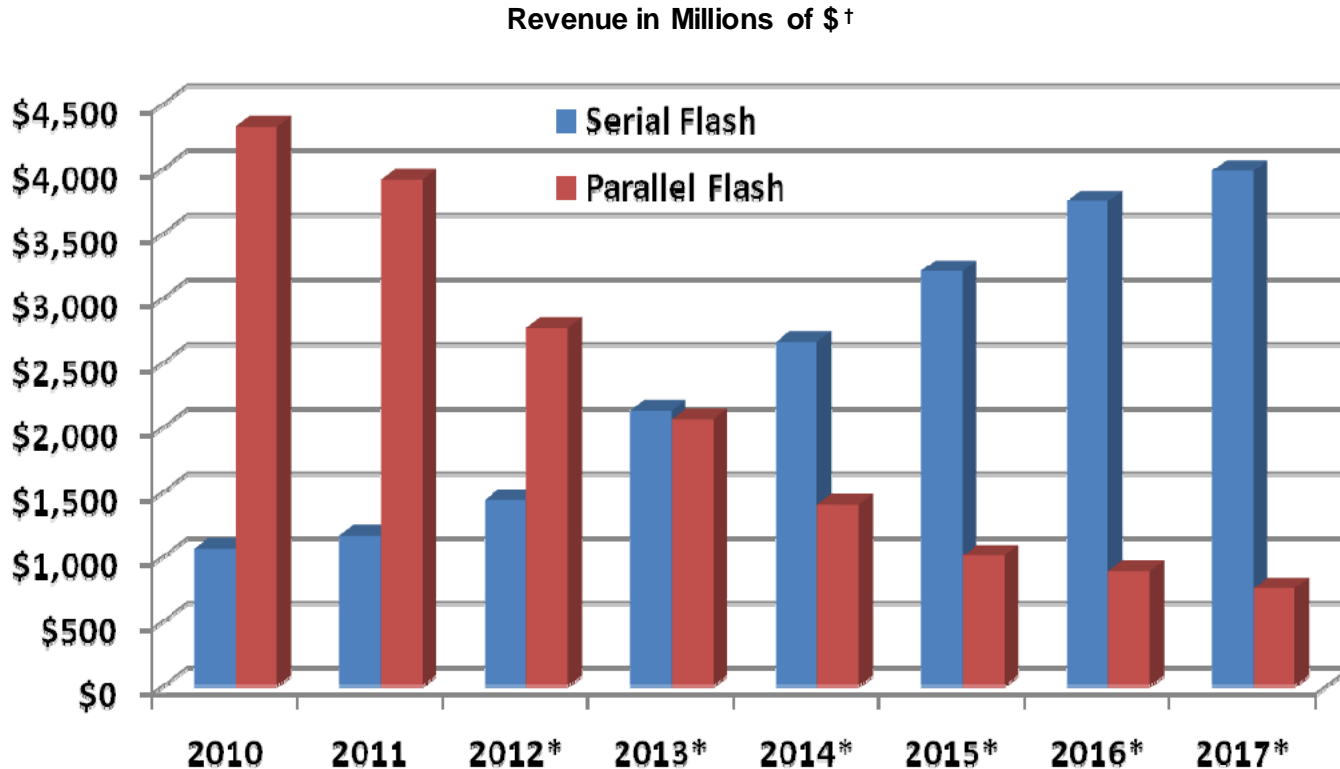




Serial NOR Flash Applications Drive Growth

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Senior Strategic Marketing Director
Winbond Electronics

NOR Flash Market by Revenue



- ## NOR Flash market is migrating from Parallel to Serial

- Serial revenue will grow from \$1B in 2010 to ~\$4B in 2017, while Parallel declines
- Revenue crossover in 2013, Units crossover in 2009 (2011 6B units ~2/3 Serial)
- Serial Flash replacing Parallel due to cost, space & pin-count advantages

Why SPI?



