AP-662

APPLICATION NOTE

Migrating from Series 2+ to Value Series 100 PC Cards

— *for Systems Using Basic 28F008SA Command Set Programming Model*

June 1998

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CONTENTS

REVISION HISTORY

Date of Revision	Version	Description
6/05/98	-001	Original version

1.0 INTRODUCTION

This document is an application note which describes the design considerations for migrating systems from the Intel Series 2+ PC Card to the Intel Values Series 100 PC Card for systems employing the 28F008SA command set. This application note is intended to supplement Intel application note *AP-622 Upgrade to the Value Series 100 Flash Memory Card* (order number 292177). The information presented herein does not relate to Series 2+ systems using the enhanced 28F016SA command set. In addition to the Series 2+ to Value Series 100 card conversion information of this application note, information on card migration in general is available from Intel application brief *AB-56 Preparing for the Next Generation Intel Flash Memory Card* (order number 292136).

2.0 MIGRATION CONSIDERATIONS

There are different aspects of system and card design which must be considered in migrating systems from Series 2+ cards to Values Series 100 cards. The design aspects which must be considered are:

a. card hardware,

b. system software, and

c. system performance

Table 1 lists both the system and card design differences between the Series 2+ card and Value Series 100 card which may affect the interchange of the two cards in a system. The differences listed are organized by card hardware, system software and system performance.

2.1 Card Hardware

Value Series 100 cards are architected to minimize card component count. A Value Series 100 card consists of the following three basic items:

a. a set of memory components comprising the card's memory array,

b. a very limited amount of chip select logic to select the memory components for a card memory cycle and

c. a single logic gate for generating the card's RDY/BSY# output from the individual ready signals (RY/BY#) generated by the card's memory components.

A Value Series 100 PC Card does not have the capability to function in all of the PCMCIA word-wide, byte-wide, and odd-byte modes for either reads or writes to common or attribute memory. Furthermore, with a Value Series 100 card attribute memory space is not separately decoded from common memory space; therefore, PC Card attribute memory cycles will access the card's common memory just as if the cycles were common memory cycles.

For a Value Series 100 PC Card, the Card Information Structure (CIS) must be stored in the flash memory array comprising PC Card common memory as there is no CIS-dedicated memory to allow for CIS storage in an isolated attribute memory area.

Like a Series 2+ card, a Value Series 100 card operates with V_{CC} power supply voltage at +5 V. However, unlike a Series 2+ card, a Value Series 100 card offers neither 3.3 V V_{CC} operation nor 12 V V_{PP} programming, and ignores the card's V_{PP} programming voltage input as the card's programming power is taken directly from the V_{CC} supply input. In an application, this difference between the two cards would be of serious concern when the system has been designed for V_{CC} at 3.3 V and not provide 5 V V_{CC} power.

The Series 2+ and Values Series 100 cards have more substantial card differences than in their programming voltage options. Unlike the Value Series 100 card, the Series 2+ card

a. contains substantial hardware provisions in addition to the card memory array. These provisions include an ASIC device and circuitry for V_{CC} detection and V_{PP} generation;

b. provides a selection of various V_{PP} programming and V_{CC} supply voltages;

c. offers a true user-enabled "deep-sleep" power-saving mode (without requiring the card's RST input to be activated). The Value Series 100 card's deep-sleep power-saving mode, on the other hand, requires that the card's RST input be activated to enact a card reset;

d. has the capability to function in any of the PCMCIA word-wide, byte-wise, and odd-byte modes for either reads or writes to common or attribute memory.

Furthermore, there are significant differences in the content of the flash memory array. The Series 2+ card supports memory densities of 4, 8, 20 and 40 Mbytes. The Value Series 100 card, on the other hand, supports

memory densities of 2, 4, 8, and 16 Mbytes. The Series 2+ card's flash memory array consists of 28F016SA memory components while the Value Series 100 card employs 28F008S5 components (2-Mbyte card) or 28F016S5 memory components (4-, 8- and 16-Mbyte cards).

For a Series 2+ PC Card the user can use an Intel-provided CIS stored as an isolated area of attribute memory within the card's ASIC or provide his own CIS by pre-programming the CIS in the card's flash memory array comprising PC Card common memory.

