



**VT82C693A**

**Apollo Pro133**

**66 / 100 / 133 MHz**

**Single-Chip Slot-1 / Socket-370 North Bridge  
for Desktop and Mobile PC Systems**

**with AGP 2x and PCI**

**plus Advanced ECC Memory Controller  
supporting SDRAM, VCM, EDO, and FPG DRAM**

Revision 1.0  
July 22, 1999

**VIA TECHNOLOGIES, INC.**

## Copyright Notice:

Copyright © 1997, 1998, 1999 VIA Technologies Incorporated. Printed in the United States. ALL RIGHTS RESERVED.

No part of this document may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language, in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual or otherwise without the prior written permission of VIA Technologies Incorporated.

VT8501, VT82C585, VT82C586B, VT82C587, VT82C590, VT82C595, VT82C596B, VT82C597, VT82C598, VT82C680, VT82C685, VT82C686B, VT82C687, VT82C691, VT82C692, VT82C693, VT82C693A, VT82C694, VT82C694A, VT82C694X, VT8601, Mobile South, Super South, Apollo VP, Apollo VPX, Apollo VP2, Apollo VP3, Apollo MVP3, Apollo MVP4, Apollo P6, Apollo Pro, Apollo Pro133, Apollo Pro133A and Apollo ProMedia may only be used to identify products of VIA Technologies.

PS/2™ is a registered trademark of International Business Machines Corp.

Pentium™, Celeron™, MMX™, and Intel™ are registered trademarks of Intel Corp.

Cyrix6x86™ is a registered trademark of Cyrix Corp.

AMD5x86™, AMD6x86™, AMD-K5™, and AMD-K6™ are registered trademarks of Advanced Micro Devices Corp.

Windows 95™ and Plug and Play™ are registered trademarks of Microsoft Corp.

PCI™ is a registered trademark of the PCI Special Interest Group.

VESA™ is a trademark of the Video Electronics Standards Association.

All trademarks are the properties of their respective owners.

## Disclaimer Notice:

No license is granted, implied or otherwise, under any patent or patent rights of VIA Technologies. VIA Technologies makes no warranties, implied or otherwise, in regard to this document and to the products described in this document. The information provided by this document is believed to be accurate and reliable to the publication date of this document. However, VIA Technologies assumes no responsibility for any errors in this document. Furthermore, VIA Technologies assumes no responsibility for the use or misuse of the information in this document and for any patent infringements that may arise from the use of this document. The information and product specifications within this document are subject to change at any time, without notice and without obligation to notify any person of such change.

## Offices:

### USA Office:

1045 Mission Court  
Fremont, CA 94539  
USA  
Tel: (510) 683-3300  
Fax: (510) 683-3301

### Taipei Office:

8<sup>th</sup> Floor, No. 533  
Chung-Cheng Road, Hsin-Tien  
Taipei, Taiwan ROC  
Tel: (886-2) 2218-5452  
Fax: (886-2) 2218-5453

## Online Services:

Home Page: <http://www.via.com.tw> (Taiwan) –or- <http://www.viatech.com> (USA)

FTP Server: <ftp.via.com.tw> (Taiwan)

BBS: 886-2-2185208

## REVISION HISTORY

Document Release	Date	Revision	Initials
0.1	12/9/98	Initial internal release as VT82C694	EC
0.2	12/31/98	Changed part number to VT82C693A Fixed definition of strapping option on MAB8# Fixed pin numbers of RESET#, PREQ#, and REQ0# Updated register definitions: Device 0 Rx68[1-0], Rx69[5], Rx50[3-1], Rx53[5], Rx69[6-5,1], Rx7A[4-1], RxF8-F9, RxAD, Device 1 Rx2 (Device ID=8691), Rx4[5], Rx41[0], Rx42[0]	DH
0.21	1/6/99	Fixed minor typo in AGP feature bullets	DH
0.22	1/13/99	Fixed placement diagram in pin descriptions	DH
0.3	4/1/99	Fixed typo in pinout section footer Changed pin AC4 from SUSCLK to PCKRUN# Added DCLKRD function to pin AB22 (MAA14) Updated function 0 registers Rx50[5,3-1], 51[5,2-1], 53[5-3, 67-64[2], 69[7-5,1], 6B[5,3-1], 6C[4], 73[4], 76[7], 7A[3], AD[4], F9, FC	DH
0.4	5/26/99	Updated & fixed typos in feature bullets and intro Modified device 0 Rx6[6], 8 default, 68[1-0], 69[7-6], 70[3], 72[7], 76[5-4], A7 readback value, FC[1-0], FD[2-0] Modified device 1 Rx2-3 and added 1B and F0-F7	DH
0.5	7/13/99	Added SDRAM AC Timing Fixed AGPREF pin description	DH
0.51	7/15/99	Fixed CPURST# and CPURSTD# pin descriptions and pin directions Added Host CPU Interface AC Timing	DH
1.0	7/22/99	Product announced so "NDA Req'd" watermark removed (content unchanged)	DH