	Parallel NOR Flash	Serial NOR Flash	SPI Advantage
Interface Pins	28 to 44	4 to 6	Lower system cost
Packaging	48-56 pin TSOP 48-64 ball BGA	8-pin SOP, WSON, USON, WLBGA	Smaller, Lower cost
Performance	8/16/32-bit bus, Best Random Access	Quad SPI Speed Comparable to PF for Fast Boot & XIP	Comparable performance with fewer pins
Architecture	128KB Sector erase	4KB Sector erase	PC Requirement, Efficient memory usage
Density	4Mb to 2Gb	512Kb to 2Gb	Serial Flash has caught up
Technology	110nm, 90nm 75nm, 65nm, 45nm	110nm, 90nm, 75nm, 65nm, 58nm	Advanced technologies for Serial Flash = Smaller Packages

Flash Memory Applications

PC-Related

Desktop, Notebook, Server
Optical Disk Drives
Hard Disk Drives
LCD Monitors
Printers



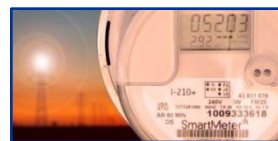
Communications

DSL and Cable Modems
Router & Switches
Wireless LAN, M2M
Bluetooth, GPS, Mobile
Phones



Consumer

LCD & Digital TV, Tablets
DVD Player & Recorders
Set Top Box, Cordless Phone
Electronic Toys/Games
Digital Cameras, Appliances

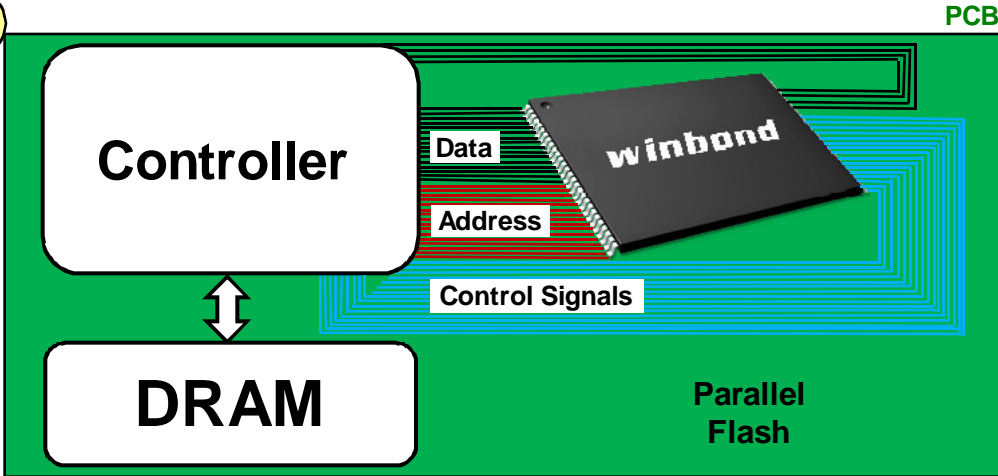


Automotive/Industrial

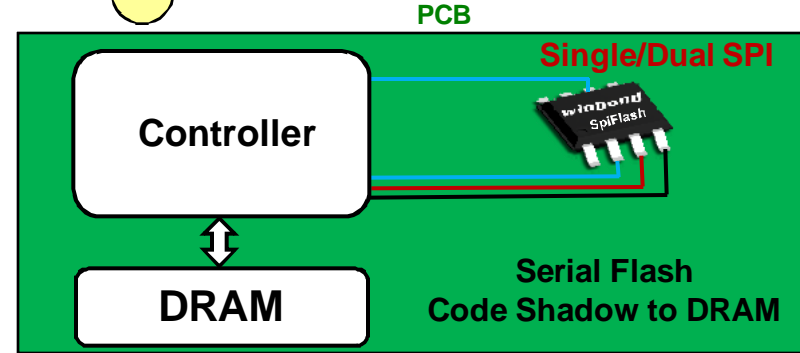
Infotainment, Driver Assist
Instrument Cluster, Camera,
Telematics, Digital Radio,
Smart Meters, Smart Grid