Series 2+ card hardware offers a wide selection of features which are not provided by the streamlined Value Series 100 card. PC Card users wishing to migrate systems from Series 2+ card usage to Value Series 100 card usage must rely on the basic capability to read and write memory without using any hardware provisions specific to the Series 2+ card.

2.2 System Software

When a system migrates from a Series 2+ card to a Value Series 100 card, system software will encounter differences in memory component ID codes and CIS composition, but will not encounter differences in memory component density or geometry. The CIS storage location may vary between the two cards. Furthermore, where it is only optional for a Series 2+ card (which can store a CIS in an attribute memory area outside of the flash memory), system software must reserve the first erase block of the flash memory array on a Value Series 100 card for CIS storage.

The flash memory array on Value Series 100 cards with memory densities at or above 4 Mbytes are structured with 16-Mbit 28F016S5 memory components (while the 2-Mbyte Value Series 100 card employs a pair of 8-Mbit 28F008S5 memory components). Series 2+ cards use 16-Mbit 28F016SA memory components for all card memory densities. Those Series 2+ cards which are available in the same card memory densities as Value Series 100 cards use components with the same geometry (16 Mbits–2 Kbytes x8) and erase block size (64 Kbytes) as the Value Series 100 cards having the same card memory density. Therefore, in migrating from the Series 2+ card to the Value Series 100 card there should be no difference in Series 2+ or Value Series 100 software due to a difference in memory component geometry.

The CIS for a Value Series 100 card of a certain memory density would differ from a Series 2+ card of the same memory density as follows:

a. The Series 2+ CIS contains tuples CISTPL_DEVICE_OC, CISTPL_DEVICE_A, CISTPL_DEVICE_OA, CISTPL_CONF and various CISTPL_CFTABLE_ENTRY tuples, while the Value Series 100 CIS does not contain these tuples;

b. Tuple CISTPL_JEDEC_C information is different between the two card families because the memory components identified by the tuple are different;

c. Tuple CISTPL_VERS1 information is different between the two card families because the card family and copyright date information identified by the tuple is different;

System software must react correctly to the differences between a Series 2+ card and Value Series 100 card in CIS content.

As the memory component ID information (accessed through the memory command "Read Identifier Codes") is different for a 28F016SA and 28F016S5 component, system software dependent on component ID must react correctly to the ID of either component. As the ID of the 28F016S5 was unknown at the time the Series 2+ card was designed into the system, most likely system software would have to be altered to process the 28F016S5 component ID.

2.3 System Performance

Differences exist in the electrical characteristics of Series 2+ and Values Series 100 cards. The differences most likely to affect an application migrating from a Series 2+ card to a Value Series 100 card relate to power supply current requirements and memory timing specifications.

Memory cycle access time for the Value Series 100 card is 100 ns for the 2-, 4-, and 8-Mbyte memory densities and 150 ns for the 16-MB density. For the Series 2+ card, memory cycle access time depends on V_{CC} supply voltage. For a 5 V Series 2+ card the memory cycle access time is 150 ns, while for a 3.3 V Series 2+ card the memory cycle access time is 250 ns.

Memory write (program) time for a single Value Series 100 card memory component is 8 µs typical, and 3 ms maximum. For the Series 2+ card the corresponding values depend on V_{CC} supply voltage. For a 5 V Series 2+ card the memory write (program) time for a single memory component is 6 µs typical, and 3 ms maximum. For a 3.3 V Series 2+ card the memory

write (program) time for a single memory component is 9 µs typical, and 3 ms maximum.

Examining the above timing numbers, Value Series 100 card's read and write (program) performance appears to be quite compatible with a 5 V Series 2+ card system. The faster memory read and write (program) times of the Value Series 100 card would provide added timing margin for the system. As block erase times of the two card families are identical for V_{CC} at 5 V and the cards have compatible memory read and write performance, system throughput should not be affected when migrating from a Series 2+ card to a Value Series 100 card.

In deep-sleep power-down mode a Series 2+ card requires V_{CC} supply current in the range of 25 µA–45 µA typical, with the exact value dependent upon card memory density. The maximum required V_{CC} supply current value is in the range of 75 µA–255 µA, again with the exact value dependent upon card memory density. The V_{PP} supply current requirement (for when the Series 2+ application uses 12 V programming) is 0 µA typical, 500 µA maximum. The Value Series 100 card does not offer a deep-sleep power-down mode (unless the card's RST input is activated) and does not require any V_{PP} supply current.

