscreen->portBits, &(*myWindow).portBits,
            &offscreen->portRect, &(*myWindow).portRect, srcCopy, 0L);

    DestroyOffscreenBitMap(offscreen); /* dump the off-screen bitmap*/
    while (!Button()); /* give user a chance to see our work of art*/
}

```

## Creating an Off-Screen Bitmap in Pascal

Let's look at a general purpose function to create an off-screen bitmap. This function creates the GrafPort on the heap. You can also create it on the stack and pass the uninitialized structure to a function similar to this one.

```

FUNCTION CreateOffscreenBitMap(VAR newOffscreen:GrafPtr; inBounds:Rect)
    : BOOLEAN;

    savePort  : GrafPtr;
    newPort   : GrafPtr;

    GetPort(savePort);    {need this to restore thePort after OpenPort changes it}

    newPort := GrafPtr(NewPtr(sizeof(GrafPort)));    {allocate the GrafPort}
    IF MemError <> noErr THEN BEGIN
        CreateOffscreenBitMap := false;    {failed to allocate it}
        EXIT(CreateOffscreenBitMap);
    END;
    {
    the OpenPort call does the following . . .
    allocates space for visRgn (set to screenBits.bounds) and clipRgn
    (set wide open)
    sets portBits to screenBits
    sets portRect to screenBits.bounds
    (See Inside Mac: Imaging with QuickDraw, pages 2-38 to 2-39)
    side effect: does a SetPort(offScreen)
    }
    OpenPort(newPort);
    {make bitmap exactly the size of the bounds that caller supplied}
    WITH newPort^ DO BEGIN {portRect, clipRgn, and visRgn are in newPort}
        portRect := inBounds;
        RectRgn(clipRgn, inBounds);    {avoid wide-open clipRgn, to be safe}
        RectRgn(visRgn, inBounds);    {in case inBounds is > screen bounds}
    END;

    WITH newPort^.portBits DO BEGIN    {baseAddr, rowBytes and bounds are in newPort}
        bounds := inBounds;
        {rowBytes is size of row It must be rounded up to even number of bytes}
        rowBytes := ((inBounds.right - inBounds.left + 15) DIV 16) * 2;

        {number of bytes in BitMap is rowBytes * number of rows}
        {see note at end of Technical Note about using _NewHandle rather than _NewPtr}
        baseAddr := NewPtr(rowBytes * LONGINT(inBounds.bottom - inBounds.top));
    END;
    IF baseAddr == nil THEN BEGIN    {see if we had enough room for the bits}
        SetPort(savePort);
        ClosePort(newPort);    {dump the visRgn and clipRgn }
        DisposPtr(Ptr(newPort));    {dump the GrafPort}
        CreateOffscreenBitMap := false;
    END
    ELSE BEGIN
        {since the bits are just memory, let's erase them before we start }
        EraseRect(inBounds);    {OpenPort did a SetPort(newPort)}
        newOffscreen := newPort;
        SetPort(savePort);
        CreateOffscreenBitMap := true;
    END;

```

Here is the procedure to get rid of an off-screen bitmap created by the previous function:

```
PROCEDURE DestroyOffscreenBitMap(oldOffscreen : GrafPtr);
  ClosePort(oldOffscreen);           {dump the visRgn and clipRgn }
  DisposPtr(oldOffscreen^.portBits.baseAddr); {dump the bits }
  DisposPtr(Ptr(oldOffscreen));      {dump the port };
```

### Using an Off-Screen Bitmap: MPW Pascal

Now that you know how to create and destroy an off-screen bitmap, let's test one out. First, let's define a few things to make the NewWindow call a little clearer.

```
CONST
  kIsVisible    = true;
  kNoGoAway     = false;
  kMakeFrontWindow = -1;
  myString      = 'The EYE'; {string to display}
```

Here's the body of the test code:

```
VAR
  offscreen : GrafPtr; {our off-screen bitmap}
  ovalRect  : Rect;    {used for example drawing}
  myWBounds : Rect;    {for creating window}
  OSRect     : Rect;   {portRect and bounds for off-screen bitmap}
  myWindow   : WindowPtr;

  InitToolbox; {exercise left to the reader}

  myWBounds := screenBits.bounds; {size of main screen }
  InsetRect(myWBounds, 50,50);    {make it fit better }
  myWindow := NewWindow(NIL, myWBounds, 'Test Window', kIsVisible,
    noGrowDocProc, WindowPtr(kMakeFrontWindow), kNoGoAway, 0);

  IF NOT CreateOffscreenBitMap(offscreen,myWindow^.portRect) THEN BEGIN
    SysBeep(1);
    ExitToShell;
  END;

  {Example drawing to our off-screen bitmap }
  SetPort(offscreen);
  OSRect := offscreen^.portRect; {offscreen bitmap's local coordinate rect }
  ovalRect := OSRect;
  FillOval(ovalRect, black);
  InsetRect(ovalRect, 1, 20);
  FillOval(ovalRect, white);
  InsetRect(ovalRect, 40, 1);
  FillOval(ovalRect, black);
  WITH ovalRect DO
    MoveTo((left+right-StringWidth(myString)) DIV 2, (top+bottom-12) DIV 2);
  TextMode(srcXor);
  DrawString(myString);
```

```
{copy from the off-screen bitmap to the on-screen window.  Note
that in this case the source and destination rects are the same size
and both cover the entire area.  These rects are allowed to be
portions of the source and/or destination and do not have to be the
same size.  If they are not the same size then _CopyBits scales the
image accordingly}
```

```
SetPort(myWindow);
CopyBits(offscreen^.portBits, myWindow^.portBits,
        offscreen^.portRect, myWindow^.portRect, srcCopy, NIL);
```

```
DestroyOffscreenBitMap(offscreen);    {remove the evidence}
```

```
WHILE NOT Button DO;    {give user a chance to see the results}.
```

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## Summary

In the example code, the bits of the BitMap structure pointed to by the baseAddr field are allocated by a NewPtr call.

Keeping a large off-screen around for any length of time may lead to heap fragmentation. One alternative that lessens this problem is to get the bits via NewHandle, so that the Memory Manager can move them when necessary. To implement this approach, you need to keep the handle separate from the GrafPort (for example, in a structure that combines a GrafPort and a Handle). When using the off-screen bitmap, lock the handle and put the dereferenced handle into the baseAddr field. You can then unlock the handle when not using the off-screen bitmap.

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## References

[Inside Macintosh: Imaging with QuickDraw](#)

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