Internal True Color

INTERNAL TRUE COLOR™

Introduction

KYRO, featuring PowerVR technology, is a “display list renderer”. For details on the benefits of Tile Based Rendering see the KYRO whitepaper ‘Tile Based Rendering – The future of 3D Graphics’.

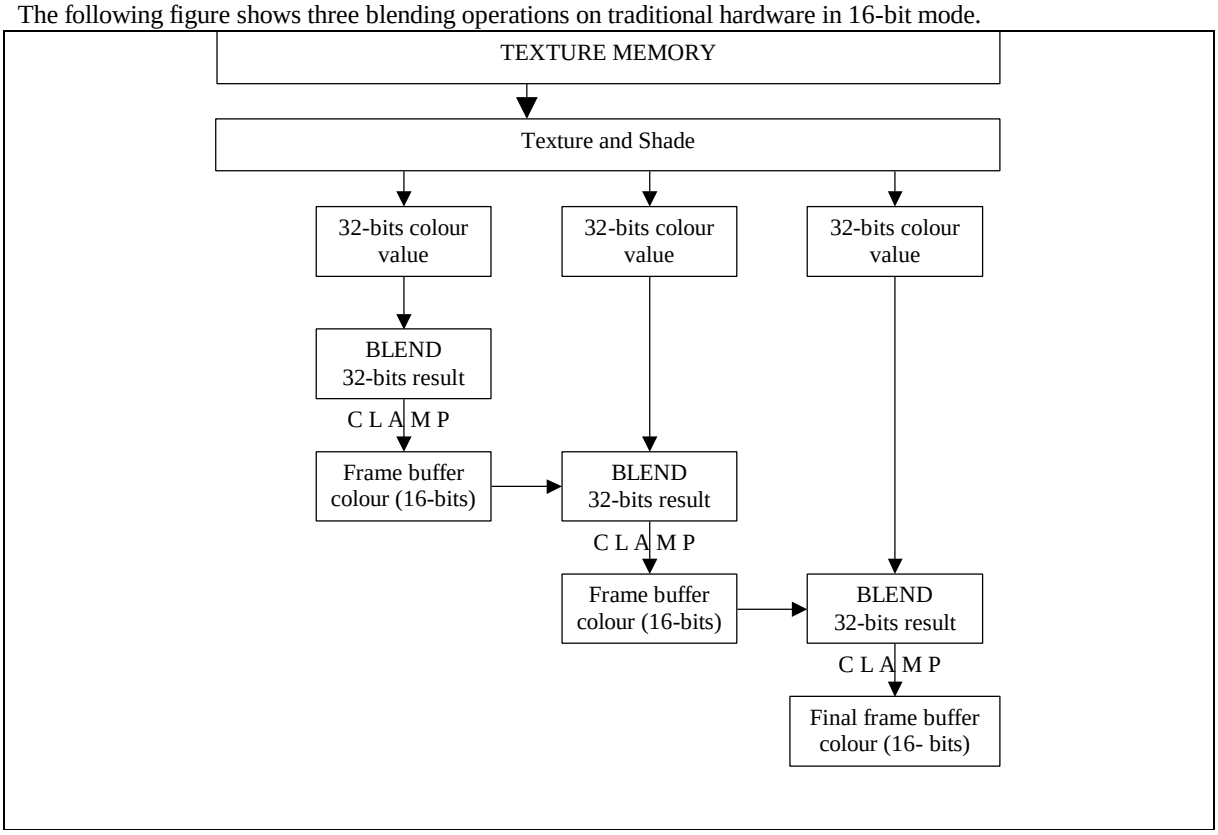
Since z-buffering and pixel blending are done entirely on-chip they can be performed at higher precision with no performance degradation. With KYRO all pixel blend operations are performed with 32-bit true color precision, irrespective of the number of translucent layers or the bit-depth of the framebuffer. This results in high image quality without performance loss in all frame buffer depths.