The Value Series 100 V_{CC} standby supply current requirements are materially higher than the deep-sleep power-down (or even standby mode) Series 2+ current requirements. When in standby mode the Value Series 100 card's V_{CC} supply current requirements are in the range of 80 µA–245 µA typical, with the exact value dependent upon card memory density. The maximum required V_{CC} supply current value is in the range of 370 µA–1,100 µA, again with the exact value dependent upon card memory density.

Besides having differences in standby or sleep current, the Series 2+ and Value Series 100 cards differ in the active current required for a read, write (program) and erase operation as shown in Table 1. The table shows that for read operations the Value Series 100 card requires less current than the Series 2+ card. For write and erase operations the relative current requirements of the two cards depend upon whether or not the V_{PP} supply generator circuit of the Series 2+ card is used in an application. If the V_{PP} supply generator is not used, then the Series 2+ card application is one which uses 12 V programming; 12 V programming results in the Series 2+ card requiring significantly less active current than the Value Series 100 card.

Although there are differences in power supply current requirements for the Series 2+ and Values Series 100 cards, unless an application is battery-powered, the differences are most likely insignificant. In a preponderance of applications it is unlikely that the differences would prevent a Value Series 100 card from being interchanged with a Series 2+ card.

3.0 SUMMARY AND CONCLUDING REMARKS

In migrating a system from Series 2+ PC Cards to Value Series 100 PC Cards, significant card differences must be considered in order to ensure that the Value Series 100 card is compatible with the system. The differences relate to card hardware as well as system software and performance. In most instances some system redesign would be required to use a Value Series 100 card in place of a Series 2+ card. The difficulties in migrating to the Value Series 100 card would be minimal if a system was designed for compatibility with a "next-generation" Intel Flash memory card. Intel application brief *AB-56 Preparing for the Next Generation Intel Flash Memory Card*, provides useful information on providing a system design path amenable to an eventual card migration.

Table 1. Design Differences between Series 2+ and Value Series 100 PC Cards

Feature	Series 2+	Value Series 100
Card Hardware		
Memory Densities	4, 8, 20 and 40 Mbytes	2, 4, 8 and 16 Mbytes
PCMCIA Bus Modes	All	Word-wide; limited byte-wide — does not include any high byte/low byte swapping
Attribute Memory Space	Separately decoded from common memory; ASIC memory or ROM available for CIS storage	Not separately decoded from common memory space
CIS Storage	In separate attribute memory space using either ASIC or ROM memory, or in common memory using card's flash memory array— exact location is user-selected at time of order	In common memory using card's flash memory array. User must protect against accidental CIS erasure (if system software uses CIS)
V_{CC} supply voltage	3.3 V or 5 V	5 V only
V_{PP} programming voltage	External 12 V or card-internal 12 V generated from V_{CC} power; internal or external V_{PP} is user-programmable	Not required—components written (programmed) from V_{CC} power
Deep-sleep power-saving mode	ASIC allows user to command card to deep sleep power-saving mode	Not available (without activating card's reset input, RST)
Card Software		
Flash memory array restrictions	None	First erase block containing CIS must not be erased (if system software uses CIS). The block should be locked to prevent against CIS erasure.
Tuples: CISTPL_DEVICE_OC, CISTPL_DEVICE_A, CISTPL_DEVICE_OA, CISTPL_CONF and various number of CISTPL_CFTABLE_ENTRY	Tuples availabe to define 3.3 V card capability and various card configurations	Tuples not required— card only has 5 V capability and single configuration
Tuple CISTPL_JEDEC_C	Tuple identifies 28F016SA memory component	Tuple identifies 28F016S5 memory component
Tuple CISTPL_VERS1	Tuple specifies Series 2+ information and 1993 copyright date	Tuple specifies Value Series 100 information and 1995 copyright date

Table 1. Design Differences between Series 2+ and Value Series 100 PC Cards (Continued)