# TABLE OF CONTENTS

<b>REVISION HISTORY</b> .....	<b>I</b>
<b>TABLE OF CONTENTS</b> .....	<b>II</b>
<b>LIST OF FIGURES</b> .....	<b>III</b>
<b>LIST OF TABLES</b> .....	<b>IV</b>
<b>APOLLO PRO133</b> .....	<b>1</b>
<b>OVERVIEW</b> .....	<b>4</b>
<b>PINOUTS</b> .....	<b>6</b>
<b>PIN DESCRIPTIONS</b> .....	<b>9</b>
<b>REGISTERS</b> .....	<b>17</b>
<b>REGISTER OVERVIEW</b> .....	<b>17</b>
<b>MISCELLANEOUS I/O</b> .....	<b>20</b>
<b>CONFIGURATION SPACE I/O</b> .....	<b>20</b>
<b>REGISTER DESCRIPTIONS</b> .....	<b>21</b>
<b>Device 0 Header Registers - Host Bridge</b> .....	<b>21</b>
<b>Device 0 Configuration Registers - Host Bridge</b> .....	<b>23</b>
Host CPU Control.....	23
DRAM Control .....	25
PCI Bus Control.....	32
GART / Graphics Aperture Control .....	36
AGP Control .....	38
<b>Device 1 Header Registers - PCI-to-PCI Bridge</b> .....	<b>40</b>
<b>Device 1 Configuration Registers - PCI-to-PCI Bridge</b> .....	<b>42</b>
AGP Bus Control .....	42
<b>ELECTRICAL SPECIFICATIONS</b> .....	<b>44</b>
<b>ABSOLUTE MAXIMUM RATINGS</b> .....	<b>44</b>
<b>DC CHARACTERISTICS</b> .....	<b>44</b>
<b>AC TIMING SPECIFICATIONS</b> .....	<b>44</b>
<b>MECHANICAL SPECIFICATIONS</b> .....	<b>46</b>

## LIST OF FIGURES

FIGURE 1. APOLLO PRO133 SYSTEM BLOCK DIAGRAM USING THE VT82C596B MOBILE SOUTH BRIDGE .....	4
FIGURE 2. <u>VT82C693A</u> BALL DIAGRAM (TOP VIEW).....	6
FIGURE 3. <u>VT82C693A</u> PIN LIST ( <u>NUMERICAL ORDER</u> ) .....	7
FIGURE 4. <u>VT82C693A</u> PIN LIST ( <u>ALPHABETICAL ORDER</u> ).....	8
FIGURE 5. GRAPHICS APERTURE ADDRESS TRANSLATION .....	36
FIGURE 6. MECHANICAL SPECIFICATIONS - 492-PIN BALL GRID ARRAY PACKAGE .....	46

## LIST OF TABLES

TABLE 1. VT82C693A PIN DESCRIPTIONS.....	9
TABLE 2. VT82C693A REGISTERS .....	17
TABLE 3. RX50 PROGRAMMING CONSTRAINTS.....	23
TABLE 4. SYSTEM MEMORY MAP .....	25
TABLE 5. MEMORY ADDRESS MAPPING TABLE .....	25
TABLE 6. VGA/MDA MEMORY/IO REDIRECTION.....	42
TABLE 7. AC TIMING MIN / MAX CONDITIONS.....	44
TABLE 8. AC CHARACTERISTICS – HOST CPU INTERFACE TIMING .....	45
TABLE 9. AC CHARACTERISTICS – SDRAM TIMING .....	45

# VIA VT82C693A APOLLO PRO133

66 / 100 / 133 MHz

Single-Chip Slot-1 / Socket-370 North Bridge  
for Desktop and Mobile PC Systems  
with AGP 2x and PCI  
plus Advanced ECC Memory Controller  
supporting SDRAM, VCM, EDO, and FPG