Traditional 3D systems are immediate mode and render polygons in the order that they are sent, with each polygon being written to memory upon completion. If subsequent polygons are blended with those already rendered e.g. to create an explosion effect, the previous polygon data must be read back into the chip, blended, and the result written back to memory. In addition to consuming significant memory bandwidth, this can also lead to serious image quality degradation when rendering in 16bpp modes. At 16 bpp each polygon is rendered internally at 32bpp, dithered to 16bpp when written to framebuffer and then read back in for use in further blend operations. This leads to cumulative image degradation as though a video tape copy has been used to make further copies. KYRO's Internal True Color™ performs all blending operations on all the pixels in each tile at the full 32bpp color resolution before performing a single high quality dither to 16bpp on output to the framebuffer if framebuffer is set at 16 bpp. In fact, KYRO's quality of rendering at 16bpp is the equal or better of many systems quality at 32bpp.

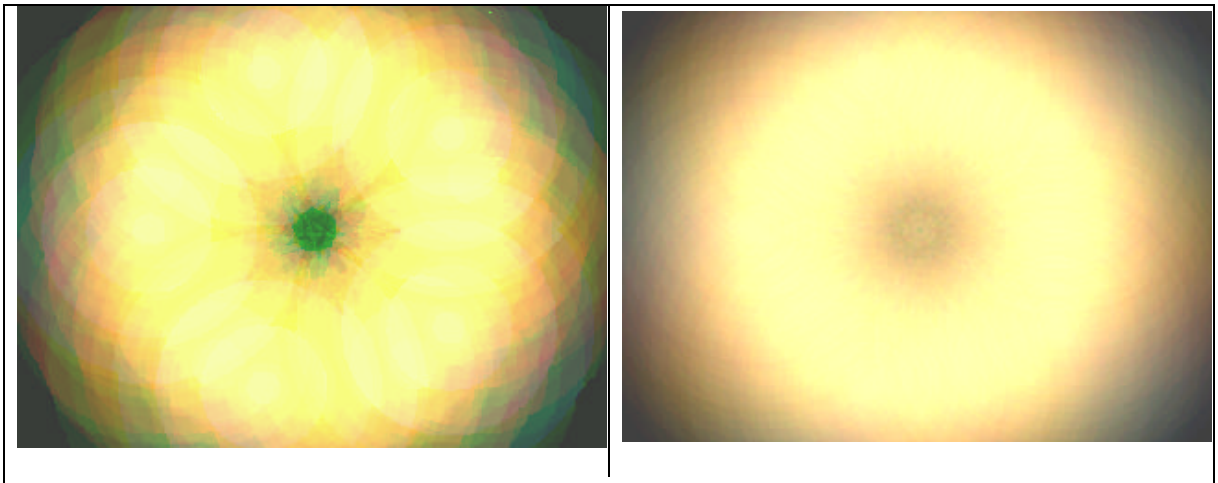
Traditional 3D Accelerators

During the traditional rendering process pixel data is maintained in the graphics pipeline at 32-bits per pixel, however once the polygon’s pixels are shaded and textured they are written to the framebuffer. If the framebuffer is 16-bit, the pixel data is truncated from 32-bits to 16-bits with a consequent loss in accuracy. If these pixels are subsequently used in a blend process (e.g. when creating an explosion effect against a background) the truncated data must be read back and used as one of the blend operands, leading to a loss in image fidelity. This loss of accuracy becomes quite noticeable when a number blending operations are performed.

The following figure shows three blending operations on traditional hardware in 16-bit mode.