Application Trends for Serial Flash

1

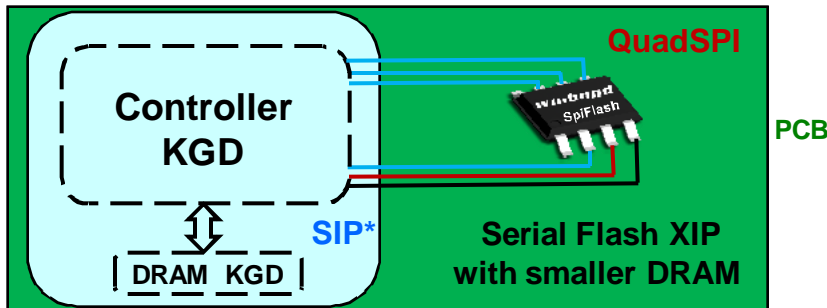


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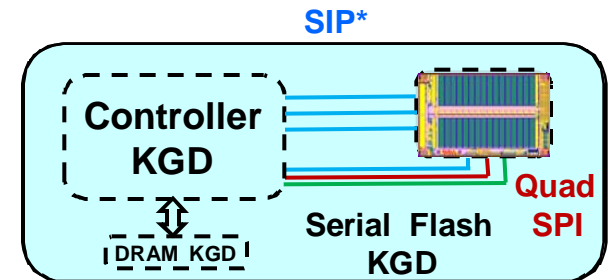


PCB = Printed Circuit Board

3



4



* SIP = System In Package

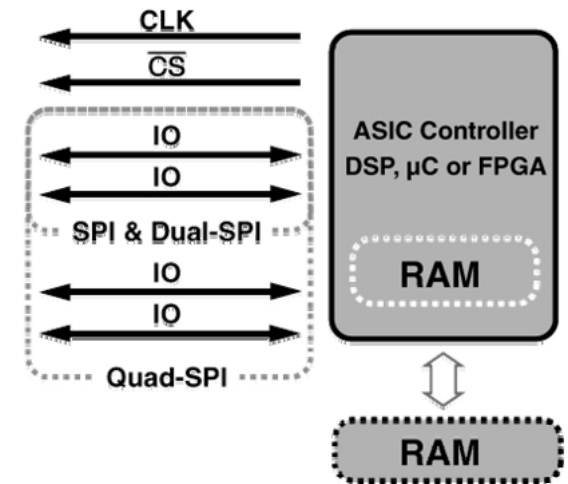
Optical Disk Drive (ODD) Serial Flash Evolution Example:

- Early designs used Controller + Parallel Flash + DRAM on a PCB
- To reduce cost and space, designs moved to Serial and eventually to System In Package (SIP) 2-Chip or 3-Chip solutions with Known Good Die (KGD)
- This trend is very similar for other applications like Mobile Phones

Quad SPI & QPI Performance

SPI Protocol		Number of Clocks			Command Overhead
Type	Fast Read Instruction	Instr.	Add.	Dummy	# Clocks
SPI	Single I/O	8	24	8	40
Dual SPI	Dual Output	8	24	8	40
	Dual I/O	8	16		24
Quad SPI	Quad Output	8	24	8	40
	Quad I/O	8	8	4	20
	Quad I/O Continuous Read	8	4		12
QPI	QPI Read	2	6	2	10-16*

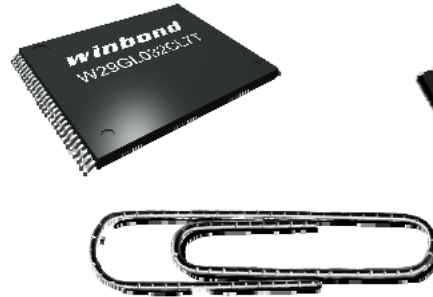
* QPI allows programmable dummy clocks to adjust to performance required



- Number of clock cycles reducing, and performance increasing
 - QuadSPI and QPI (Quad Peripheral Interface) offer XIP (eXecute In Place) = Direct code execution – No need for DRAM or buffer memory

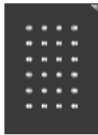
Space Efficient Packaging

Parallel Flash



Serial Flash

BGA24
8x6mm
(TC)=4x6



BGA24
8x6mm
(TB)=5x5



WSON8
8x6mm*
(ZE)



WSON8
6x5mm*
(ZP)



USON8
2x3mm*
(UX)



WLPGA8
1.4x2.4mm*
8Mb (BY)



WLPGA8
1.8x2.7mm*
16Mb (BY)



TSSOP8
173mil
(SD)



SOP8
150mil
(SN)



