Garrett's Workshop
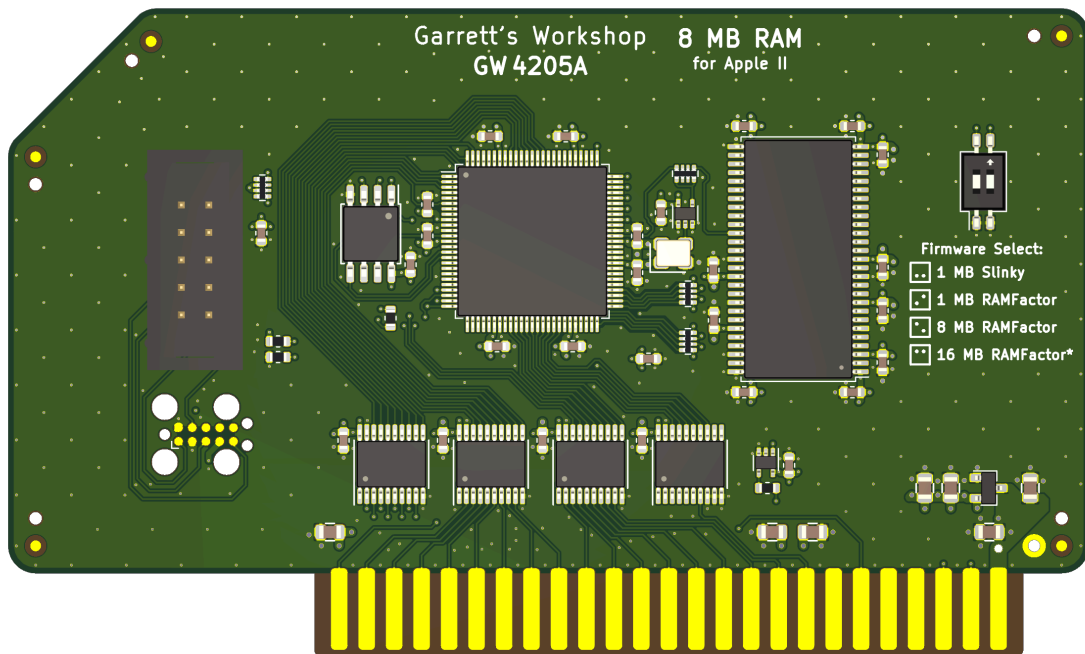
GW4205A "GR8RAM"

RAMFactor/Slinky-compatible RAM Expansion Card for Apple II series

User's Guide

GR8RAM was designed by Zane Kaminski and Garrett Fellers

Overview

GR8RAM (GW4205A) provides an Apple II-series machine with 8 MB of RAMFactor- or Slinky-type memory usable as a fast RAM disk or as RAM by supported applications.

Low-Power, SDRAM-Based Design

Thanks to a modern, low-power design, GR8RAM uses a maximum of 0.2 watts when idle (40 mA @ 5V) and 0.4 watts in active use (80 mA @ 5V). Unlike other Slinky- and RAMFactor-compatible RAM cards, which are built with vintage asynchronous DRAM chips, GR8RAM uses modern SDRAM. This design allows for low power consumption and improved reliability over other memory cards using 15+ year old chips.

Adjustable Capacity, Highly Compatible

GR8RAM's capacity and firmware can be changed to either emulate an original 1 MB Apple Slinky RAM card, a 1 MB Applied Engineering RAMFactor card, an 8 MB RAMFactor, or, experimentally, a 16 MB RAMFactor.

USB Firmware Update Capability

GR8RAM includes a USB firmware update adapter. The firmware update utility requires a 64-bit Intel or ARM PC running Windows 10 or later. Supported systems also include Windows 10 or later running under Apple Boot Camp or Parallels Desktop on both Intel and ARM Macs.

Ecologically Friendly, Gold-Plated PCB

GR8RAM is built with a lead-free, ENIG gold-plated, 4-layer PCB and is fully EU RoHS-compliant. All units are tested extensively before shipment, and only new parts are used to build GR8RAM.

Open-Source Design

GR8RAM's design is fully open-source. The schematics, board layouts, CPLD firmware, and utility software are all freely available for commercial and noncommercial use. To download the design files, visit the Garrett's Workshop GitHub page: https://github.com/garrettsworkshop

Compatibility Notes

RAMFactor and Slinky Firmware Selection

GR8RAM supports two separate firmware options and three separate RAM capacity settings. GR8RAM can be used with either the Apple "Slinky" Memory Expansion Card firmware or the Applied Engineering RAMFactor 1.4 firmware. The Slinky firmware supports only 1 MB capacity, but the RAMFactor firmware supports 1 MB, 8 MB, and 16 MB capacities. The firmware and RAM capacity settings are chosen using the Firmware Select switch on the right side of the card.