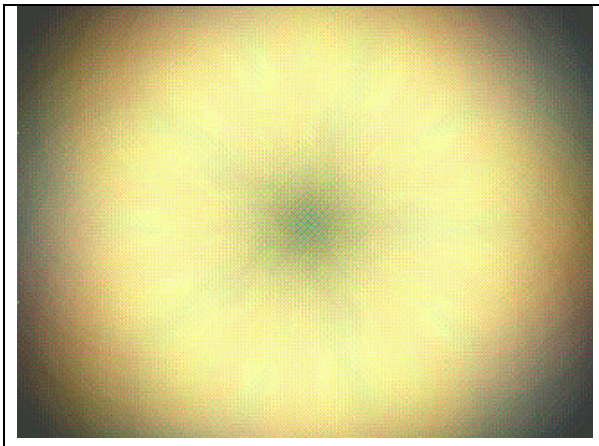


This results in visual artifacts:

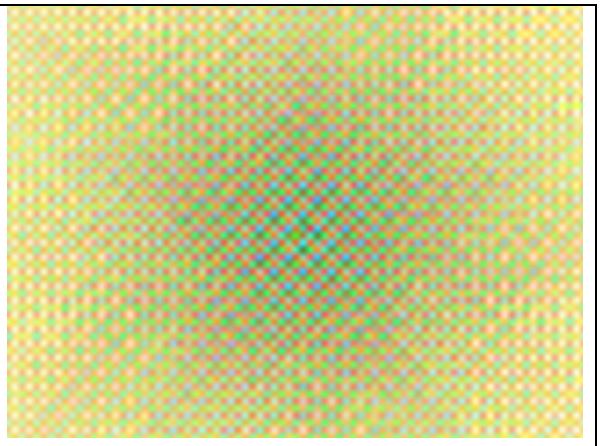


Blending to 16bpp **Blending to 32bpp**

Dithering is typically used to make the visual errors less noticeable. Dithering approximates a color by using a number of the other colors available and distributing the error across them. Dithering tends to reduce the obvious errors caused by color truncation but results in a grainier image and is also much less effective when the dithering process is repeated, as it must be when pixels written out are used again in a blend operation.



