SGS-THOMSON MICROELECTRONICS

AN907 APPLICATION NOTE

COMPATIBILITY BETWEEN ST BOOT BLOCK AND INTEL SMARTVOLTAGE FLASH MEMORIES

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INTRODUCTION

Flash memory is proving to be a popular choice for the storage of information which is to be updated in-circuit at a later time after production. The larger capacity available and lower cost with the Flash technology compared to the similarly capable, but less dense, EEPROM technology has lead to Flash being used as code storage in many new applications.

One area which has given concern with Flash memory is the multiple sources for Flash memory devices, and the differing specifications giving incompatibilities preventing multiple sourcing of products.

SGS-THOMSON Boot Block Flash memories, 2 Mbit and 4 Mbit, are pin to pin replacements of the original Intel 2 Mbit and 4 Mbit Boot Block Flash memories. This application note addresses the compatibility issues between Flash memory devices from SGS-THOMSON and the same density Boot Block SmartVoltage memories from Intel.

COMPATIBLITY ISSUES

In general compatibility between two similar Flash memory devices can be determined by examining the following topics:

– Device size and organisation:
  - Memory sector addresses and size
  - Package and pin out configuration

– Programming issues:
  - Programming Command Sequences
  - Device Identification codes
  - Boot Block Write Protection
  - Memory Write Protection

The read characteristics are well standardized and seldom generate compatibility issues.

DEVICE SIZE AND ORGANISATION

The Flash memory devices covered in this Application Note are the 2 Mbit and 4 Mbit, with Boot Block protect for the M28Fxxx family and Boot Block unprotect for the M28Wxxx family (2.7V to 3.6V read voltage). The published sales types for these devices are shown in Table 1.

These devices have the same density and are organised in the identical way to the Intel SmartVoltage equivalent parts. The addresses and the size of the blocks for the different product versions are described in Figures 1 to 4.

Table 1. ST vs Intel SmartVoltage Sales Types

Size	Org.	Package	Intel SmartVoltage	ST	
				5V ± 10% Read, Protected Boot Block	2.7V to 3.6V Read, Unprotected Boot Block
2Mbit	(x8)	TSOP40	E28F002BV-T	M28F211	M28W231
			E28F002BV-B	M28F221 (1)	M28W241 (1)
	(x8, x16)	TSOP48	E28F200CV-T	M28F210 (1)	
			E28F200CV-B	M28F220	
	(x8, x16)	SO44	PA28F200BV-T	M28F210	
			PA28F200BV-B	M28F220	
			TB28F200BV-T	M28F210	
			TB28F200BV-B	M28F220	
4Mbit	(x8)	TSOP40	E28F004BV-T	M28F411	M28W431
			E28F004BV-B	M28F421 (1)	M28W441
			TE28F004BE-T	M28F411	M28W431
			TE28F004BE-B	M28F421 (1)	M28W441
	(x8, x16)	TSOP48	E28F400CV-T	M28F410	M28W430 (1)
			E28F400CV-B	M28F420	M28W440
			TE28F400CE-T	M28F410	M28W430 (1)
			TE28F400CE-B	M28F420	M28W440
	(x8, x16)	SO44	PA28F400BV-T	M28F410	
			PA28F400BV-B	M28F420	
			TB28F400BV-T	M28F410	
			TB28F400BV-B	M28F420	

Note: 1. Contact your local SGS-THOMSON Product Marketing for availability of the ST devices.

In addition to the generic ST sales type mentioned in Table 1, the speed, package and temperature range must be specified to generate a commercial product reference (e.g. M28F211-120N1). For more detailed information on the subject please refer to the specific product datasheet or to the ST memory shortform.

Figure 1. Memory Map, Byte-wide Addresses, compatible with Intel E28F002BV

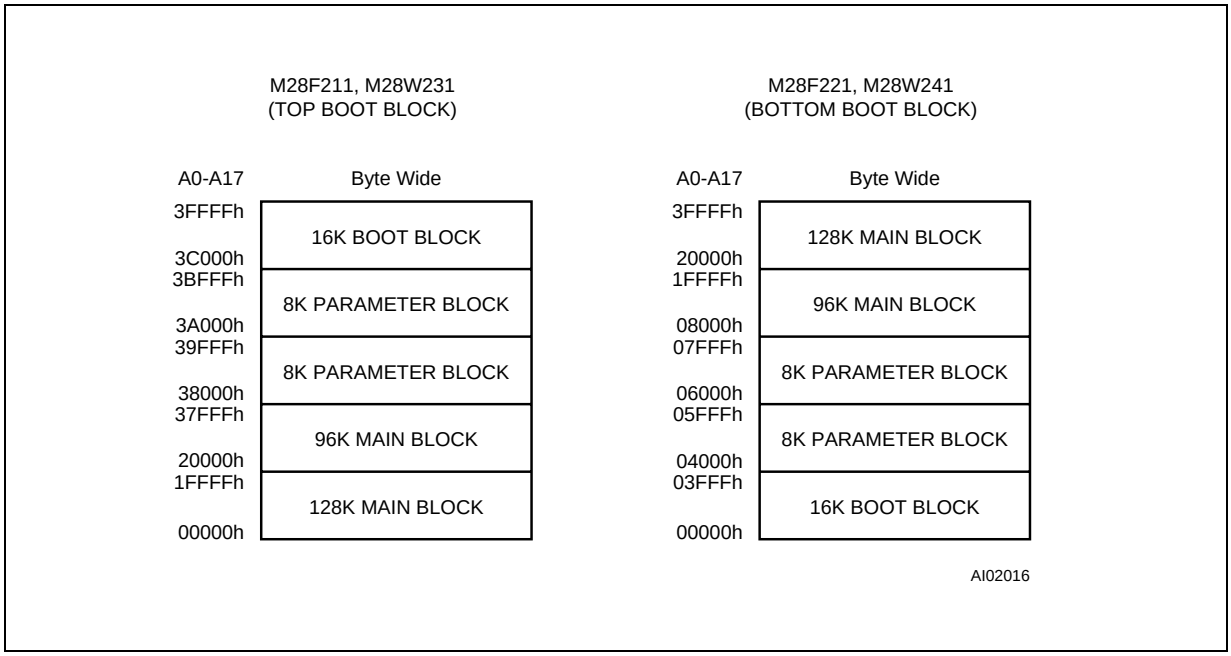


Figure 2. Memory Map, Byte-wide Addresses, compatible with Intel 28F200BV and 28F200CV