- **AGP / PCI / ISA Mobile and Deep Green PC Ready**

- GTL+ compliant host bus supports write-combine cycles
- Supports separately powered 3.3V (5V tolerant) interface to system memory, AGP, and PCI bus
- Modular power management and clock control for mobile system applications
- Combine with VIA VT82C596B south bridge chip for state-of-the-art system power management

- **High Integration**

- Single chip implementation for 64-bit Slot-1/Socket-370 CPU, 64-bit system memory, 32-bit PCI and 32-bit AGP interfaces
- **Apollo Pro133** Chipset: **VT82C693A** system controller and **VT82C596B** PCI to ISA bridge
- Chipset includes UltraDMA-33/66 EIDE, USB, and Keyboard / PS2-Mouse Interfaces plus RTC / CMOS on chip

- **High Performance CPU Interface**

- Supports Slot-1 and Socket-370 (Intel Pentium II™, Pentium III™ and Celeron™) processors
- 66 / 100 / 133 MHz CPU Front Side Bus (FSB)
- Built-in PLL (Phase Lock Loop) circuitry for optimal skew control within and between clocking regions
- Five outstanding transactions (four In-Order Queue (IOQ) plus one input latch)
- Supports WC (Write Combining) cycles
- Dynamic deferred transaction support
- Sleep mode support
- System management interrupt, memory remap and STPCLK mechanism

## • Full Featured Accelerated Graphics Port (AGP) Controller

- Synchronous and pseudo-synchronous with the host CPU bus with optimal skew control

<u>PCI</u>	<u>AGP</u>	<u>CPU</u>	<u>Mode</u>
33 MHz	66 MHz	133 MHz	4x synchronous
33 MHz	66 MHz	100 MHz	3x synchronous
33 MHz	66 MHz	66 MHz	2x synchronous

- AGP v2.0 compliant
- Supports SideBand Addressing (SBA) mode (non-multiplexed address / data)
- Supports 133MHz 2X mode for AD and SBA signaling
- Pipelined split-transaction long-burst transfers up to 533 MB/sec
- Eight level read request queue
- Four level posted-write request queue
- Thirty-two level (quadwords) read data FIFO (256 bytes)
- Sixteen level (quadwords) write data FIFO (128 bytes)
- Intelligent request reordering for maximum AGP bus utilization
- Supports Flush/Fence commands
- Graphics Address Relocation Table (GART)
  - One level TLB structure
  - Sixteen entry fully associative page table
  - LRU replacement scheme
  - Independent GART lookup control for host / AGP / PCI master accesses
- Windows 95 OSR-2 VXD and integrated Windows 98 / NT5 miniport driver support

## • Concurrent PCI Bus Controller

- PCI buses are synchronous / pseudo-synchronous to host CPU bus
- 33 MHz operation on the primary PCI bus
- 66 MHz PCI operation on the AGP bus
- PCI-to-PCI bridge configuration on the 66MHz PCI bus
- Supports up to five PCI masters
- Peer concurrency
- Concurrent multiple PCI master transactions; i.e., allow PCI masters from both PCI buses active at the same time
- Zero wait state PCI master and slave burst transfer rate
- PCI to system memory data streaming up to 132Mbyte/sec
- PCI master snoop ahead and snoop filtering
- Two lines of CPU to PCI posted write buffers
- Byte merging in the write buffers to reduce the number of PCI cycles and to create further PCI bursting possibilities
- Enhanced PCI command optimization (MRL, MRM, MWI, etc.)
- Forty-eight levels (double-words) of post write buffers from PCI masters to DRAM
- Sixteen levels (double-words) of prefetch buffers from DRAM for access by PCI masters
- Delay transaction from PCI master accessing DRAM
- Read caching for PCI master reading DRAM
- Transaction timer for fair arbitration between PCI masters (granularity of two PCI clocks)
- Symmetric arbitration between Host/PCI bus for optimized system performance
- Complete steerable PCI interrupts
- PCI-2.2 compliant, 32 bit 3.3V PCI interface with 5V tolerant inputs