16 MB Capacity

The GR8RAM card has 16 MB of RAM onboard, so it can provide as much as 16 MB of RAMFactor memory. Most applications, however, do not work correctly with 16 MB of RAMFactor memory. We therefore recommend only using the 16 MB capacity setting with programs known to be compatible with 16 MB of RAMFactor memory.

Installation

Hardware

GR8RAM must be installed into one of the Apple II's peripheral card slots numbered 1 through 7. On machines with eight slots such as the Apple II and II+, using GR8RAM in slot 0 is not supported. Also ensure that GR8RAM is inserted in the correct orientation. Markings on the card indicate the side which is to face towards the rear of the Apple II.

Software

The RAMFactor and Slinky-type RAM provided by GR8RAM is automatically recognized by ProDOS as a RAM disk device. If a bootable copy of ProDOS is copied to the RAM disk, the card is bootable using a PR#n command. Select application such as AppleWorks can use RAMFactor or Slinky RAM directly; refer to these programs' documentation to determine compatibility.

RAM/Hardware Test

GR8RAM can be tested by the host Apple II system. To test a GR8RAM card, enter the machine language monitor from BASIC using the "CALL -151" command. Depending on the slot into which your GR8RAM is installed, a different command must be entered in the monitor to begin the test. In the monitor, type "C", followed by the slot number into which the GR8RAM is installed, followed by "AG", then press the enter key. For example, if your GR8RAM card is installed in slot 7, type "C70AG" and then press the enter key to begin the test. The RAM test will run indefinitely until it the computer is restarted or an error is detected.

Firmware Update

GR8RAM's firmware should only be updated as necessary to fix bugs or resolve compatibility issues. The latest firmware is available from our website, http://garrettsworkshop.com.

To install the firmware update, make sure your Apple II is off and your Windows PC is on. Connect the update adapter to your PC using a microUSB cable. Insert the update adapter (with USB cable still connected) into the update adapter connector on the GR8RAM card. Install the GR8RAM card into your Apple II, then launch the update program and follow the instructions. If your PC does not have the correct drivers for the update adapter, the update program may request administrator permission to install them.

After a firmware update is applied, you must power-cycle your Apple II before using your GR8RAM card.

Technical Specifications

Physical Dimensions

Parameter	Value
Height	59.817 mm $\pm$ 0.2 mm
Width	99.949 mm $\pm$ 0.2 mm
Thickness	< 10 mm
Weight	< 28 g

Electrical Specifications

Specifications are valid over temperature range of $0\ ^\circ\text{C} - 85\ ^\circ\text{C}$ and $V_{CC} = 4.5\ \text{V} - 5.5\ \text{V}$.

Parameter	Value	Conditions
$V_{IH_{min}}$	2.0 V	
$V_{IL_{max}}$	0.8 V	
$V_{OH_{min}}$	2.5 V	$I_{OH} = -4\ \text{mA}$
$V_{OL_{max}}$	0.5 V	$I_{OL} = 4\ \text{mA}$
Output Slew Rate	< 1.5 V/ns	
$I_{I_{max}}$	$\pm$ 20 µA	$V_{in} = 0\ \text{V} - 5.5\ \text{V}$
$C_{IO_{max}}$	20 pF	all other signals
	10 pF	all other signals
$I_{CC_{max}}$	120 mA	

Information for Developers: GR8RAM Signature

GR8RAM can be distinguished from other Slinky- and RamFactor-compatible RAM cards by the presence of the following signature bytes in the card's DEVSEL address space:

Location	Value
$C0X4	$47 (ASCII 'G', as in GW)
$C0X5	$05 (as in GW42**05**A)
$C0X6	$41 (ASCII 'A', as in GW4205**A**)

The firmware version is reported at address $C0X7. $10 corresponds to version 1.0. Subsequent versions will have higher numbers, e.g. $11 for 1.1, $1E for 1.14, $5E for 5.14, etc.

To avoid activating softswitches present on non-RamFactor/Slinky cards, a potential GR8RAM card should be first identified as a RamFactor/Slinky card by the presence of signature bytes in the IOSEL space before checking before checking $C0X4-$C0X6 in the DEVSEL space.

Information for Developers: Theory of Operation

The operation of GRRAM is somewhat different from that of other expansion RAM cards for the Apple IIgs. While other cards are implemented with asynchronous DRAM chips, GR8RAM uses modern synchronous DRAM (SDRAM). GR8RAM also does not use a parallel ROM chip but instead has a ROM-in-RAM architecture. In the GR8RAM, the driver firmware is loaded from a serial flash memory into a reserved area of RAM when the Apple II is booted up, rather than being read from a ROM while the computer is operating.