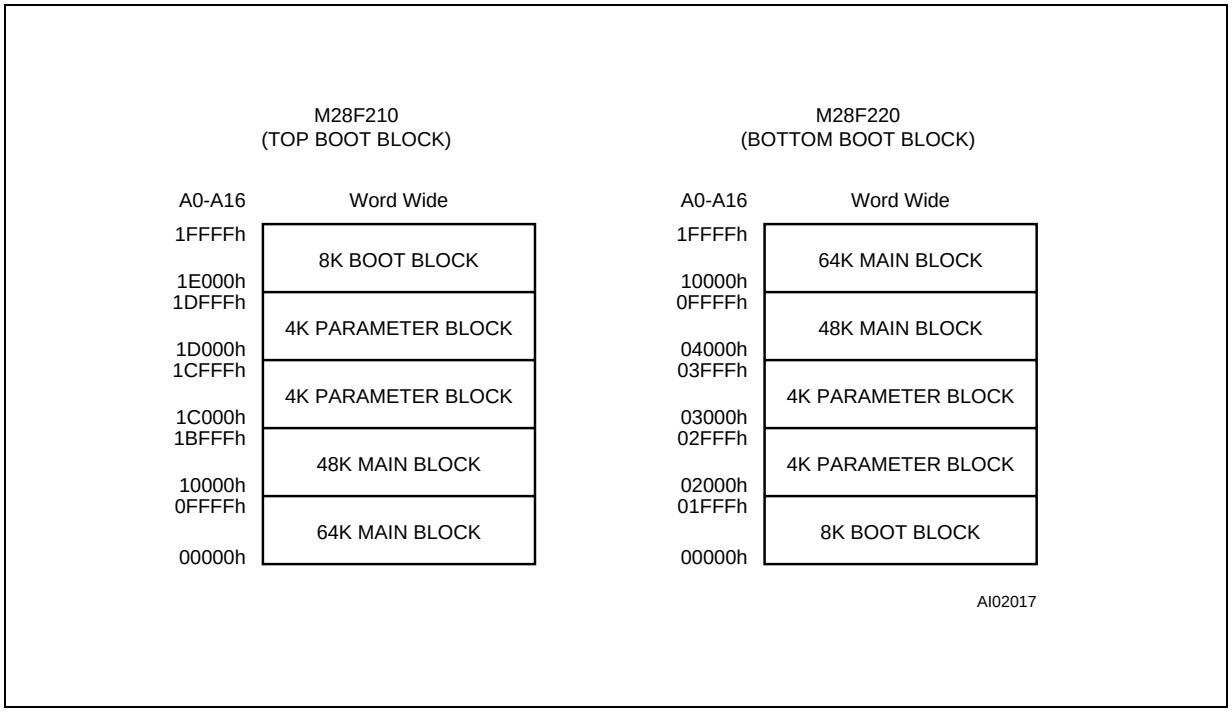


Figure 3. Memory Map, Byte-wide Addresses, compatible with Intel 28F004BV and 28F004BE