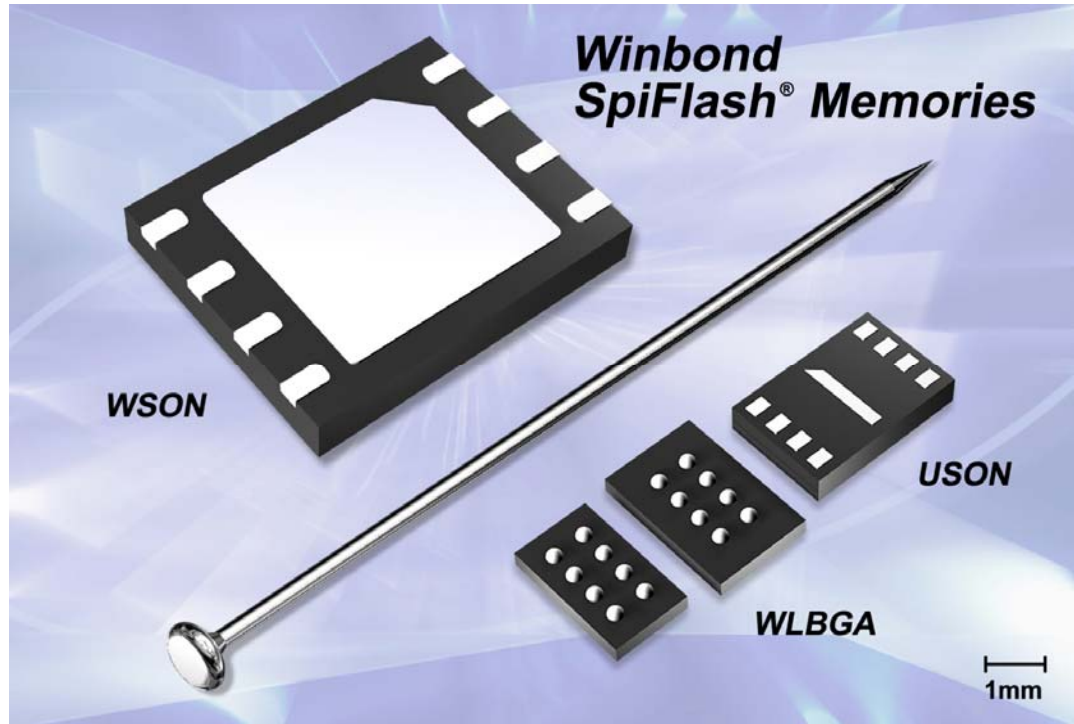
SOP8
208mil
(SS)



SOP16
300mil
(SF)

* <1mm thickness

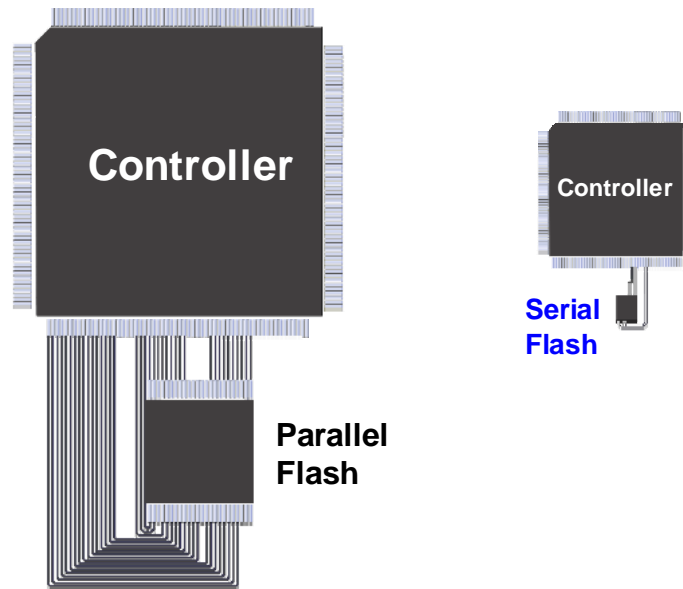
Ultra-Small Form Factor Packages



- New USON & WLBGA (CSP) packages
 - <20% the size of popular Serial Flash packages like 8-pin SOIC and WSON
- Ideal for space constrained applications including
 - Mobile Phones, Tablets, GPS, M2M, WLAN, HDD, Bluetooth, MP3 & more

Summary

- Serial Flash has become a popular alternative to Parallel Flash as well as the solution of choice for emerging applications due to:
 - Pin-count
 - Space Efficiency
 - System cost
 - Chip cost
 - Performance



Thank You