Feature	Series 2+	Value Series 100
Memory component ID (read with Read Identifier Codes command)	All cards (28F016SA component): A0 hexadecimal	4-, 8-, and 16-MB cards (28F016S5 component): AA hexadecimal; 2- MB card (28F008S5 component): A6 hexadecimal
System Performance		
Read cycle time	Depends on V_{CC} supply voltage: 5 V card: 150 ns min. 3.3 V card: 250 ns min.	Depends on memory density: 2-, 4-, and 8-MB cards: 100 ns min. 16-MB card: 150 ns min.
Write cycle time	Depends on V_{CC} supply voltage: 5 V card: 150 ns min. 3.3 V card: 250 ns min.	Depends on memory density: 2-, 4-, and 8-MB cards: 100 ns min. 16-MB card: 150 ns min.
Write (program) time	Depends on V_{CC} supply voltage: 5 V card: 6 µs typ., 3 ms max. 3.3 V card: 9 µs typ., 3 ms max.	8 µs typ., 3 ms max.
Block erase time	Depends on V_{CC} supply voltage: 5 V card: 0.6 sec. typ., 10 sec. max. 3.3 V card: 0.8 sec. typ., 10 sec. max.	0.6 sec. typ., 10 sec. max.
Following current values assume x16 Mode Memory Bus Operation:		
V_{CC} sleep current	Depends on memory density: 4 MB: 25 µA typ., 75 µA, max. 8 MB: 25 µA typ., 95 µA, max. 20 MB: 35 µA typ., 155 µA, max. 40 MB: 45 µA typ., 255 µA, max.	Depends on memory density: 2, 4 MB: 30 µA typ., 170 µA, max. 8 MB: 30 µA typ., 170 µA, max. 16 MB: 30 µA typ., 300 µA, max.
V_{PP} sleep current (if using external 12 V V_{PP} supply)	0 mA typ., 0.5 mA max.	Not applicable
V_{CC} standby current	Depends on memory density: 4 MB: 110 µA typ., 210 µA, max. 8 MB: 115 µA typ., 230 µA, max. 20 MB: 120 µA typ., 250 µA, max. 40 MB: 150 µA typ., 300 µA, max.	Depends on memory density: 2, 4 MB: 80 µA typ., 370 µA, max. 8 MB: 135 µA typ., 600 µA, max. 16 MB: 245 µA typ., 1,100 µA, max.
V_{PP} standby current (if using external 12 V V_{PP} supply)	0 mA typ., 0.5 mA max.	Not applicable
V_{CC} read current	100 mA max.	75 mA max.
V_{PP} read current (if using external 12 V V_{PP} supply)	0 mA typ., 0.5 mA max.	Not applicable

Table 1. Design Differences between Series 2+ and Value Series 100 PC Cards (Continued)

Feature	Series 2+	Value Series 100
V_{CC} write (program) current	Depends on whether external or card-internal 12 V V_{PP} supply is used: with external V_{PP} supply: 50 mA max. with internal V_{PP} supply: 175 mA max.	150 mA max.
V_{PP} write (program) current (if using external 12 V V_{PP} supply)	20 mA typ., 30 mA max.	Not applicable
V_{CC} erase current	Depends on whether external or card-internal 12 V V_{PP} supply is used: with external V_{PP} supply: 50 mA max. with internal V_{PP} supply: 150 mA max.	100 mA max.
V_{PP} erase current (if using external 12 V V_{PP} supply)	12 mA typ., 22 mA max.	Not applicable

APPENDIX A
ADDITIONAL INFORMATION

Order Number[1,2]	Document/Tool
210830	*1998 Flash Memory Databook*
290491	*Intel Series2+ Flash Memory Cards, 4-, 8-, 20- and 40 Megabytes,* Datasheet
290546	*Intel Value Series 100 Flash Memory Cards, 2-, 4-, 8- and 16 Megabytes,* Datasheet
292136	*AB-56 Preparing for the Next Generation Intel Flash Memory Card,* Application Brief
292177	*AP-622 Upgrade to the Value Series 100 Flash Memory Card,* Application Note

NOTES:

1. Please call the Intel Literature Center at (800) 548-4725 to request Intel documentation. International customers should contact their local Intel or distribution sales office.
2. Visit Intel's World Wide Web home page at http://www.Intel.com for technical documentation and tools.