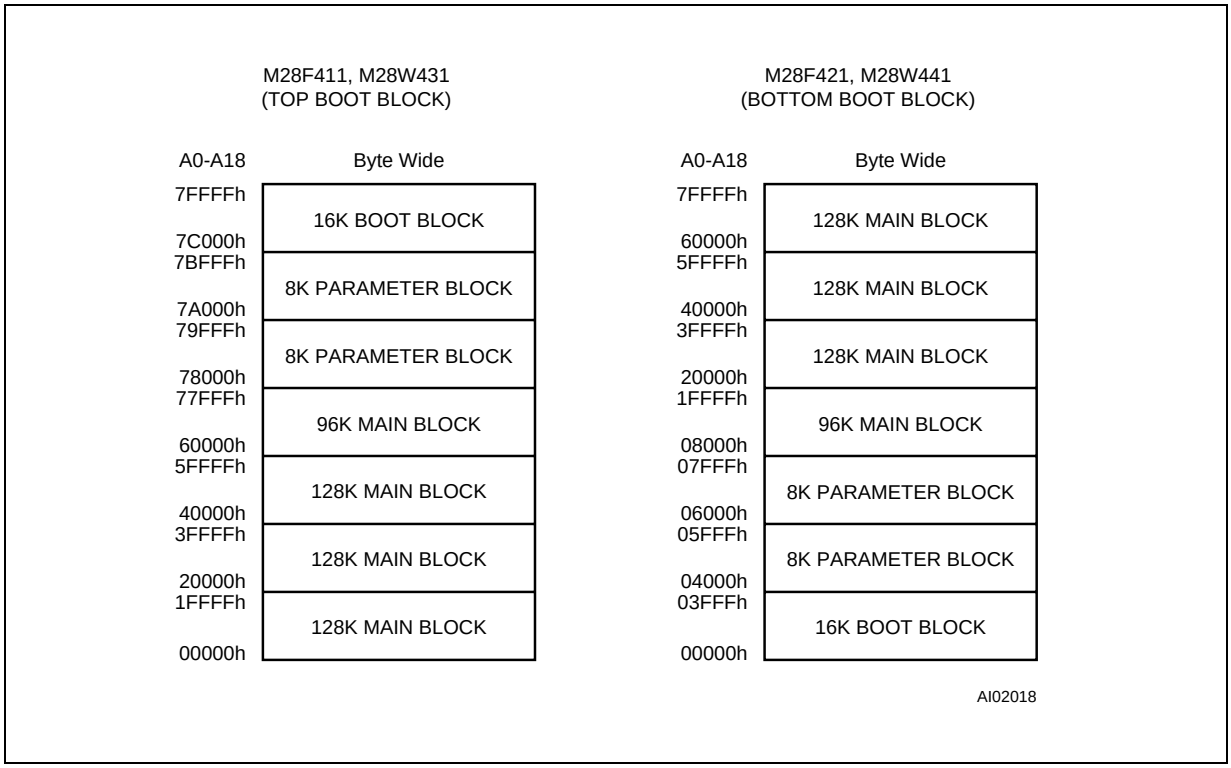
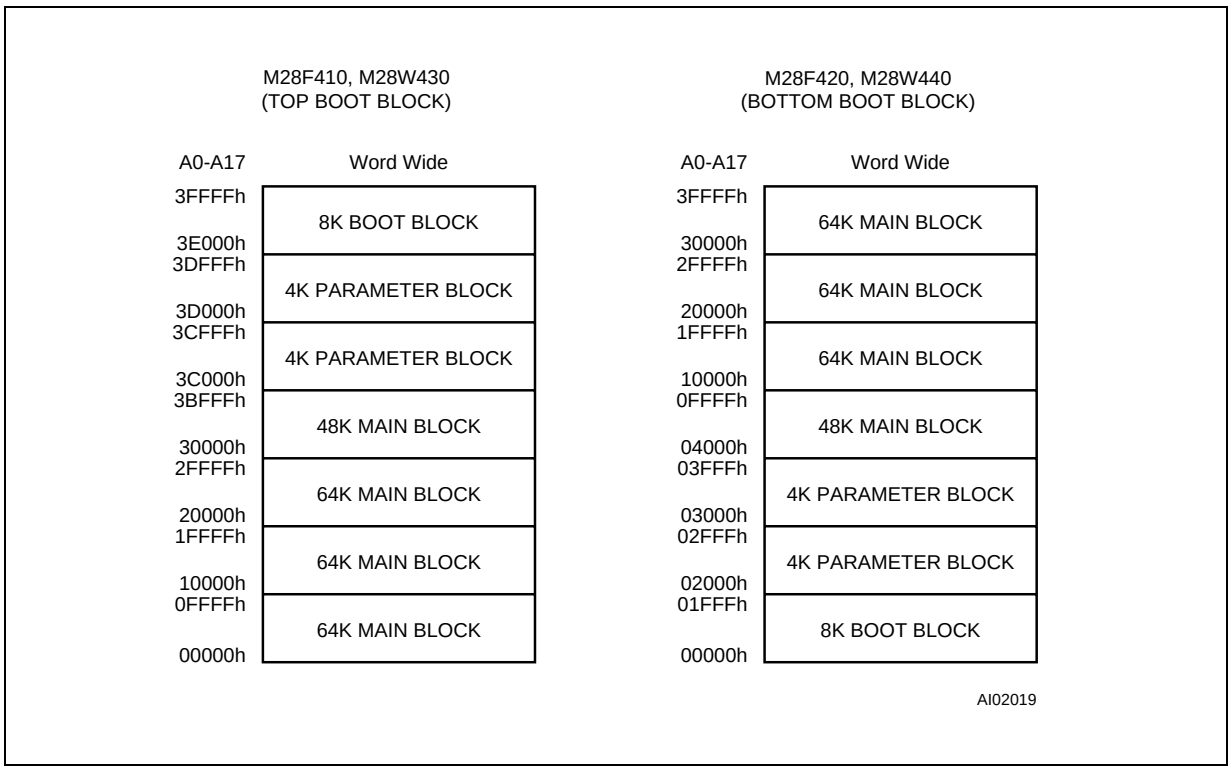


Figure 4. Memory Map, Byte-wide Addresses, compatible with Intel 28F400CV, 28F400CE and 28F400BV



PACKAGING AND PIN OUT CONFIGURATION

The 2 Mbit and 4 Mbit Boot Block are offered in three different types of packages: TSOP40, TSOP48 and SO44. As shown in Figures 5 to 10, the SGS-THOMSON and Intel SmartVoltage memories are equivalent in terms of pin-out apart from the function of one pin.

It can been seen that the pin marked as WP# for the Intel SmartVoltage types is given either as DU (Do Not Use) or NC (Not Connected) for the SGS-THOMSON part. The WP# function on the Intel SmartVoltage part is used as an optional Boot Block protection selector, this will be referred to in the next section on programming.

Despite this DU specification, this pin can accept any voltage from 0V to V_{CC}+0.5V without changing the memory functionality, thus making it easy to adapt the Boot Block products to SmartVoltage designs.