- **Advanced High-Performance DRAM Controller**

- DRAM interface synchronous with host CPU (66/100/133 MHz) or AGP (66MHz) for most flexible configuration
- DRAM interface may be faster than CPU by 33 MHz to allow use of PC100 with 66 MHz Celeron or use of PC133 with 100 MHz Pentium II or Pentium III
- DRAM interface may be slower than CPU by 33 MHz to allow use of older memory modules with a new CPU
- Concurrent CPU, AGP, and PCI access
- Supports FP, EDO, SDRAM and VCM SDRAM memory types
- Different DRAM types may be used in mixed combinations
- Different DRAM timing for each bank
- Dynamic Clock Enable (CKE) control for SDRAM power reduction in high speed systems
- Mixed 1M / 2M / 4M / 8M / 16M / 32MxN DRAMs
- 8 banks up to 1.5 GB DRAMs (256Mb DRAM technology)
- Flexible row and column addresses
- 64-bit data width only
- 3.3V DRAM interface with 5V-tolerant inputs
- Programmable I/O drive capability for MA, command, and MD signals
- Dual copies of MA signals for improved drive
- Optional bank-by-bank ECC (single-bit error correction and multi-bit error detection) or EC (error checking only) for DRAM integrity
- Two-bank interleaving for 16Mbit SDRAM support
- Two-bank and four bank interleaving for 64Mbit SDRAM support
- Supports maximum 8-bank interleave (i.e., 8 pages open simultaneously); banks are allocated based on LRU
- Independent SDRAM control for each bank
- Seamless DRAM command scheduling for maximum DRAM bus utilization (e.g., precharge other banks while accessing the current bank)
- Four cache lines (16 quadwords) of CPU to DRAM write buffers
- Four cache lines of CPU to DRAM read prefetch buffers
- Read around write capability for non-stalled CPU read
- Speculative DRAM read before snoop result
- Burst read and write operation
- x-2-2-2-2-2-2 back-to-back accesses for EDO DRAM from CPU or from DRAM controller
- x-1-1-1-1-1-1 back-to-back accesses for SDRAM
- BIOS shadow at 16KB increment
- Decoupled and burst DRAM refresh with staggered RAS timing
- CAS before RAS or self refresh

- **Advanced System Power Management Support**

- Dynamic power down of SDRAM (CKE)
- Independent clock stop controls for CPU / SDRAM, AGP, and PCI bus
- PCI and AGP bus clock run and clock generator control
- VTT suspend power plane preserves memory data
- Suspend-to-DRAM and Self-Refresh operation
- EDO self-refresh and SDRAM self-refresh power down
- 8 bytes of BIOS scratch registers
- Low-leakage I/O pads

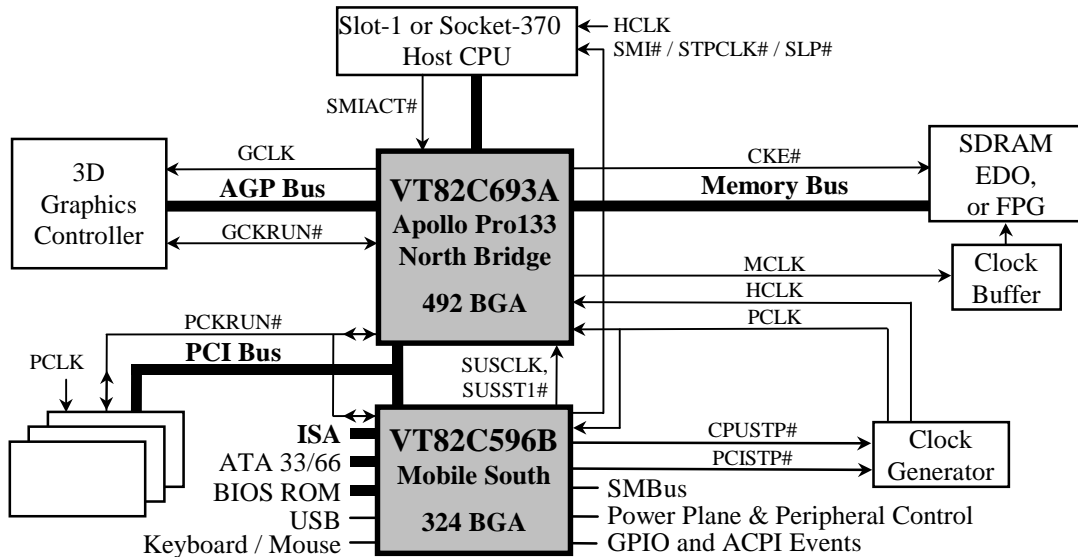
- **Built-in NAND-tree pin scan test capability**

- **3.3V, 0.35um, high speed / low power CMOS process**

- **35 x 35 mm, 492 pin BGA Package**

## OVERVIEW

The *Apollo Pro133* is a high performance, cost-effective and energy efficient chip set for the implementation of AGP / PCI / ISA desktop personal computer systems from 66 MHz, 100 MHz and 133 MHz based on 64-bit Socket-370 and Slot-1 (Intel Pentium-II, Pentium III, and Celeron) super-scalar processors.