Blending to 16bpp with dithering



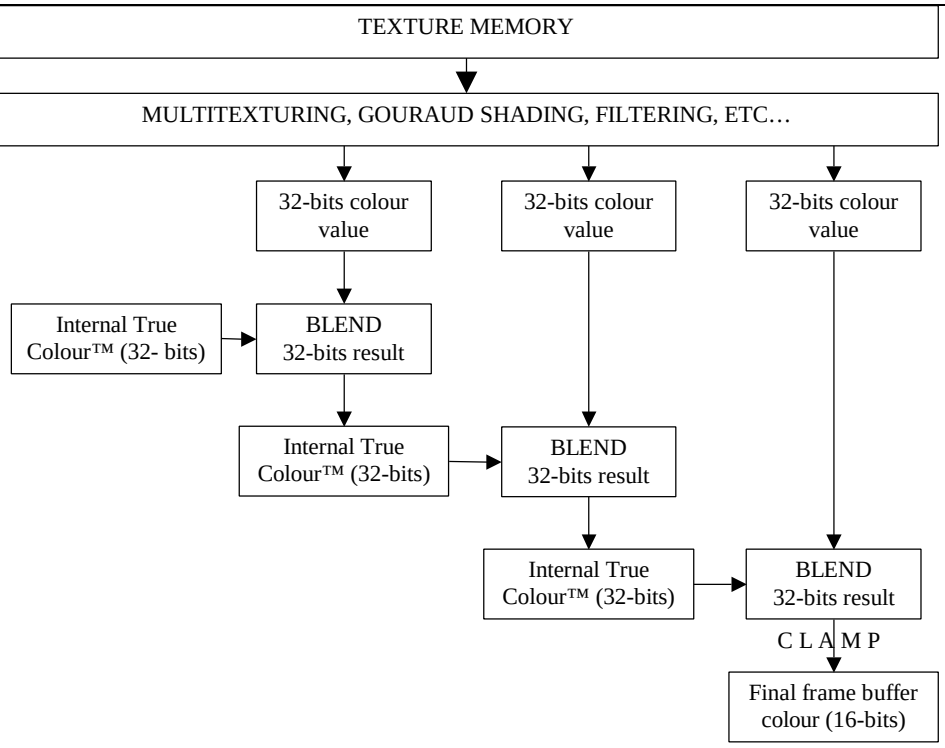
Zoomed in dither pattern

Finally, traditional 3D renderers **must** use a 32bpp framebuffer to achieve certain blending effects that use the Alpha (or translucency) component of triangles already rendered to screen. This is because the Alpha component is lost in the conversion from 32bpp to 16bpp.

KYRO

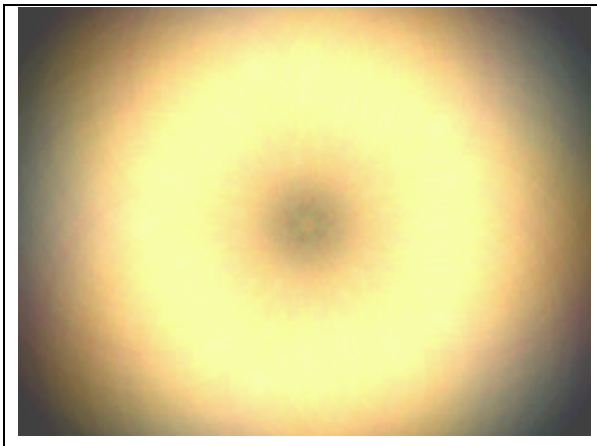
KYRO's Internal True Color™ means that all pixel operations for a scene are completed on chip at 32-bit true color bit depths, maintaining the best possible image quality irrespective of the number of image layers or framebuffer bit depth.
Internal True Color™ only truncates or dithers the data once for the final image as it goes to the 16-bit Frame Buffer. As all the operations are done in 32-bits this makes the final result look almost identical to traditional renderers using a 32-bit Frame Buffer. This allows the user to get excellent image quality and keep the 16-bit framebuffer performance benefits.

KYRO Framebuffer Access - Figure 1 shows a three layers blending process on a KYRO 16-bit framebuffer.

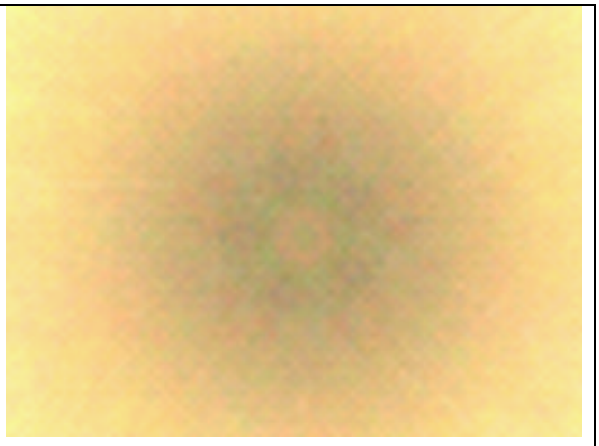


KYRO Framebuffer Access - Figure 1

On KYRO's Internal True Color™ no precision is lost during the blending process. Only the final color to be output to the framebuffer is truncated to a 16-bits value. This results in an image quality far superior than traditional 16-bits framebuffer renderers:



Internal True Colour™ Dithering 16-bit



Internal True Colour™ 16-bit Dithering x4

Summary

KYRO's Internal True Color™ boasts superior image quality when compared to traditional accelerators. In 16 bit framebuffers, KYRO avoids the color banding or grainy effects present on other hardware allowing the user to maintain the 16bpp performance in the game without sacrificing visual quality. Internal True Color™ blending also saves memory bandwidth (avoiding the multiple read/write frame buffer operations that traditional renderers have to perform) whatever the color depth, with the result that KYRO provides class-leading performance in 32bpp modes as well.

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