Figure 5. ST vs Intel Pin Configuration comparison 2 Megabit TSOP40

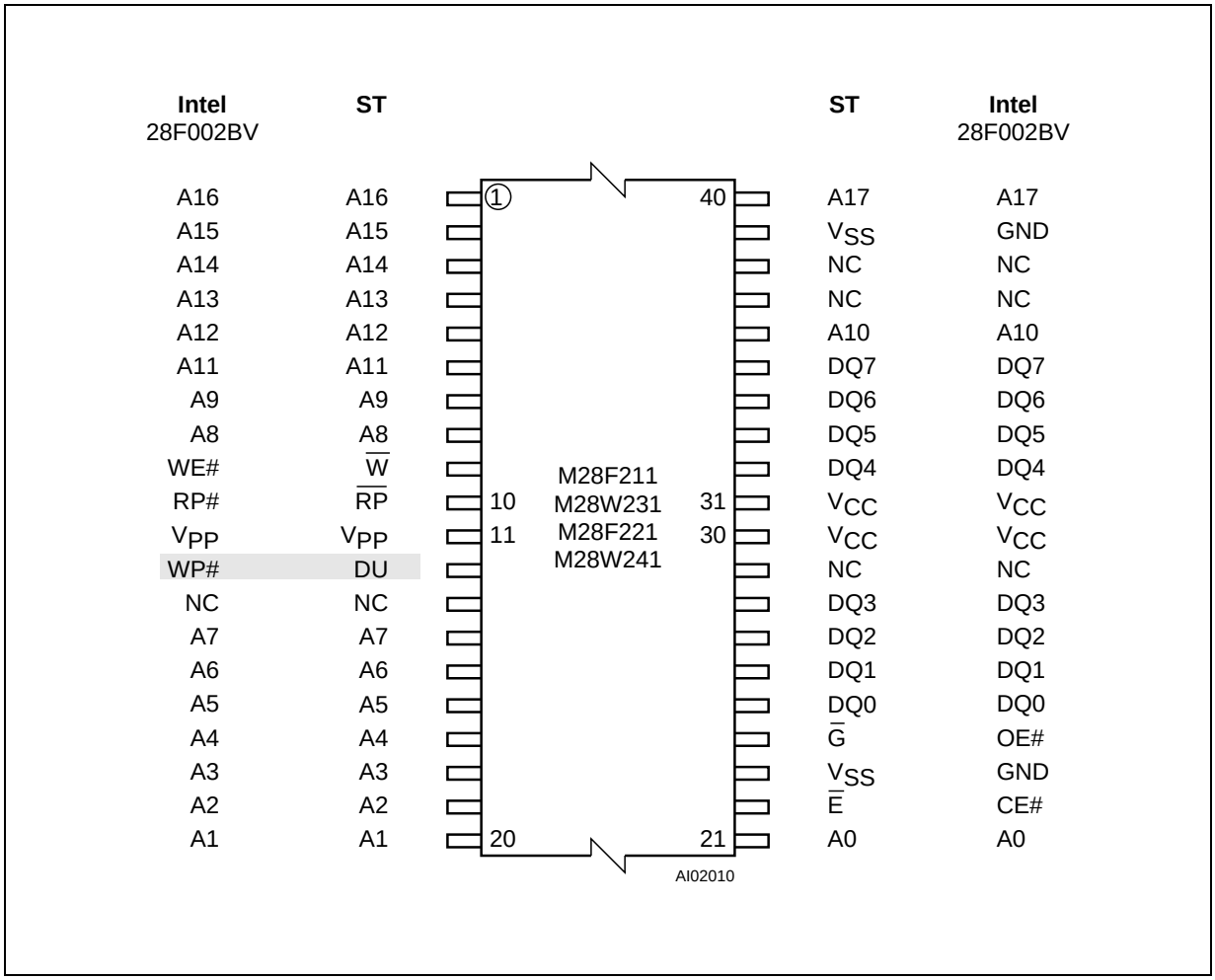


Figure 6. ST vs Intel Pin Configuration comparison 2 Megabit TSOP48

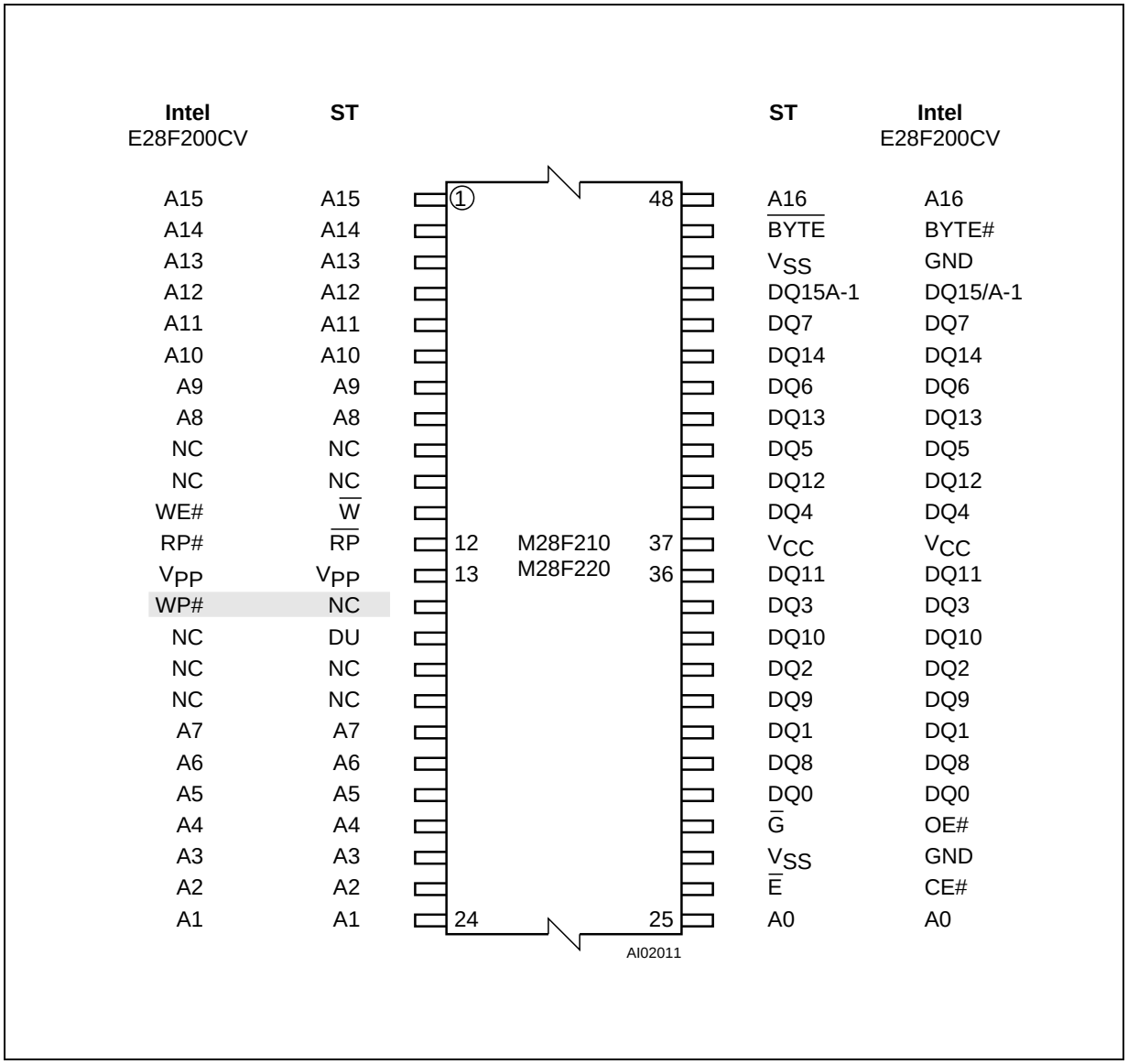


Figure 7. ST vs Intel Pin Configuration comparison 2 Megabit SO44

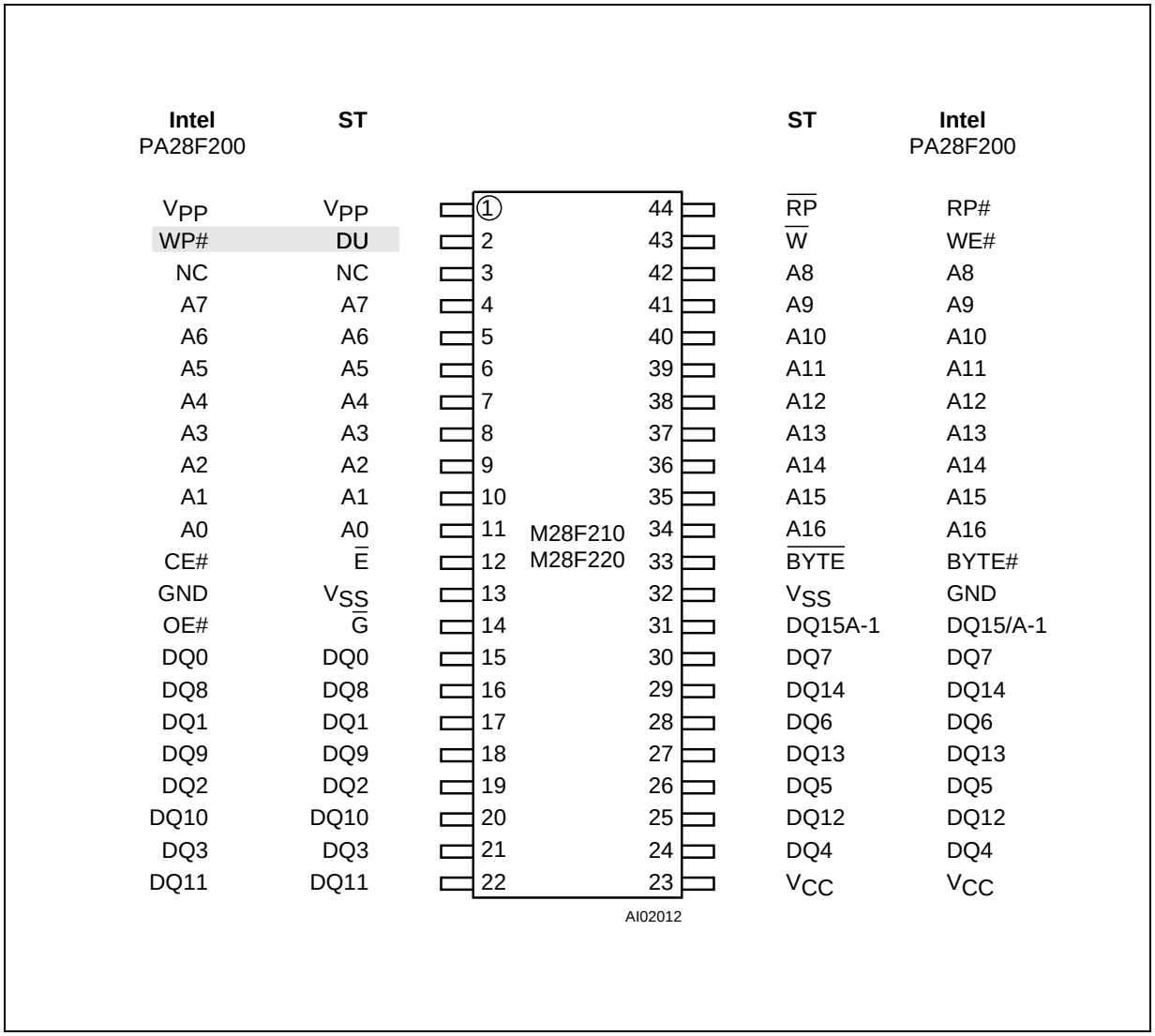


Figure 8. ST vs Intel Pin Configuration comparison 4 Megabit TSOP40

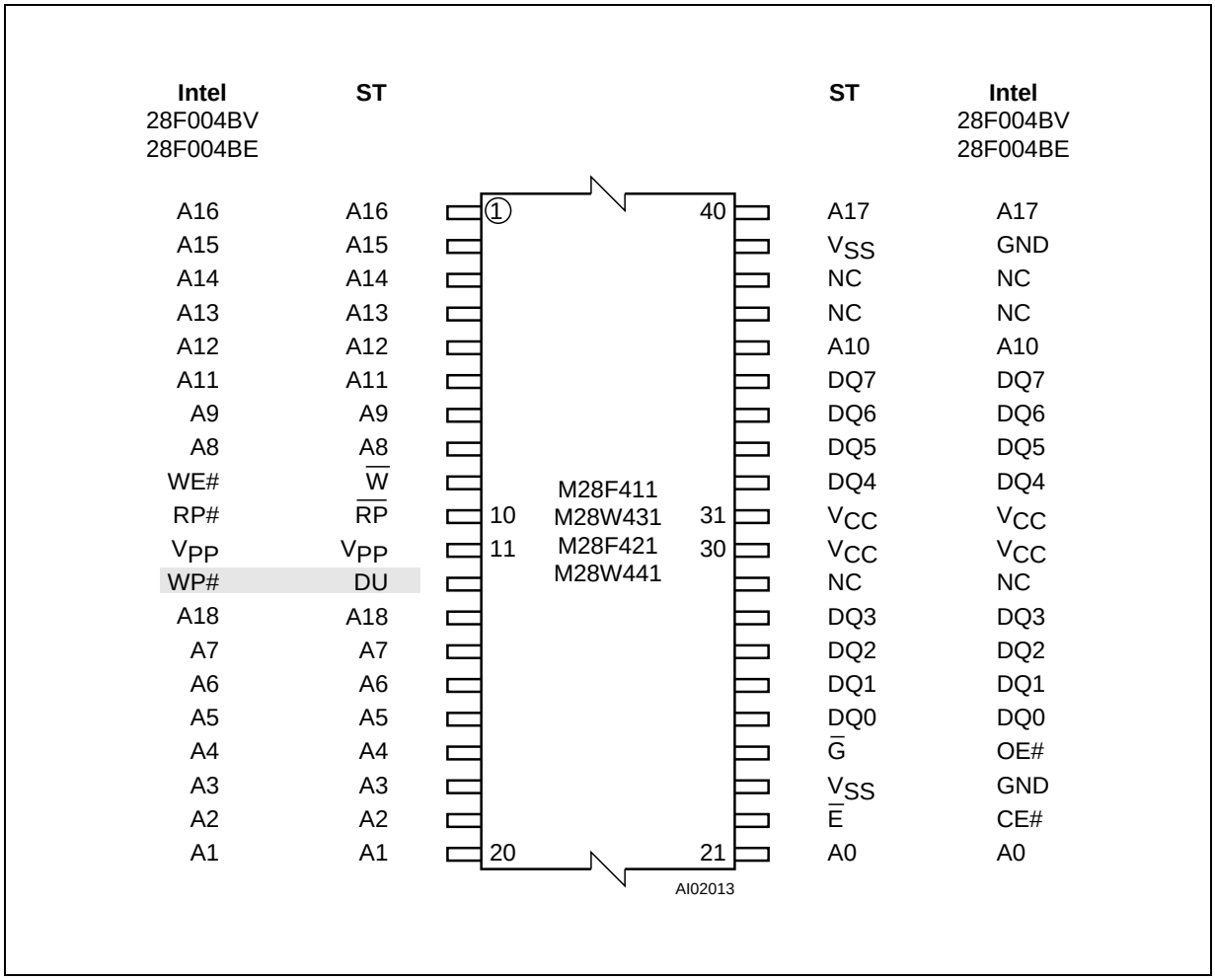


