GBA Plus: A Dual-Mode FPGA Core Specification for the Analogue Pocket

Abstract

The Game Boy Advance (GBA) remains a landmark handheld console, yet existing FPGA re-implementations focus solely on cycle-accurate preservation. This paper introduces **GBA Plus**, an open specification for a dual-mode FPGA core targeting the Analogue Pocket. Legacy Mode reproduces the original GBA with full compatibility, while Plus Mode extends the architecture with a 1600×1440 framebuffer, expanded VRAM banks, additional DMA channels, and an optional 33 MHz CPU clock. By publishing this specification openly, we invite the FPGA and retro-computing communities to implement, evaluate, and extend the design.

1. Introduction

FPGAs have become central to digital preservation, enabling cycle-accurate re-implementations of legacy consoles. While projects such as MiSTer and Analogue Pocket cores emphasize fidelity, they rarely explore how modern FPGA resources can extend historical systems. GBA Plus addresses this gap by proposing a dual-mode architecture that balances preservation with innovation.

2. Background

- **GBA Architecture**: ARM7TDMI @ 16.78 MHz, 240×160 display, 96 KB VRAM, 4 DMA channels, 40 sprites/line.
- **FPGA Retro-Cores**: MiSTer, Analogue Pocket, Mega65 — all prioritize accuracy, with limited extension.
- **Opportunity**: Use FPGA headroom to enable new creative ecosystems while retaining backward compatibility.

3. Specification Highlights

- **Mode Detection**: ROM header scan for `"GBAPLUS\0"`.
- **Clocking**: 16.78 MHz (Legacy) or 33 MHz (Plus).
- **Video Pipelines**: Legacy scaler (240×160 → 1440×960) vs. Plus passthrough (1600×1440).
- **Memory Map**: 2 MB banked VRAM, extended palette/OAM, 6 DMA channels.
- **Sprite Engine**: FSM supporting 64 sprites/line with priority-aware blending.
- **Blending Modes**: Opaque, 50/50, 75/25.

4. Evaluation Plan

Although no implementation is provided here, the specification defines test methodology:

- Compatibility: commercial GBA test ROMs in Legacy Mode.
- Performance: DMA throughput, sprite stress tests at 33 MHz.
- Plus Demos: full-screen tilemap, 64-sprite blending.

5. Community Engagement

The specification is hosted on GitHub and archived on Zenodo with a DOI. Contributions are invited via issues and pull requests. This open model encourages collaborative development and reproducibility.

6. Conclusion

GBA Plus demonstrates how FPGA cores can serve both archival and creative purposes. By publishing the specification openly, we aim to catalyze community implementation and establish a blueprint for future dual-mode retro-console cores.