**Figure 1. Apollo Pro133 System Block Diagram Using the VT82C596B Mobile South Bridge**

The Apollo Pro133 chip set consists of the VT82C693A system controller (492 pin BGA) and the VT82C596B PCI to ISA bridge (324 pin BGA). The system controller provides superior performance between the CPU, DRAM, AGP bus, and PCI bus with pipelined, burst, and concurrent operation.

The VT82C693A supports eight banks of DRAMs up to 1.5GB. The DRAM controller supports standard Fast Page Mode (FPM) DRAM, EDO-DRAM, Synchronous DRAM (SDRAM) and Virtual Channel SDRAM (VC SDRAM), in a flexible mix / match manner. The Synchronous DRAM interface allows zero wait state bursting between the DRAM and the data buffers at 66/100/133 MHz. The eight banks of DRAM can be composed of an arbitrary mixture of 1M / 2M / 4M / 8M / 16M / 32MxN DRAMs. The DRAM controller also supports optional ECC (single-bit error correction and multi-bit detection) or EC (error checking) capability separately selectable on a bank-by-bank basis. The DRAM controller can run at either the host CPU bus frequency (66 /100 /133 MHz) or at the AGP bus frequency (66 MHz) with built-in PLL timing control.

The VT82C693A system controller also supports full AGP v2.0 capability for maximum bus utilization including 2x mode transfers, SBA (SideBand Addressing), Flush/Fence commands, and pipelined grants. An eight level request queue plus a four level post-write request queue with thirty-two and sixteen quadwords of read and write data FIFO's respectively are included for deep pipelined and split AGP transactions. A single-level GART TLB with 16 full associative entries and flexible CPU / AGP / PCI remapping control is also provided for operation under protected mode operating environments. Both Windows-95 VXD and Windows-98 / NT5 miniport drivers are supported for interoperability with major AGP-based 3D and DVD-capable multimedia accelerators.

The VT82C693A supports two 32-bit 3.3 / 5V system buses (one AGP and one PCI) that are synchronous / pseudo-synchronous to the CPU bus. The chip also contains a built-in bus-to-bus bridge to allow simultaneous concurrent operations on each bus. Five levels (doublewords) of post write buffers are included to allow for concurrent CPU and PCI operation. For PCI master operation, forty-eight levels (doublewords) of post write buffers and sixteen levels (doublewords) of prefetch buffers are included for concurrent PCI bus and DRAM/cache accesses. The chip also supports enhanced PCI bus commands such as Memory-Read-Line, Memory-Read-Multiple and Memory-Write-Invalid commands to minimize snoop overhead. In addition, advanced features are supported such as snoop ahead, snoop filtering, L1 write-back forward to PCI master, and L1 write-back merged with PCI post

write buffers to minimize PCI master read latency and DRAM utilization. Delay transaction and read caching mechanisms are also implemented for further improvement of overall system performance.

The 324-pin Ball Grid Array VT82C596B PCI to ISA bridge supports four levels (doublewords) of line buffers, type F DMA transfers and delay transaction to allow efficient PCI bus utilization and (PCI-2.2 compliant). The VT82C596B also includes an integrated keyboard controller with PS2 mouse support, integrated DS12885 style real time clock with extended 256 byte CMOS RAM, integrated master mode enhanced IDE controller with full scatter / gather capability and extension to UltraDMA-33/66 for 33/66 MB/sec transfer rate, integrated USB interface with root hub and two function ports with built-in physical layer transceivers, Distributed DMA support, and OnNow / ACPI compliant advanced configuration and power management interface.

For sophisticated power management, the Apollo Pro133 provides independent clock stop control for the CPU / SDRAM, PCI, and AGP buses and Dynamic CKE control for powering down of the SDRAM. A separate suspend-well plane is implemented for the SDRAM control signals for Suspend-to-DRAM operation. Coupled with the VT82C596B south bridge chip, a complete power conscious PC main board can be implemented with no external TTLs.

The Apollo Pro133 chipset is ideal for high performance, high quality, high energy efficient and high integration desktop and notebook AGP / PCI / ISA computer systems.