Figure 9. ST vs Intel Pin Configuration comparison 4 Megabit TSOP48

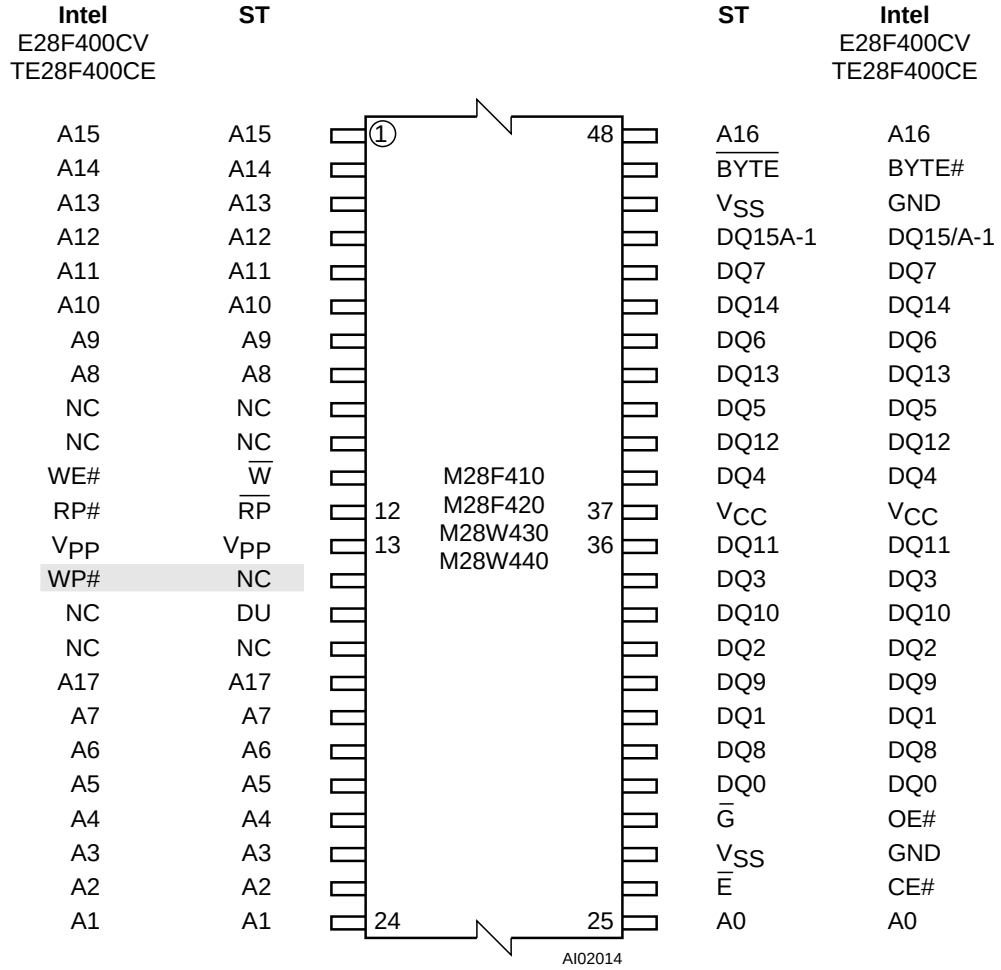
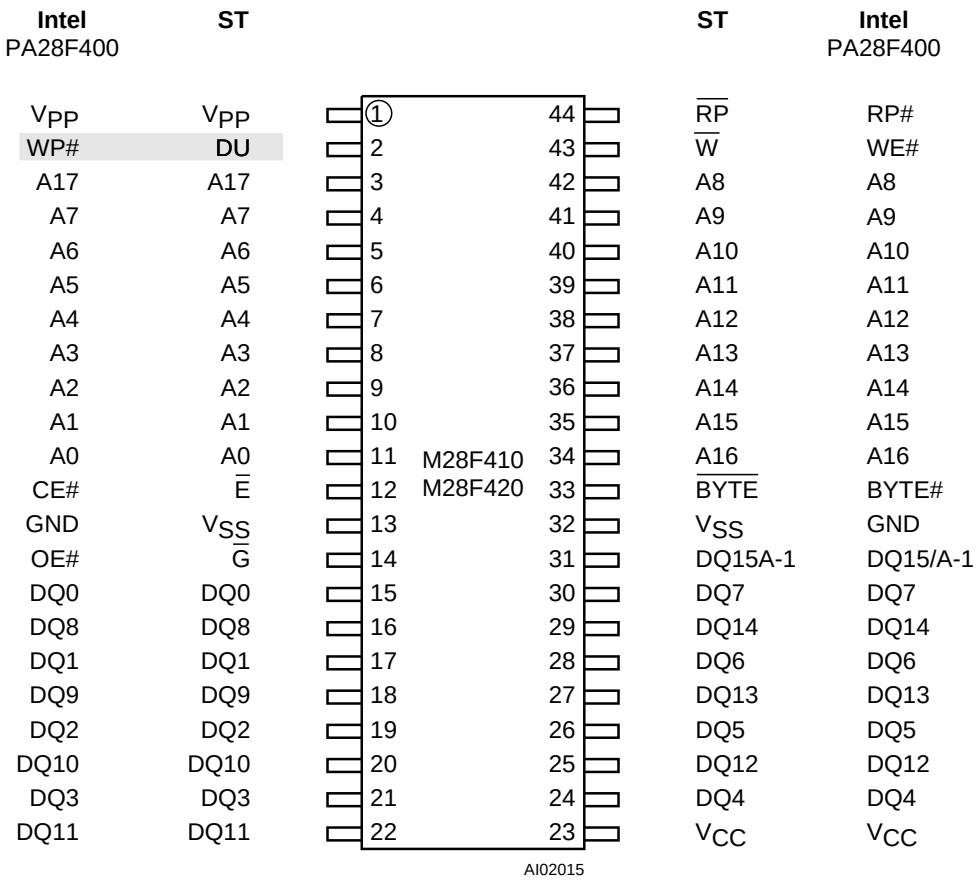


Figure 10. ST vs Intel Pin Configuration comparison 4 Megabit SO44



PROGRAMMING ISSUES

Programming Command Sequences

The ST Boot Block 2 Mbit and 4 Mbit Flash memories and the Intel SmartVoltage Flash memories use exactly the same command code sequences to control the programming and erasure of the flash blocks. This means that the algorithm used to program or erase the device are the same.

Due to the necessity for programming equipment to correctly identify the memory type and manufacturer, the devices return the appropriate Device Identification codes as shown in Table 2. When programming in-circuit, these codes should be selected according to the device used.

Both devices use the V_{PP} pin to enable the programming operations. The ST device requires a standard 12V ± 5% or ± 10% programming voltage applied to the V_{PP} pin. However the Intel SmartVoltage part allows programming at a voltage of 12V ± 5% or 5V ± 10% for systems where 12V for programming is not available. Thus for commonality in using the alternative sources, it is recommended to use the 12V programming voltage (for example by using the ST662A DC/DC 5V/12V converter when the 12V is not available on the board).

Table 2. Device Identification Codes

Size, Org & V_{CC}/V_{PP}	ST (1)		Intel SmartVoltage (2)	
	Device	Code	Device	Code
2Mbit (x8) 5V/12V	M28F211	E4h	28F002BV-T	7Ch
	M28F221	E8h	28F002BV-B	7Dh
2Mbit (x8) 3V/12V	M28W231	E5h	28F002BV-T	7Ch
	M28W241	E9h	28F002BV-B	7Dh
2Mbit (x8, x16) 5V/12V	M28F210	E0h	28F200CV-T/28F200BV-T	2274h
	M28F220	E6h	28F200CV-B/28F200BV-B	2275h
4Mbit (x8) 5V/12V	M28F411	F6h	28F004BV-T	78h
	M28F421	FEh	28F004BV-B	79h
4Mbit (x8) 3V/12V	M28W431	F7h	28F004BV-T	78h
	M28W441	FFh	28F004BV-B	79h
4Mbit (x8, x16) 5V/12V	M28F410	F2h	28F400CV-T/28F400CE-T/28F400BV-T	4470h
	M28F420	FAh	28F400CV-B/28F400CE-B/28F400BV-B	4471h
4Mbit (x8, x16) 3V/12V	M28W430	F3h	28F400CV-T/28F400CE-T/28F400BV-T	4470h
	M28W440	FBh	28F400CV-B/28F400CE-B/28F400BV-B	4471h

Notes: 1. Manufacturer Code = 20h
2. Manufacturer Code = 89h

BOOT BLOCK WRITE PROTECTION

The protection of the Boot Block against erroneous write sequences is an important consideration for applications such as automotive applications and computer BIOS (for example this gives a "permanent" base from which to execute and update Plug and Play code).

The only major difference between the two manufacturer's devices is the use of an additional option for programming the Boot Block with the Intel SmartVoltage devices and the associated changes to certain voltage levels.

For the ST 5V/12V (i.e. M28Fxxx) products (and the equivalent Intel non-SmartVoltage technology devices) unlocking the Boot Block area is made by setting the $\overline{RP}$ pin = V_{HH} (V_{HH} is specified at 11.4V min and 12.6V max) with V_{PP} greater than or equal to V_{PPH} (V_{PPH} is specified at 11.4V min and 12.6V max).

Setting $\overline{RP}$ = V_{IH} (V_{IH} is specified at 2.0V min and V_{CC} +0.5V max) will lock the Boot Block, preventing any further modification, unless the area is unlocked again. This is summarized in Table 3.

For the ST 3V/12V products (i.e. M28Wxxx) the unlocking of the Boot Block area is not needed as these products are delivered with the Boot Block unprotected. The Boot Block as well as the other memory Blocks are protected when V_{PP} = V_{PPL} (V_{PPL} is specified at 6.5V max). They are unprotected when V_{PP} = V_{PPH}.

The Intel's SmartVoltage devices provide an additional method to unlock the Boot Block using a TTL level signal on WP#. When WP# = V_{IL} the Boot Block is locked and any program or erase operation will result in an error indication in the status register. All other blocks remain unlocked in this condition and can be programmed or erased normally. When WP# = V_{IH}, the Boot Block is unlocked and can be programmed or erased. This feature is overidden and the Boot Block unlocked when $\overline{RP}$ = V_{HH}.

For compatibility issues, it is recommended that the WP# input is held at $\leq V_{IL}$, allowing programming at V_{PP} = 12V and using $\overline{RP}$ in the normal way.

Nevertheless, the 2 Mbit and 4 Mbit Boot Block Flash memory devices from SGS-THOMSON can withstand any voltage from 0V to V_{CC} +0.5V on the DU pin (positioned at the location of the Intel SmartVoltage WP# pin for the TSOP40 and SO44 packages) without any change in functionality.

MEMORY WRITE PROTECTION

Protection from erroneous writes to the main memory block is achieved by taking V_{PP} to V_{PPL}. When this condition is met, any attempt to modify data in the flash memory (for example, using write or erase commands) will return an error indication in the status register.

The primary difference between the ST Flash memory and the SmartVoltage is a result of the requirement for the SmartVoltage devices to program and erase at 5V. The requirement for programming and erasing at 12V was for V_{PP} to be at V_{PPL} for write protection. However in order for the SmartVoltage to operate at the lower voltage range, the V_{PP} protection level has been reduced V_{PPLK} = 1.5V max.

In addition, bit 3 of the Status Register which indicates V_{PP} status indicates a low V_{PP} condition if the V_{PP} voltage drops below V_{PPH}, specified at 4.5V min or 11.6V min for SmartVoltage. For SGS-THOMSON 12V Programming devices, and Intel non-SmartVoltage devices, the V_{PP} status bit will indicate a low V_{PP} condition for the voltage of V_{PP} below V_{PPH}, specified at 11.4V min.

Applications designed to use both manufacturers' devices should accomodate switching of V_{PP} to 12V for programming and erasing and to 0V for total memory protection.

Table 3. Memory Protection

Programming Voltage	$\overline{RP}$	Block Protection
V_{PPL}	V_{IH}	All Blocks Locked
X	V_{IL}	All Blocks Locked (Reset condition)
V_{PPH}	V_{HH}	All Blocks Unlocked
V_{PPH}	V_{IH}	Boot Block Locked

Note: X = V_{PPH} or V_{PPL}.

CONCLUSION

The ST Boot Block products are pin to pin replacements of the Intel Boot Block products. With some design precautions described in this Application Note, they are also pin to pin replacements of the equivalent Intel Smartvoltage products. The essential requirement to ensure this compatibility is to mantain the availability of 12V on the V_{PP} pin for programming and erasing.

Warning

In all cases it is recommended to make a direct comparison of the AC and DC characteristics as shown in the corresponding datasheets in order to be sure that either memory is compatible with your design.